European Commission

STUDY TO SUPPORT THE IMPACT ASSESSMENT FOR THE REVIEW OF DIRECTIVE 2000/53/EC ON END-OF-LIFE VEHICLES

Final report

CONTRACT NO. 07.0201/2020/839200/SFRA/ENV.B.3
with updates under
CONTRACT NO. 09.0202/2023/890692/SFRA/ENV.B.3

Written by Oeko-Institut e.V.: Yifaat Baron, Izabela Kosińska-Terrade, Clara Loew, Andreas Köhler, Katja Moch, Jürgen Sutter, Kathrin Graulich, Frederick Adjei
Mehlhart Consulting: Georg Mehlhart
June 2023

EUROPEAN COMMISSION

Directorate-General for Environment
Directorate B - Circular Economy
Unit B3
European Commission
B-1049 Brussels

STUDY TO SUPPORT THE IMPACT ASSESSMENT FOR THE REVIEW OF DIRECTIVE 2000/53/EC ON END-OF-LIFE VEHICLES

Final report

CONTRACT NO. 07.0201/2020/839200/SFRA/ENV.B.3
with updates under
contract no. 09.0202/2023/890692/SFRA/ENV.B.3

Manuscript completed in June 2023

LEGAL NOTICE

This document has been prepared for the European Commission however it reflects the views only of the authors, and the European Commission is not liable for any consequence stemming from the reuse of this publication. More information on the European Union is available on the Internet (http://www.europa.eu).

PDF	ISBN 978-92-68-00707-5	doi:10.2779/855228	KH-07-23-129-EN-N

Luxembourg: Publications Office of the European Union, 2023

© European Union, 2023

The reuse policy of European Commission documents is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under a Creative Commons Attribution 4.0 International (CC-BY 4.0) licence (https://creativecommons.org/licenses/by/4.0/). This means that reuse is allowed provided appropriate credit is given and any changes are indicated.

For any use or reproduction of elements that are not owned by the European Union, permission may need to be sought directly from the respective rightholders.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEFINITIONS OF TERMS USED

Abbreviation	Full term/ definition
3R Directive	Directive 2005/64/EC on the type approval of motor vehicles with regard to their reusability, recyclability and recoverability
Art	Article of a Directive/Regulation
ACEA	European Automobile Manufacturers' Association
ACEM	European Association of Motorcycle Manufacturers
ASR	Automotive Shredder Residue
ATF	Authorised treatment facility
ATV	All-terrain vehicle
BEV	Battery Electric Vehicle
CE	Circular Economy
CEAP	Circular Economy Action Plan
CoD	Certificate of destruction
CRM	Critical Raw Materials
CSDD	Corporate Sustainability Due Diligence Directive
CSS	Chemicals Strategy for Sustainability
DG ENV	Directorate-General for Environment
DPP	Digital product passport
EC	European Commission
EEC	Electric and electronic components
EEE	Electric and electronic equipment
ELT	End-of-life tyres
ELV	End of life vehicle

Abbreviation	Full term/ definition
ELVD	End of life vehicle Directive; Directive 2000/53/EC as last amended by Directive (EU) 2018/849 of 30 May 2018
EoL	End of life or End-of-life
EPR	Extended Producer Responsibility
ESPR	Ecodesign for Sustainable Products Regulation
EV	Electric Vehicle
GADSL	Global Automotive Declarable Substance List
GLARE	Glass laminate aluminium reinforced epoxy (fibre metal laminate)
GVW	Gross Vehicle Weight
GWP	Global Warming Potential
HDV	Heavy Duty Vehicle
IA	Impact assessment: the study that this Inception report describes
IMDS	International Material Data System
JRC	Joint Research Centre
kg	Kilograms [unity of weight]
L	L-type approved vehicles: Motor vehicles with less than four wheels [but does include light four-wheelers]
LCA	Life cycle assessment
LDV	Light Duty Vehicle
M	M-type approved vehicles: Vehicles having at least four wheels and used for the carriage of passengers
MCA	Metal Content Assumption as defined by Commission Decision 2005/293/EC
Misc.	Miscellaneous
MS	Member State of the European Union
N	N-type approved vehicles: Power-driven vehicles having at least four wheels and used for the carriage of goods
NACE	Statistical Classification of Economic Activities in the European Community
NRMM	Non-road mobile machinery
O	O-type approved vehicles: Trailers (including semitrailers)
OEM	Original Equipment Manufacturer. In principle tier 1 and tier 2 suppliers of the automotive sector can be also OEMs. However, in this study OEM refers to the vehicle producers.

Abbreviation	Full term/ definition
OPC	Open Public Consultation
PAH	Polycyclic aromatic hydrocarbons
PGM	Platinum group metals
PO	Policy option
POM	Put on the market
POP-Regulation	Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants
PRO	Producer responsibility organisation
PST	Post Shredder Technology
PTW	Powered two- and three-wheelers
PVC	Polyvinyl chloride
REACH	Regulation 1906/2007/EC concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency (ECHA)
REE	Rare earth elements
RoHS	Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment
SCIP	Database on Substances of Concern In articles as such or in complex objects (Products)
SHF	Shredder heavy fraction
SLF	Shredder light fraction
SME	Small and medium enterprises
SRM	Secondary raw materials
t	Tons [unity of weight]
TOR	Terms of reference (07.0201/2020/839200/SFRA/ENV.B.3) for this project under Framework contract ENV.F.1/FRA/2019/0001
UEA	United Arab Emirates
UK	United Kingdom
VIN	Vehicle identification number is a unique code, including a serial number, used by the automotive industry
WEEE	Waste electric and electronic equipment
WFD	Waste Framework Directive: Directive 2008/98/EC of the European Parliament and the Council of 19 November 2008 on waste and repealing certain Directives, as last amended by Directive (EU) 2018/851 of 30 May 2018

Disclaimer
"The information and views set out in this report are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein."

Executive Summary

Abstract

The "Study to Support the Impact Assessment for the Review of Directive 2000/53/EC[1] on End-of-Life Vehicles" is to assist the European Commission in developing the impact assessment for the revision of the End-of-Life Vehicles Directive (ELVD), also looking at Directive 2005/64/EC (3RD)[2] (amendment of contract). It aims to address shortcomings in the ELVD identified in the EC evaluation report[3], providing where possible quantitative information on potential impacts of various policy options compared to the "business as usual" scenario. This allows exploring options for the revision of the ELVD and the 3RD through assessing their impacts. The study develops and assesses impacts of the identified policy options based on environmental, economic, and social impacts, in line the BRG[4].

Executive Summary

Introduction and context

The Directive 2000/53/EC on end-of-life vehicles (ELVD) was adopted in 2000 with the aim of preventing waste from vehicles, promoting the reuse, recycling, and other forms of recovery of end-of-life vehicles (ELVs) and their components, and improving the environmental performance of all economic operators involved in the life cycle of vehicles. It sets out measures on waste prevention, the collection and environmentally sound treatment of ELVs, sets targets for the reuse and recycling (85%) as well as reuse and recovery (95%) of materials and components from ELVs, and includes requirements for providing information on components and materials used in vehicles.
An evaluation of the ELVD was published by the EC on 15 March 2021. It identified various shortcomings in the Directive and in its coherence with the corresponding 3R type-approval Directive. The ELVD Directive also needs to be reviewed in the light of the orientations set out by the European Green Deal and the Circular Economy Action Plan, which define an ambitious agenda to transform the European economy, based on a modern, competitive, low carbon and circular industry, and the recently adopted EU legislation on waste management.
The general objective of this final report of the "Study to Support the Impact Assessment for the Review of Directive 2000/53/ES on End-of-Life Vehicles" is to support the preparation of the impact assessment for a new regulatory framework for the ELVD conducted by the European Commission, as well as its coherence with the corresponding 3R type-approval Directive.

[1] Directive 2000/53/ES of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles. See: EUR-Lex - 32000L0053 - EN - EUR-Lex (europa.eu)

[2] Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC, see https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32005L0064

[3] COMMISSION STAFF WORKING DOCUMENT
EVALUATION of Directive (EC) 2000/53 of 18 September 2000 on end-of-life vehicles {SWD(2021) 61 final}

[2] BR-GL-Chapter 3-Impact assessment (europa.eu)

Impact assessment framework, methodology, and stakeholder consultation

The approach to structure this study follows the EC Better Regulation Guidelines[5] and the Better Regulation Toolbox[6], which define a set of key questions that an impact assessment (IA) must answer. The study includes the development of policy options (PO) that are to be analysed and compared. The IA is focused on measures that should help to solve various problems and to achieve the four main objectives 'comprehensive coverage of the sustainable production and dismantling of all relevant vehicles by the Directives', 'improving the design and production of vehicles to support reuse and recycling', 'addressing the problem of the ELVs of unknown whereabouts', and 'analysis of Extended Producer Responsibility (EPR)'. In this regard, the study was structured as follows:

1. Problem definition per Objective: identification of the current situation and the main problems/shortcomings affecting the ELVD, and who is affected by this. This includes their scale, causes, and consequences, as well as the likelihood that they persist in the absence of EU policy intervention. Furthermore, the problem drivers were identified.

2. Identification of policy options for reviewing the ELVD per Objective: the main general measures that should be pursued to address the problems were identified for improving the effectiveness, efficiency, relevance, and consistency of the ELVD. Policy options cover the whole Directive and were presented against the objectives for the review of the Directive.

3. Analysing the impacts of the different policy actions and providing a comparison of the different options: For each measure, different actions were developed that consider the opinion of the European Commission and consulted stakeholders. Their likely social, environmental, and economic impacts were assessed. Finally, monitoring possibilities were outlined. A wide range of possible actions were identified to improve the current legal framework. Based on the detailed assessments and proposed choices for actions (sub-measures) per measure, this final report compares different sub-measures and concludes in a preferred sub-measure for each measure.

A stakeholder consultation process was performed to ensure that stakeholders' views were sought on all key impact assessment questions and to provide relevant information and data for assessing the measures of this study. In the consultation, industry associations (producers, manufacturers, traders, and recyclers), environmental protection organisations, general public, consumers, MS public administration, and other stakeholders (e.g., academia) were consulted. In particular, targeted interviews were carried out. Furthermore, a series of sectoral consultation meetings and a MS Expert Group meeting were held.

[5] COMMISSION STAFF WORKING DOCUMENT Better Regulation Guidelines, SWD (2017) 350. See: https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines.pdf

[6] See: https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulationwhy-and-how/better-regulation-guidelines-and-toolbox/better-regulation-toolbox_en

Current situation and potential measures

Circularity of vehicles

- The CEAP explicitly addresses the revision of EU legislation on ELVs with a view to prevent waste, increase recycled content, promote safer and cleaner waste streams, and ensure high-quality recycling. The CEAP inter alia aims at a reduction of waste by linking design issues to end-of-life treatment and introducing rules on mandatory use of recycled materials for the construction of vehicle components. Further, it imposes efforts to promote more circular business models in the automotive industry. In the context of circularity, the recently adopted Chemicals Strategy for Sustainability also strives for a safe and sustainable-by-design approach and for non-toxic material cycles. The current ELVD needs better consistency with the objectives of the European Green Deal and the Circular Economy Action Plan since it does not sufficiently address key areas.
- The analysis of the current situation regarding design for circularity (including design for dismantling, the presence of hazardous substances, and type approval provisions), re-use and recycling, market conditions for recyclates, as well as the management of specific raw materials in vehicles (e.g. steel, aluminium, copper, glass, neodymium, and PGMs) shows that there is significant room for improvements.
- The production of vehicles has experienced important changes since the adoption of the ELVD 20 years ago. This is especially the case for the increasing use of new materials, technologies, and components in vehicles, such as plastics, carbon fibre or electronics, which pose challenges for their dismantling, recovery and recycling. In addition, the proper dismantling of vehicle parts and materials is becoming increasingly complex. The vehicles currently on the market are more difficult to dismantle and recycle than they were in 2000, when the ELVD was adopted. The problem is caused by manifold reasons, for example too general and vague provisions of the ELV Directive and the associated 3R Directive or a lack of incentives for car producers to optimise vehicles for improved end-of life treatment. Without EU intervention, the contribution of vehicle production and dismantling to the goals of a circular economy (reuse, repair, and recycling), is expected to decrease.
- Policy options related to the problems identified should improve circularity in the design, production, and end-of-life treatment of vehicles (objective 2). More specific objectives associated with specific life-cycle stages that have been formulated are improve design and production of vehicles to support reuse and recycling, increase the reuse and remanufacturing rates of parts and components, increase the recycling rates of materials and components, ensure transparency and a fair distribution of costs linked to the treatment of ELVs along the supply chain, and ensure elimination of hazardous substances in vehicles.
- To achieve the objective, over 20 measures devised to increase the circularity of vehicles have been developed, described (including expected outcomes), and shortlisted for further assessment (see section on ‘Impact Assessment’ below).

Missing vehicles

- Missing vehicles means that there is an observable difference in the input/output balance for the European vehicle park. When comparing the stock and the input/output, it is obvious that the reported output does not reflect the total output. As reported in previous studies the gap is between 3 and 4 million vehicles. However, there is evidence that the stock is even overreported, which would even increase the number of missing vehicles. Reasons for missing vehicles are for example the non-reported export of used vehicle to other / non-EU-countries or the treatment in not authorised treatment facilities.

- In consideration of different studies, the detailed input-output flows for 2019 have been updated and calculated for EU-27. The result shows that 10.43 million vehicles exited the stock of registered vehicles in EU-27, thereof 6.06 million ELVs were treated within the EU, 0.97 million were exported to non-EU countries and the whereabouts of 3.4 million vehicles is unknown.
- Besides, the Intra-EU trade of used vehicles and ELVs, the definition of end-of-life status, and the Extra-EU export of used vehicles and ELVs have been analysed.
- The overall problem is that the whereabouts of approximately 30 % to 40 % of the M1 and N1 vehicles is not known, and it cannot be proven whether the European legislation is applied or not. They could be exported without being reported to customs or registration authorities, or simply dumped. To date, it is not possible to assess whether all end-of-life vehicles are directed to ATFs.
- This results in economic losses for the formal sector and social impacts for informal sector workers. In addition, it is believed that (some) of the recyclables will be lost if they are not directed to legal facilities. The problem is mainly caused by manifold reasons such as market failures, regulatory failures, and behavioural biases.
- The EU should react since the problem of missing vehicles is well known since 2011. However, the problem has not changed and continues to endanger the objective of the ELV Directive that all end-of-life vehicles should be depolluted and dismantled in ATFs in compliance with the minimum requirements of the ELV Directive.
- To address the problem of missing vehicles, the three specific objectives have been pointed out: ensure that all ELVs are treated in accordance with the requirements of the ELV Directive, reduce levels of illegal dismantling and illegal export of ELVs, and enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards.
- An initial assessment of effectiveness and feasibility was completed based on 20 defined measures, with the result that some of the measures are considered unavoidable, others are discarded or kept on the agenda for later consideration. The preferred measures are described (including expected outcomes) and shortlisted for further assessment (see section on 'Impact Assessment' below).

Extended Producer Responsibility

- The term EPR is not explicitly mentioned in the current ELVD, but some provisions oblige the member States to implement basic obligations for the producers. At the same time the WFD established detailed provisions for EPR schemes in Article 8 and 8a for all wastes.
- The analysis of the current situation regarding the EPR, including stakeholder involvement, show that the provisions in the ELVD on the producers' responsibility for the management of ELVs are limited when compared to the obligations for producers, especially regarding financially contribution.
- The overall problem is the quality of recycling and cross contaminations for material recycling since almost all countries allow to segregate the mentioned materials in the shredding process. More challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, might require more effort at ATFs and results in a reduced profit of the ATFs. The market conditions therefore do not allow to internalise the costs linked to high quality recycling and re-use of materials from ELVs and the current EU regulatory framework does not address this problem either. Besides, the system is exposed to strong competition of the illegal sector.
- The problem is caused purely by economically driven factors. The Eu should react to make EPR in the ELV sector future-proof.

- To address the problem of EPR, the objective should ensure transparency and a fair distribution of costs linked to the treatment of ELV.
- The objective is to contribute financially to the collection, treatment, and recycling of ELVs. The measures addressing aspects of the EPR are not assessed as a policy option but considered as measures under Policy options regards the sections scope / circularity / missing vehicles. Several advanced economic incentives were analysed in discussed.

Extension of the vehicle categories in scope of the ELV Directive

- When analysing the burden and benefits of amending the ELVD, also the question of the appropriateness of the vehicle categories in scope occurs. The possibility of extending the scope to additional vehicle categories is sought to analyse the possibility of incentivising a circular approach in the production and end-of-life treatment of vehicles currently outside the scope of the ELVD. Where the necessity and feasibility of extending ELVD's scope to additional vehicle categories is discussed, the question also arises as to whether this results in consequences for the scope of the 3R Directive[7].
- In the EU, 322 million vehicles were registered in 2020. Currently, by unit, ~83 % of all vehicles are within the scope of the ELVD (~74 % Passenger cars (M1 type) and ~9 % lorries (N1 type)) resulting in 17% of vehicles (by unit) that are not covered. In terms of mass, about 33 % (~159 million tons of the stock) are not covered by the ELVD. Vehicles that are not covered are powered two-wheelers (PTW) (L), buses (M2, M3), lorries (N2, N3), semi-trailers (O), and special purpose vehicles. Information that provides an overview of the current situation of end-of-life treatment and circularity of vehicles not in scope of ELVD is rare.
- Though the majority of vehicles is covered by the ELVD, significant gaps by weight remain with regards to vehicles other than M1 and N1. Six problems associated with the vehicles not covered by the ELVD that have been identified are: the potential to contribute to the CE of a large share of vehicles is not exploited yet; missing traceability; no legal incentive to design for circularity; current legal setup is insufficiently harmonized across the EU; inconsistency between scopes of ELVD and 3R Directive; increase of the total amount of vehicles. Problem drivers have been investigated in relation to the market and in relation to existing regulation. Acting on EU level means to close regulatory loopholes that exist between EU MS, avoid potential 'loss' of material resources and to avoid leakage of pollutants where no or unsound treatment is applied, thereby contributing to a level playing field.
- Policy options related to the problems identified should ensure a comprehensive coverage of the sustainable production and waste management at EoL (dismantling, sorting, reuse, recycling, recovery, disposal) of all relevant vehicles by the ELVD. This includes all materials and components of the vehicle.
- To achieve the objective, twelve measures devised to extending the scope of the ELVD have been developed and described (note: none of them has been discarded at a later stage). It is important to note that some of these measures only apply to vehicles that are not yet in scope, some measures apply to M1 and N1 already included in the current ELVD, and a third set of measures are being considered as new provisions for M1 and N1 as well as for those not yet in scope of the ELVD.

[7] Directive 2005/64/EC 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability.

Impact assessment

Circularity of vehicles

The baseline reflects what would happen under a “non-policy-change” scenario without new policy intervention, and assuming realistic implementation of existing legislation. Under the current ELVD any actions taken by manufacturers to increase the circularity of vehicles are voluntary, aside from the prohibition of hazardous substances. Such actions are expected to continue and to increase in magnitude, however at a slow pace. Achieving the reuse and recycling target of 85% is expected to become harder in the following years.

- A total of six measures were discarded at initial stages based on a viability check. The remaining measures have been shortlisted, analysed and grouped into policy options. A bottom-up approach has been developed to allow an analysis at the material level for most measures and in some cases also at the vehicle level. Assessed impacts were compiled to evaluate the policy options in an iterative manner, meaning that after their assessment the policy options were finetuned and related impacts compiled and analysed.
- Measures included under ‘Policy Option 2.1: Design improvements’ are oriented towards the change of the design of vehicles with a view to improve the substance content of vehicles and stimulate the market for secondary materials in cases where recycling is not sufficiently high. Measures have a high level of prescriptiveness, requiring OEMs to apply certain changes to their design over time to ensure compliance. Measures included under ‘Policy Option 2.2: Design improvements via information, 3R Type Approval modernisation and circularity strategy’ address information or reporting requirements that would require OEMs to make changes in design to comply, however without prescribing how the design of vehicles is to be changed. Measures included under ‘Policy Option 2.3: Improving the treatment of vehicles at end-of-life’ aim at improving the quantities and qualities of reuse and recycling through requiring waste management operators to comply with certain practices, to achieve certain targets and in some cases to align technologies with minimum standards.
- The analysis shows that for some materials, some measures might be more effective than others, while some measures may have a low return on investment. In order to address this, in a second step a set of feasible measures for each material was identified, which was then in the focus of the subsequent assessment of the final policy options. In this regard, a detailed analysis of the materials steel, aluminium, copper, glass, plastics, electric and electronic components, and non-recyclables has been carried out. Besides the different materials, further detailed investigations regarding measures on the design of vehicles and preparation for their being put on the market (vehicle level), measures addressing the treatment of vehicles at EoL (vehicle level), and hazardous substances have been carried out.

Based on the results of the material/component specific analysis, the revised policy options were analysed.

The first policy option shows the lowest costs but also does not provide high benefits. Policy option 2 and 3 both lead to significantly higher benefits, with PO 3 being slightly more reaching but also at a higher burden. These options in particular raise the amounts of components and materials that will be recovered from ELV at end-of-life and to some degree also their quality. This is particularly important for allowing a decrease in the dependability of the EU on extra-EU sources (primary but also secondary in some cases).

PO 2 is generally more prescriptive, making dismantling of various components obligatory, whereas PO 3 uses measures such as recycling targets or PST requirements to allow more flexibility as to how the objectives are reached.

- Looking at the analysis for steel and copper, whereas for many categories both PO 2 and 3 show a similar relation of costs and benefits, it seems that PO 2 leads to higher credits, meaning that in general this PO is more effective for copper. However, looking at steel, PO 3 is assumed to lead to higher benefits as the quality of steel scrap shall improve and increase the range of applications for which it can be used significantly.
- For aluminium both PO 2 and PO 3 show that there is a need for more stringent regulation however in lack of data the preferred option is inconclusive.
- For glass, though PO 2 and PO 3 deliver benefits in the same order, main differences are expected in favour of PO 2 due to the reduced complexity of monitoring.
- For plastics, GWP impacts are not so high, however the benefits in terms of SRM would feed into the manufacture of vehicles and allow reducing the dependency on primary materials and thus solving the current market failure. Though POC 3 may suggest higher benefits, it will also have higher costs. Whether this is justified or not is hard to say, but it could also be considered to apply each of the options at a different sage to develop an increasing ambition over time.
- All options result in more dismantling of electric and electronic components from vehicles, increasing the potential for recycling base materials (Fe, Cu and Al) but more importantly also of precious and critical metals. Decisions on which electric and electronic components (EEC) are to be dismantled depend on the objective. If the main objective is to improve the removal of copper impurities from Fe and Al scrap (also increasing copper recycling amounts), dismantling could be an alternative for cases where advanced shredding and PST are not applied (more flexible approach). When the objective is also to improve the recycling of precious and critical materials, the importance of dismantling of EEC prior to shredding increases and in some cases certain sub-components (e.g., magnets) may also need to be dismantled form components to ensure their sufficient recovery. Though for some materials this has an environmental relevance, for others it may be more of a geopolitical decision related to the dependency of the EU for supply of certain materials

Missing vehicles (Objective 3)

Regarding the aspect of missing vehicles and illegal export the situation and problem were manyfold discussed with the Member States at different level for instance it was continuously a topic in the working group meetings, respectively the TAC meeting for the ELVD. As a baseline scenario it is estimated that the situation of 30% to 40% missing vehicles will persist without any principal changes. As some Member States are aiming to implement national specific legislation, we consider that the baseline (for the entire EU) will improve regards the missing vehicles marginally (-2 %).

All measures were checked for legal or technical feasibility and effectiveness. The remaining measures are shortlisted and are grouped for three policy options, namely Policy option 3A Enhanced reporting & enforcement, Policy option PO 3B Interoperable national registers and harmonisation, Policy option PO 3C EU wide vehicle registration and export controls.

It is difficult to assess the impacts of measures and policy options addressing the aspect of missing vehicles as is has manyfold reasons and diverse stakeholders are affected. As far as the impacts are not directly detectable, we established a model, describing the shifts between diverse categories of whereabouts. The distinction of the analysed measures is relevant as a shift from one to another has different impacts on different stakeholders.

Th results of the model calculations for the change in missing vehicles due to the effects of the different policy options show that it is very likely that the Policy Option PO 3A is at risk to fail in generating substantial improvements regards the share / number of missing vehicles.

Policy Option PO 3B provides the tools for cooperation between the MS but a clear method for the calculation of the change in the vehicle fleet is missing. Therefore, the current problem that a comparable performance monitoring by country regards missing vehicles is not possible will persist and cause limited incentive to improve the overall situation on missing vehicles. While the Policy Option PO C is considered as effective regards the quality of the exported vehicles it is most likely that exports of older vehicles (without valid certificate) to non-EU Member States will even increase ("last chance") in the period before the restrictions enter into force. For the assumptions regards the shifts between the categories we take into consideration that the enforcement date will be 2027 and the adverse effects will become effective in 2025 and the intended effects become visible in 2030.

The selection of potential impacts was achieved under consideration of BRG Tool #18.

To investigate the **economic impacts**, the affected stakeholders were identified. These are ATFs, used car dealer, shredder plants and recycling industry, vehicle owner, and public authorities.

As **environmental impacts** the following five impacts were identified:

(1) Resources available for recycling if treated in the EU (resources not lost)

(2) In the method of life cycle assessments (LCA) credits are granted for recycling

(3) Less waste in receiving (extra EU) countries

(4) Illegal treatment might not treat all refrigerants from the air conditioning system and all waste oil

(5) It is expected that the illegal ELV treatment is sending the same amounts of steel, aluminium and catalytic converter to recycling and applies the same effort for separation of spare parts.

Social impacts were identified as:

(1) Employment (additional employment subject to social security contributions)

(2) Less air pollutant in receiving countries

(3) Better road safety equipment of vehicle fleet in receiving countries

The comparison of the options 3A, 3B and 3 C was completed according to BRG Toolkit #11. The comparison highlights economic, social and environmental impacts, their costs and proportionality to the issue at hand, the benefit/cost ratios and the coherence with other EU policy objectives.

As a result, it is shown that all three policy options have their specific shortcomings and a combination of measures is necessary, addressing the different reasons for the missing vehicles. In consequence the measures 1.1b, 2.3, 1.2-1.7, 1.9, 2.5, 2.6, 2.7b, and 3.3 are selected for the preferred policy option. Several of the measures addressing the implementation of the EPR have also an effect on the missing vehicle and have been added to the selection. In general, the interrelation with measures selected to improve design for circularity and measures selected to improved reuse and recycling will have additional positive impacts on the number of missing vehicles.

Extended Producer Responsibility (Objective 4)

The measures addressing aspects of the EPR are not assessed as a policy option but considered as measures under Policy options regards the sections scope / circularity / missing vehicles.

Extension of the vehicle categories in scope of the ELV Directive (Objective 1)

- In the baseline scenario, no provisions on vehicles which are not yet in scope of the ELVD are added to the ELVD (or related Directives, i.e., type approval and 3R Directive).
- The baseline as well as three options (A, B, C) represent the scenarios between which impacts have been compared in the detailed assessment. The three options, with increasing level of ambition, are Option A "Scope Extension of ELV legislation and 3R Directive to all type-approved L, M, N and O vehicles with information requirements", Option B "Scope Extension of ELV legislation and 3R Directive to all type-approved L, M, N and O vehicles with basic requirements", and Option C "Scope Extension under ELVD and 3R Directive with full application of requirements".
- Option A is not recommended, as it is inherent to the nature of information requirements that economic burdens, i.e., costs for reporting and administrative burden, are high but benefits are not directly expected (highly inefficient). Compared to the problems described and the extent of impacts in the baseline, measures of Option A are considered not proportionate (low effectiveness). Option B is considered the preferred option. The strongest argument is the cost-benefit ratio (efficiency). Measures result in environmental benefits, namely benefits from heavy metal restrictions and from formalised treatment. The total economic burden of Option B is considered appropriate in light of the objective it will reach and the problems that it will solve. Sub-options of Option C are assessed as generally beneficial provided that data is available to tailor them accordingly to the vehicle specifications. This suggests that these provisions might be considered for the future. Another general finding is that regardless of the option chosen, it is important to align the scope of ELVD and 3R Directive.

1. Introduction

1.1 Background: Shortcomings of the current ELV Directive

An evaluation of the ELV Directive (ELVD) was published on 15 March 2021. It identified various shortcomings in the Directive and in its coherence with the corresponding 3R type-approval Directive (Williams et. al 2020).

The European Commission is now investigating options to revise the current EU rules on the ELVs with a particular focus on the identified problem areas, as well as the general alignment and coherence of the ELV and the 3R type-approval Directives with the sectoral EU policies and legislation.

Special consideration has been given to the implementation of the Directives,

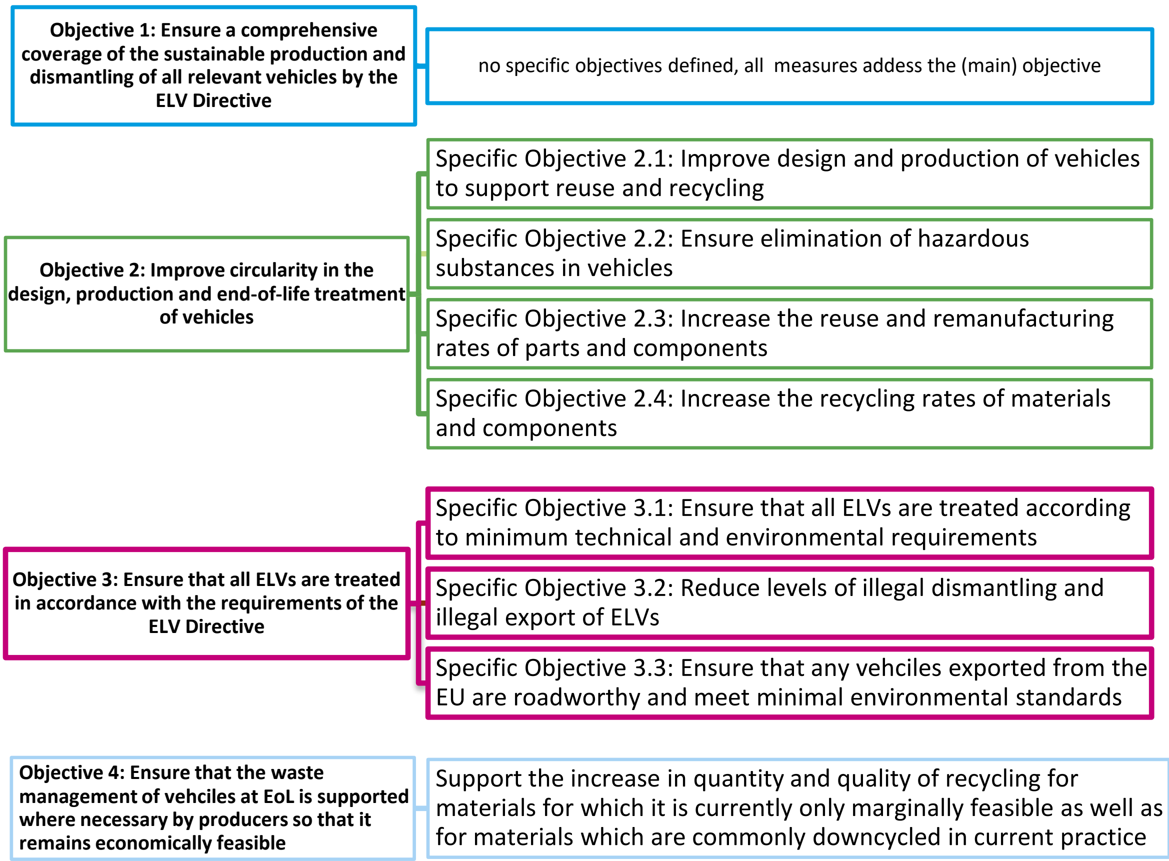
- to the comprehensive coverage of the sustainable production and dismantling of all relevant vehicles by the Directives (Objective 1 – Scope),
- to improving the design and production of vehicles to support reuse and recycling (Objective 2 – circularity), and
- to the problem of the end-of-life vehicles of unknown whereabouts (Objective 3 – Missing vehicles).

In this respect, the impact assessment is focused on measures that should help to solve the various problems and to achieve the three main objectives specified above.

1.1.1 Intervention Logic

The problems identified in the evaluation of the ELV Directive as well as other aspects of importance raised through other European policy (e.g., the CEAP, the Green Deal, the sustainable Chemicals Strategy) were investigated and developed further. On this basis four main objectives were developed as well as specific objectives to be achieved. The results of these investigations and the detail of the various problems and drivers and the objectives developed respectively are detailed in Section 2 and its parts. The following figure provides an overview of the main and specific objectives tackled throughout this report.

Figure 1-1 Overview on objectives and specific objectives



1.2 Methodology of the study

1.2.1 Impact Assessment according to Better Regulation

This study is framed by the methods and guidance related to impact assessment, analysis of impacts and stakeholder consultation that are outlined in the Better Regulation and its related tools.

The first step has been the definition of an intervention logic for the Directive, where in relation to the various problems identified with its current implementation, objectives were defined that have served as orientation for the proposal and assessment of possible future measures. Along with the intervention logic, it was also of importance to detail the current situation in relation to certain aspects and problems and how this is to be considered in the base-line option of a case in which the Directive is not changed, and its implementation develops as it would without any interventions. In relation to the problems identified, it shall thus be considered whether the problem and its related impacts are likely to persist in the absence of action at the EU policy level, as well as whether their scale is expected to increase or decrease. The starting point for the intervention logic is based on the recently published study in support of the Commission's Evaluation of the Directive (Williams et al., 2020).

This study foresees the development of policy options (PO) that are to be analysed and compared. The policy options address the Directive in relation to the main objectives defined for the various problems identified and, in this respect, each of them should propose certain measures to solve the problems identified through achieving the objectives specified therein. How these measures perform and compare in terms of their costs and benefits is analysed later, but the objective is to strive for improving the effectiveness, efficiency, relevance and consistency of the ELVD.

It is followed by the assessment of impacts of the policy options based on the combination of the single measures that they consist of. For the purpose of the assessment, the main types of impacts are considered as a first step, followed by a characterisation of such impacts and as far as possible their quantification in quantitative or at least qualitative terms. This is based on a review of available data and literature as well as information to compiled based on stakeholder input. On the basis of the assessment of the economic, environmental and social impacts conducted, a first comparison at the level of specific objectives is performed. These later feed into a final comparison of the options compiled for the Directive as a whole. The Better Regulation Guidelines, and in particular Tool #57 on Analytical Methods to Compare Options or Assess Performance has been considered in this analysis.

To address the BRG requirement that 'all relevant impacts should be assessed qualitatively and quantitatively whenever possible. Quantification of impacts will not be possible in all cases but it is expected that efforts are [made] systematically', we will document the effort that was undertaken to obtain quantitative data, where only qualitative data is available.

1.3 Synopsis of stakeholder activities

Stakeholder consultation is an essential part of any impact assessment and is an obligatory part of the process aimed at ensuring that all stakeholders have the chance of providing their views so that they can be taken into consideration. See the synopsis of stakeholder activities detailed in Annex III.

1.3.1 Consultation Strategy

Within the preparation of the impact assessment, the consultation of stakeholders aims at capturing the views and ideas of relevant stakeholders, allowing them to provide relevant and robust information and data for assessing possible options for a new regulatory framework on ELVs, incl. the 3R type approval. The following synopsis report was prepared following the better regulation guidelines (Tool 55). It outlines the different steps and consultation activities which were conducted to feed into the assessment.

1.3.1.1 Consultation objectives

The objective is to ensure that stakeholders' views are sought on all key impact assessment aspects. The aim is to collect information from stakeholders in relation to the various problems and the measures proposed for achieving the objectives defined for each problem and their likely impacts. This information will complement information and data gathered through other sources (e.g., literature review, existing policy and position papers, Eurostat data and other statistical data sources, etc.). All inputs (data, information, etc.) from the consultation shall be incorporated into the impact assessment at appropriate points, i.e., information provided by stakeholders shall support the analysis of the problems, identification of options that could answer the objectives and their analysis.

1.3.1.2 Stakeholders consulted

Relevant stakeholders were grouped as follows:

- **Industry associations** (automotive industry (OEMs) for different vehicle types including material and component suppliers, dismantlers (ATFs), shredders, recyclers; including small and medium enterprises). The experience and knowledge of the industry located at the different life cycle stages is very important to assess the impact of the alternative policy options because the measures tailored to a specific life cycle stage have interlinkages with other life cycle stages. Industrial operators constitute a well-structured sector. There are several organisations at EU level that cover individual steps of the material and component supply, production and different end-of-life management steps. These organisations and their members (individual companies) are able to convey the different interests and views of their members and to provide important input (e.g., market developments and other data and information) for the assessment.
- **Environmental protection organisations, general public, consumers**. The contribution of environmental NGOs is of high interest to link the particular case of ELVs with broader considerations of circular economy, resource efficiency, transboundary shipment of (hazardous) wastes, pollution, i.e., environmental conditions of end-of-life management etc. End-users and consumers directly experience the impact of certain measures in their day-to-day life (e.g., amendments in vehicle registration processes, e.g., temporary deregistration or repairability, spare part availability and costs of repair). Of particular interest is the fact that their views go beyond purely technical considerations.
- **MS public administration**. This group consists of government experts from all Member States, particularly environmental agencies, national EPR organisations, the registration and/or type approval authorities, market surveillance bodies. The experience of national administrations related to certain measures and options is highly specific and could be relevant. National administrations were consulted through a survey and/or through the participation in the meeting for Member States' representatives.
- **Other stakeholders,** e.g., academia, think tanks, etc., who may have a good knowledge and an interest in alternative options and their analysis and assessment were consulted on specific issues. Specifically, representatives from the United Nations Economic Commission for Europe (UNECE) and the United Nations Environment Programme (UNEP) were consulted on the impacts of European ELV framework revision in relation to international agreements. Another stakeholder group consulted in the group of other stakeholders is that of vehicle insurance companies playing an important role at a vehicle's end-of-life in the case of accidents.

Lists of stakeholders to be consulted for the impact assessment study in each of the consultation activities were provided to the European Commission (EC), aiming at a balanced representation of the stakeholder groups and the different stakeholders representing various sectors and areas. The list covered EU-wide associations and individual companies; different sectors from e.g., manufactures to environmental NGOs. An overview of stakeholders that participated in each consultation activity is provided in the sub-sections of the summary of the stakeholder consultation below.

1.3.1.3 Consultation methodology

For the consultation with various stakeholders, different tools were applied. The table below (Table 1-1) summarises the individual consultation methods and provides an overview of the overall consultation strategy.

In comparison to the initial consultation strategy, the elements of consultation of MS as well as the follow-up consultation after the workshop were included as additional consultations. It was found that some MS have experiences with legislation addressing problems targeted in the review of the ELVD, and questions arising on information provided by stakeholders required additional contacting to clarify their contributions. Furthermore, the consultation activities in relation to the "Study to develop and assess options to review Directive 2005/64/EC (3R Directive) and integration of the results into the impact assessment of the ELV Directive are summarized within this synopsis".

Please note that contributions received in the context of the public consultations published on the "Have Your Say" web portal cannot be regarded as the official position of the Commission and its services and thus do not bind the Commission. Furthermore, the contributions cannot be considered as a representative sample of the EU population.

1.3.2 Summary of stakeholder consultations process

All consultation activities are summarized in the following.

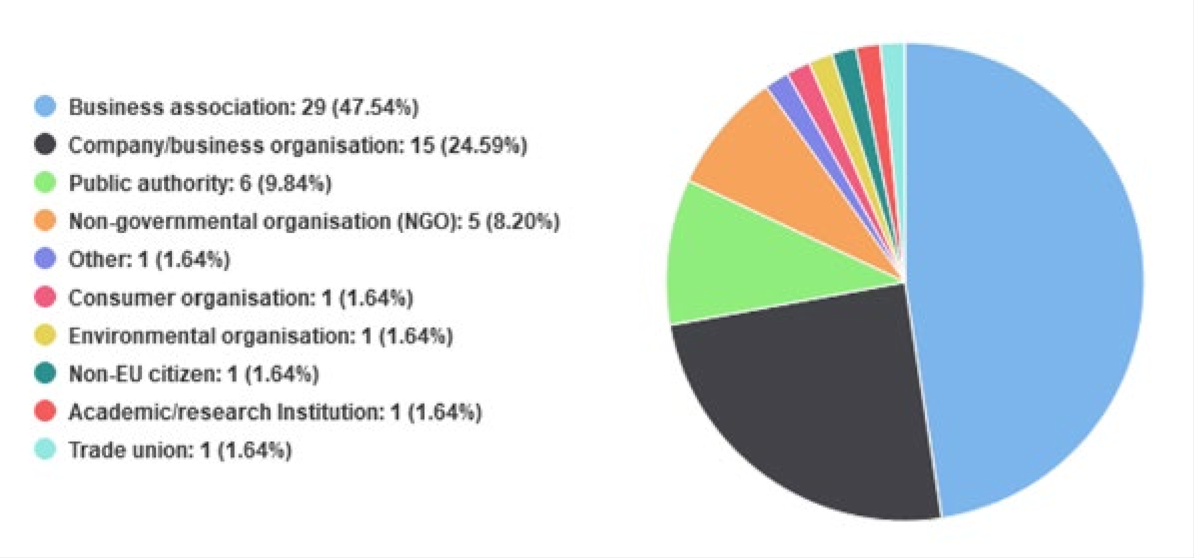
For some of the documentations of the stakeholder activities, no general publication is intended. However, the European Commission was provided with those documentations of stakeholder consultation activities not presented in this Annex, if not indicated differently by consulted organisations, i.e. where information was not disclosed.

1.3.2.1 Feedback on the inception impact assessment

An inception impact assessment setting the pathway for the revision of the ELVD was published on ec.europa.eu[8] and open for public feedback between 22 October 2020 and 19 November 2020. The feedback received stemmed from 61 entries. 47 of the participants submitted an additional document along with their contribution. Submitted documents and entries on the feedback website were looked at and attributed to the different topics of the revision.

[8] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

Figure 1-2 Affiliation of stakeholders (n=61) participating in the public feedback on the inception IA



Source: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en (access 16.06.2022)

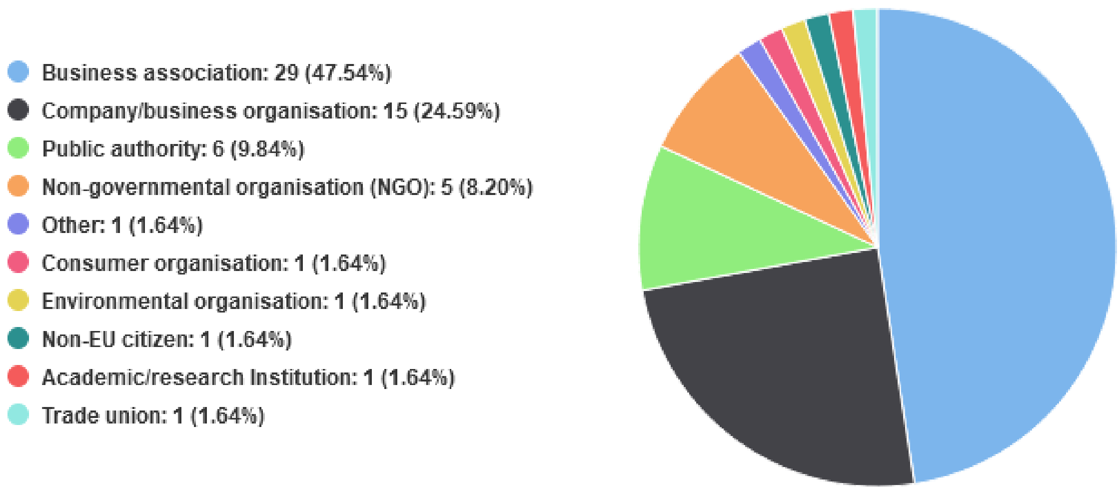
Table 1-2 provides input as to the various aspects referred to in the different contributions

Table 1-1 Overview of different methods of the project's consultation strategy

What	Public feedback[9]	Online public consultation (OPC)	Targeted consultation	Stakeholder workshop	Consultation of Member States	Follow up consultation activities after the workshops
How	No specific format of feedback required, additional written contributions possible	Online Questionnaire Survey with the possibility to provide additional written contributions	Web conference interviews	2-day online meeting	Ad-hoc survey and 1-day meeting	Written feedback on the content presented in the workshop and written exchange
Why	To explain the approach and invite them to contribute	To validate/obtain data and information and to gain opinions on more detailed/specific aspects	To validate/obtain data and information and to gain opinions on more detailed/specific aspects	To discuss specific aspects, validate findings, gather additional evidence	To inform MS on measures and policy options, to discuss specific aspects, gather additional evidence and experiences from MS	To gather evidence that was requested in the workshop, to ask clarification questions on feedback, opinion and information provi-ded, to request additional data
Who	All stakeholders	Specific stakeholder groups	Selected key stake-holders from specific stakeholder groups	Specific stakeholder groups	Representatives / Experts of MS authorities	Targeted stakeholders
How data / information was used in the impact assessment	Information used to structure the OPC questionnaire, to provide an initial overview of interested stakeholders	Identification of opinions of specific stakeholder groups; participating stakeholders were invited to the stakeholder work-shop; for stakeholders invited to the targeted consultation, identify topics to which the study team expected the interviewed stakeholder to contribute	Validate assumptions, understand the situation of selected key stakeholders, information used for identification of measures and policy options for reviewing the ELV Directive, information used for the impact analysis of measures.	Information used for revising the measures and policy options for reviewing the ELV Directive, information used for the impact analysis of measures.	Learn from experiences of MS-specific legislation already addressing problems targeted in the review of the ELVD and with regards to the measures proposed on EU level	Used for the impact analysis of measures

9 https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

Figure 1-3 Affiliation of stakeholders (n=61) participating in the public feedback on the inception IA



Source: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en (access 16.06.2022)

Table 1-2 Number of contributions referring to the topics of review

Topics of the review	No. of contributions referring to the topic
Missing vehicles	47
Illegal exports	37
Reporting vehicle fleet	24
Reporting reuse – recycling	21
Definition recycling	12
Separate reuse target	33
Material specific material targets	31
Data accessibility	27
Design for circularity	24
Recycled target contents	27
EPR system	22
ELVD scope	14
Coherence – substances	11
Coherence – definitions	12

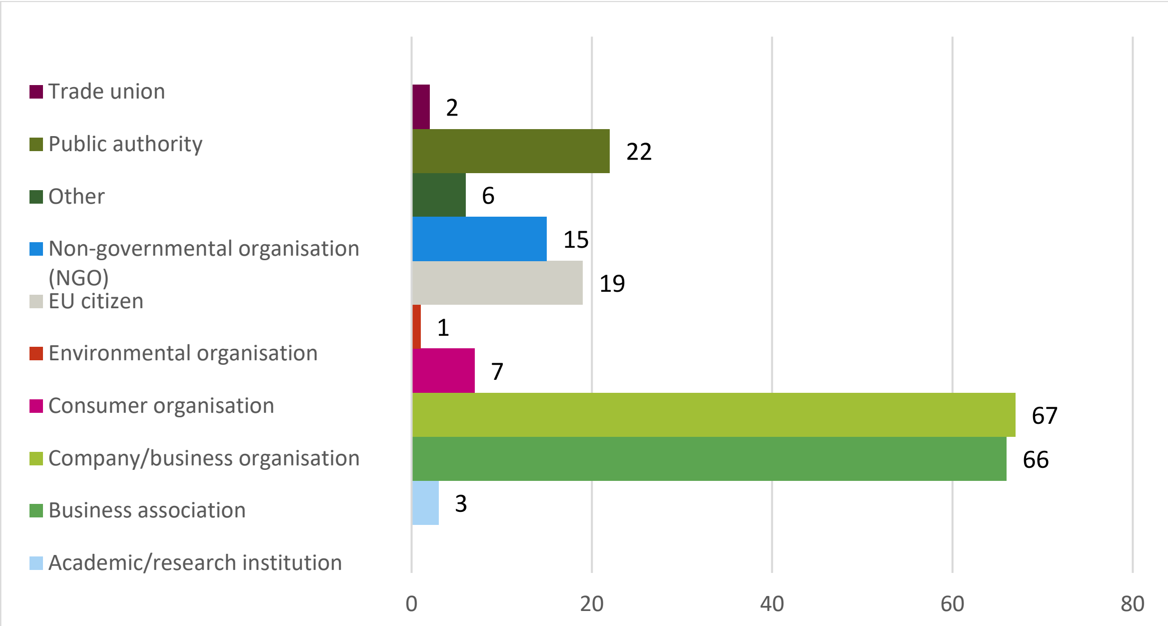
The feedback can be found on https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en.

1.3.2.2 Open Public Consultation

The stakeholder consultation was held between 20 July 2021 and 26 November 2021 as a public EU stakeholder consultation. It targeted all citizens and organisations. The EC sent invitations to participate to various parties, including stakeholders identified for this purpose by the consultants. The consultation was launched on the EU public consultation platform and was publicly available throughout the consultation duration. The consultation took place in the form of an online survey and enabled two forms of input: (a) through a stakeholder survey (a shorter questionnaire targeting input from "interested citizens with only a general interest in the area of end-of-life vehicles", 10 questions in total; and a longer questionnaire targeting input from individuals with "specific knowledge and/or interest about end-of-life vehicles", 43 questions in total; and (b) additionally, stakeholders were given the option to provide written input, e.g., position papers and evidence/data.

In total, 208 participants took part in the survey during the consultation period, see their affiliation to stakeholder groups in Figure 8-2. Of all the organisations that provided input, two organisations provided input to the questionnaire through two representatives each (i.e., two questionnaires were completed for these organisations).[10]

Figure 1-4 Answer to the question "I am giving my contribution as: …" (multiple options)

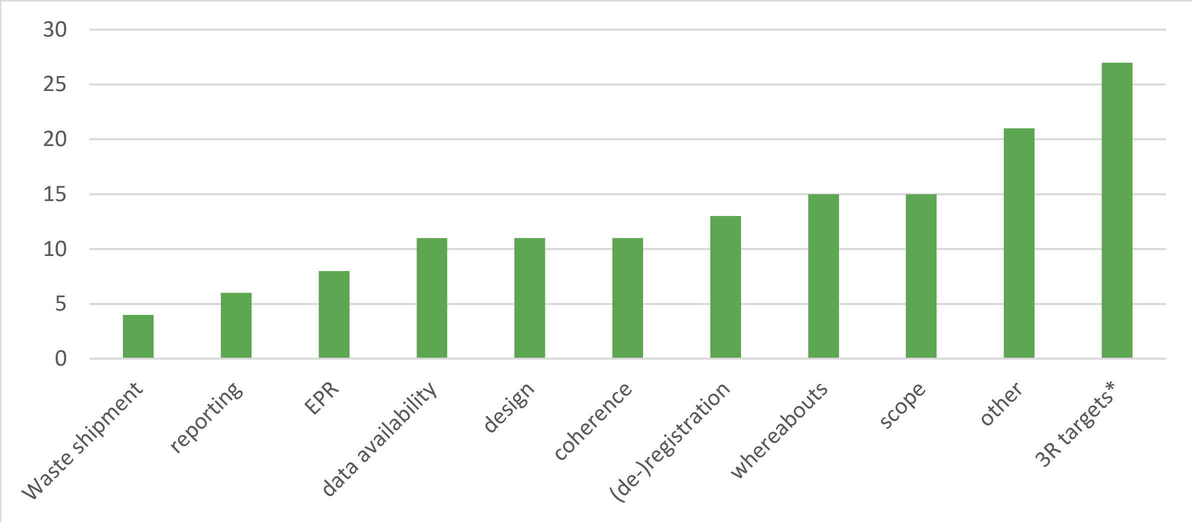


A total of 57 stakeholders submitted written contributions in addition to the answers to the consultation survey questions[11]. The contributions were first screened to identify the main issues that they addressed. The following figure shows how many of the written contributions referred to a number of specific issues that were also referred to in the OPC survey and give a first indication as to the aspects addressed by stakeholders in this format.

[10] Ministry of the Environment of the Czech Republic, and Galloo (a company from the dismantling and recycling sector incl. shredder and PST operators).

[11] One stakeholder submitted 2 times answers to the consultation adding two different written contributions.

Figure 1-5 Key words of main aspects discussed in the written contribution (n=58)



Notes: (*) including recycled content target
The category 'other' includes: Handling of hazardous components/waste (n=2); (Recycling of) EV (n=6); Remanufacturing; Annex I of the EU Directive 2000/53/EC; batteries in electric cars, carbon footprint requirement; role of insurances; ATFs: More controls over ATFs, illegal ATFs are more cheaper, but without environmental standards (n=3); ASR (Automotive Shredder Residue); batteries are way more heavy than in the ELVD stated; Removal of tyres, batteries etc.

Source: Own compilation

The obtained answers to the questions were processed via Microsoft Excel, written input was summarized per topic. A summary of the results is found in Annex III. The complete evaluation of answers to the open public consultation is among the material that was provided to the European Commission. A summary report, all contributions and documents annexed to contributions can be found in Annex III.

Identical answers to the OPC were received from

- VFSE Automotive WG (organisation size: micro), EuPC Automotive Division (micro), PlasFuelSys (micro), PLASTIC OMNIUM - CLEAN ENERGY SYSTEMS DIVISION (large)
- Two different individuals of the Ministry of the Environment of the Czech Republic
- DEMONTA Trade SE (organisation size: medium) and Czech Association of Circular Economy (large)

1.3.2.3 Targeted stakeholder consultation

A targeted consultation (interviews) was held starting in November 2021. The phase was split into two rounds of interviews:

- The **main study interviews** held in the period from 03 November to 03 December 2021. In this round, the consultants conducted 20 interviews, see the list of interviewed organisations in Table 1-1. One additionally invited stakeholder (ANEC BEUC) did not participate due to the questions being too technical for the stakeholder group they represent. The group of stakeholders that participated in the main study interviews consisted of automotive manufacturers for cars, trucks, vans, buses, and motorcycles (n=3), suppliers of materials and (second-hand) components (n=6), stakeholders involved in the EoL management (n=7), and individual other stakeholders including a PRO, a registration and international authority each, a stakeholder representing insurance companies, and environmental NGOs.

- **Interviews held in relation to the 3R Type Approval Directive** in the period from 17 December 2021 to 07 February 2022. The invited group of stakeholders consisted of automotive manufacturers (n=5), type approval technical services (n=3), type approval authority/ market surveillance (n=2), international authorities and one stakeholder conducting dismantling trials. Inputs were obtained from 8 out of 12 invited stakeholders (a few per written contribution only), see Table 1-3.

The consultation phase was organised as follows: The interviews were distributed internally according to the focus of the respective associations or stakeholders and the work focus of the experts. The interviewees were initially contacted indicating the goal and scope of the study. When no answer was received, reminders were sent. Date and time for the interview were agreed on and consultants provided a web conference tool. An interview guideline was sent to the stakeholders in advance of the meeting. Due to the extent of the main study questionnaire, it was accompanied by an indication of the sections to which the study team expected the interviewed stakeholder to contribute (see Table 1-1). Other sections were included for transparency, and the interviewees could also contribute to the questions therein. Often, answers were received with specification of topics of interest for the stakeholders. In some cases, stakeholders responded to topics additional to those planned for the interview (not displayed in Table 1-1). Only in some cases, was the whole questionnaire subject of the interview. Protocols of results were prepared after the interview and sent for approval to the respective interview partner. Together with the approval, consultants asked for the permission to cite answers given in the interview in the study report. If rejected, information was not included in the report.

Scope	*Hazardous substances*	*Design 4 circularity*	*Coherence (3RD)*	*Recycling definition*	*Reuse target*	*Material recycling targets*	*Data accessibility*	*EPR*	*Missing vehicles*	*Illegal export*	*Reporting: vehicle fleet*	*Repoorting: reuse recycling*
x	*x*	*x*	*x*		*x*	*x*	*x*	*x*	*(x)*	*(x)*	*x*	
x	*(x)*	*(x)*	*(x)*	*(x)*	*(x)*	*(x)*	*(x)*	*(x)*			*(x)*	*(x)*
	x	*x*	*x*		*x*	*x*	*x*	*x*			*x*	
x	*x*	*x*	*(x)*				*x*					

	x*	x*		x		x*	x	x				
	x*	x*		x		x*	x	x				
(x)	x	x	(x)		x		x	(x)				
x	x*	x*	(x)	x	x	x*	x	x				x
		x*	(x)	x		x*		x				x
	x*	x*	x	(x)		x*	x	x				x
(x)		x	(x)		x	x	x	x*				x
(x)		x	(x)	x	x	x	x	x*				x
(x)		x	(x)		x	x	x	x				x

x		*(x)*	*(x)*	*x*	*x*	*x*	*x*	*x*				*x*
(x)									*x*	*x*	*x*	
	x		*x*						*x*	*x*	*x*	
					x			*x*	*(x)*	*(x)*		
x	*x*	*x*			*x*	*x*		*x*	*x*	*x*		

x		*x*			*x*		*(x)*					
	(x)	*x*	*(x)*	*x*		*x*	*x*	*x*				*x*

Table 1-3 Stakeholders invited to interviews held in relation to the 3R Type Approval Directive

#	Organisation name	Input provided	Details of contact
1	United Nations Economic Commission for Europe (UNECE)	Yes	Aspects of 3R type approval covered under the interview in the ELVD IA main study
2	Kraftfahrtbundesamt (Germany)	No	Contacted but did not respond
3	Ministère de la Transition écologique France	Yes	Interview held on 27.12.21
4	European Automobile Manufacturers' Association (ACEA)	Yes	Written input provided on 07.02.22
5	BMW (manufacturer)	No	No answer to various attempts to schedule an interview (contacted 10.12.21, reminder sent on 27.1. and 10.02.22)
6	VW (manufacturer)	Yes	Interview held on 14.01.22, with Porsche
7	Porsche (manufacturer)	Yes	Interview held on 14.01.22, with VW
8	Stellantis (manufacturer)	Yes	Interview held on 17.12.21
9	TÜV Nord (Type approval technical service)	No	Scheduled interview was cancelled by TÜV Nord, alternative contact details were sent without a response when requesting to reschedule the interview
10	IDIADA (Type approval technical service)	No	Written input promised, questionnaire sent and response requested by mid-January, reminders sent on 27.1. and 10.2.22. No answer obtained.
11	Tech4You (operators of IDIS; dismantling trials)	Yes	Interview held on 07.02.22
12	UTAC (Type approval technical service)	Yes	UTAC provided additions to the Ministère de la Transition écologique, France

See the positions of stakeholders mentioned in Annex III

Approved interview documentations were gathered and distributed within the study team in order to use input of all interviews for developing the measures in further detail and assessing related impacts. The input from the targeted consultation has been taken into consideration for the preparation of initial results and the development of initial measures that were presented at the sectoral stakeholder meetings as well as the MS meeting (see sections below).

Though in most cases stakeholders gave their consent to cite information provided through the interviews, confirmed interview documentation is not intended for publication itself. The documentations are among the material that was provided to the European Commission.

1.3.2.4 Survey in relation to 3R Directive

A 3R-Directive-specific survey was conducted with stakeholders on this subject in proximity to interviews (see section before). The survey was developed similarly to the interview questionnaires for consulting three different stakeholder groups: OEMs, technical services, and type approval authorities. For all three groups, questions on the link to the ELVD, on the process of type approval and on possible future amendments were identical, a stakeholder group-specific set of questions was added to each one. The questionnaire was agreed on and is available to the European Commission.

The survey was distributed to OEMs through requesting the association ACEA to send the survey questionnaire to its members. The European Commission assisted in sending the questionnaire to type approval authorities. The survey was also forwarded to type approval technical services that had been initially identified but not interviewed.

Four Member States participated (3 provided the filled-out survey, 1 provided short input per email), and one OEM send a confidential contribution. Additional information was received from three more organisations/stakeholder groups

- one position paper (from ACEA),
- one interview in the main study was used to get specific information on the 3R Directive (UN ECE/UNEP), and
- one e-mail with additional explanatory information was received, in relation to the information provided in one of the specific interviews (from MS representatives from France).

In the round of written feedback in April 2022 (follow-up after the workshop in March 2022), a further written contribution from Germany was received.

Based on the indication of a lot of stakeholders, most of the information cannot be cited in this report as information has been provided on a confidential basis or interview documentations have not been confirmed by interviewees.

The positions of stakeholders are summarised in Annex III.

1.3.2.5 Stakeholder Workshop on 23/24 March 2022

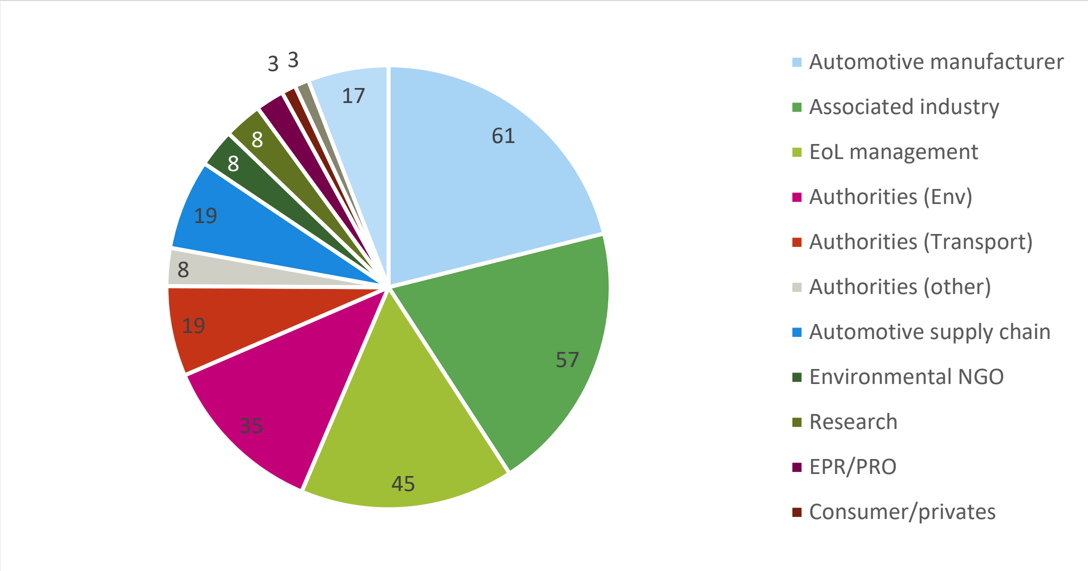
In cooperation with the Commission, the contractor prepared the stakeholder workshop and the Member States meeting (see the chapter on “consultation of MS” below). All meetings were organised as web conferences which were hosted by the consultants. In cooperation with the EC, the consultants prepared the agenda and an invitation letter, and the EC invited participants. Stakeholder contacts from the targeted consultation were provided by the consultants. Further selection of invitees was done by the European Commission, e.g., participants of the open public consultation. Associations were invited, but, in comparison to the targeted consultation, more individual companies were present. The contractor prepared material to inform participants on the contents of the meeting which were send around to invited stakeholders beforehand. At the meeting, the contractor gave an input (presentation) on the current situation in relation to the problems, the measures under consideration, initial results and topics for discussion.

The meetings were structured according to the topics. The agenda is provided below. Meetings were facilitated by the consultant's team members; minutes were prepared of each meeting.

Table 1-4 Agenda of the stakeholder workshop

Day 1 - THU 23 March 2022			Day 2 – FRI 24 March 2022		
9:00-9:15	EC: Welcome	Presentation	9:00-9:15	EC: Welcome	
9:15-10:45	Current situation + measures for Design/Reuse + Remanufacturing/Recycling	Presentation by the consultants, clarification questions	9:15-10:45	Current situation + measures + analysis + first results for Recycled content - JRC	Presentation, clarification questions + Discussion
11:00-12:00	Analysis method + first results for Design/Reuse + Remanufacturing/Recycling	Presentation by the consultants, clarification questions	11:00-13:00	Current situation + measures + analysis + first results and discussion for Missing vehicles + illegal exports	Presentation, clarification questions + Discussion
12:00-13:00	Discussion on Design/Reuse + Remanufacturing/Recycling	Discussion	14:00-15:45	Current situation + measures + analysis + first results and discussion for Scope	Presentation, clarification questions + Discussion
14:00-15:30	Pre-conditions for Design/ Reuse + Remanufacturing/ Recycling: EPR + Access to Information (current situation + measures + analysis + first results)	Presentation Discussion	16:00-16:30	Wrap up for each objective	Presentation
15:45-16:45	Due diligence; Hazardous substances; NdFeB magnets.	Presentation Discussion	16:30-17:00	Outlook - EC	Presentation
16:45-17:15	Overarching aspects				

Figure 1-6 Overview of composition of stakeholder registered* for the workshop (n=289)



Note: The category of "automotive manufacturers" includes manufacturers of all types of vehicles, incl. motorcycles, vehicles accessible to disabled people, caravanning industry, to name some. / The category of "associated industry" includes, among others, all (secondary) raw material-related industry stakeholders. / (*) The numbers relate to the registrations for the workshop. Due to changing audience during and last-minute requests before the workshop, it was not possible to analyse the composition of stakeholders in relation to their actual participation.

Source: own compilation

Possibilities of participation in the meeting:

- To gather input from a larger audience of stakeholders, and additional interaction tool (app called *Slido*) was used during the workshop to survey the views of the participants on certain aspects. Slido questions were answered by participants in the course of the presentations of the consultants or in the days following the workshop.
- For oral contributions, stakeholders could write in the chat the essence of their comment and wait to be requested to speak.
- After the workshop, all participants had two weeks to submit additional information and data to substantiate their views (see section 8.4.7)

A summary of discussed aspects per topic can be found in the summary of key positions of stakeholders in section 8.5.
For each of the topics, the consultants took into account aspects that were discussed in the meetings, and where (updates of) data was provided, e.g., in relation to the material composition of L-type approved vehicles, these were feed into the calculation of impacts for the final report.

The parts of the documentation of the stakeholder workshop not intended for publication and provided solely to the EC include:

- Participants list;
- Minutes of the meeting;
- Documentation of the chat of the online meeting; and
- Slido results.

1.3.2.6 Consultation of Member States

The consultation of MS consisted of two elements:

a) Adhoc survey

A questionnaire for Member State Experts was prepared covering the four topics:

- Management of Shredder Light Fraction (SLF) and Shredder Heavy Fraction (SHF),
- Fees or taxes to support recycling of ELVs,
- Enhanced Producer Responsibility (EPR) System,
- Waste management of other types of vehicles.

The questionnaire was sent out to the MS in February with most MS sending answers prior to the workshop, and a few (2-3) sent afterwards . Answers to the questionnaire were provided by 15 MS, namely Lithuania, Belgium, Ireland, Estonia, Slovakia, Greece, Malta, Finland, Croatia, Spain, France, Czech Republic, the Netherlands, Sweden, and Germany. Additional documents were received from Belgium only.

As for the processing of the data, it is to be said that no statistical evaluation of responses was made, but responses are exemplarily summarised for two of the four topics as follows. Where information from the survey is used in the main report, it is referenced, and all questionnaires are available to the EC.

Management of Shredder Light Fraction (SLF) and Shredder Heavy Fraction (SHF). In 6 MS, the disposal of untreated SLF/SHF in landfills is prohibited. 4 MS prohibit the disposal in landfills of fractions from post shredder treatment (PST). 4 MS (in case of BE only Flanders) allow to consider untreated SLF for the purpose of road construction, within which 3 consider it as recycling. Selected detailed responses showed that some countries defined certain criteria for acceptance of waste at the landfill that have to be fulfilled (e.g., POP content in the residues or that the residues intended to landfill cannot be recycled of incinerated anymore). BE (Flanders) allows the disposal in landfills of fractions from PST, however the costs for disposal are higher than the costs for recycling or thermal treatment. Some countries admitted that due to a disposal ban in their countries the recycling rates of ELVs increased.

Waste management of other types of vehicles. In ES, FR, CZ, BE (Flanders), and LT the waste management of **motorcycles** is governed by specific national legislation? This is not the case in SK, EL, MT, FI, HR, NL, DE, SE, and IE. In ES, CZ, BE (Flanders), and LT waste management of **trucks** is governed by specific national legislation. This is not the case in SK, EL, MT, FI, HR, FR, NL, DE, SE, IE. Of those that do not have specific national legislation, several countries (HR, FI, EL, NL, DE) indicated that the treatment of motorcycles and trucks is ensured and/or environmental permits for facilities are requested through general waste legislation. Additional information on waste management of other types of vehicles was provided by 4 MS (LT, BE, CZ, DE).

b) Member State Workshop on 31. March 2022

In cooperation with the Commission, the contractor prepared a Member State Representatives workshop in addition to the stakeholder workshop (see above). The meeting was organised as web conferences which was hosted by the consultants. In cooperation with the EC, the consultants prepared the agenda and an invitation letter, and the EC invited participants. The same material as for the stakeholder workshop was distributed among MS representatives to inform participants on the contents of the meeting beforehand, also, representatives of the MS were invited to participate in the stakeholder workshop. Thus, assuming that MS representatives could inform themselves in the stakeholder workshop as well as with the provided information, at the meeting, the contractor gave a very short additional input (presentation) the problems, the measures under consideration, and topics for discussion.

The meeting was structured according to the topics. Additional three presentations were held by Member State representatives from France, Belgium, and the Netherlands. The agenda is provided in Table 1-5. Meetings were facilitated by the consultant's team members; minutes were prepared and provided to the European Commission.

Table 1-5 Agenda of Workshop with Member State Representatives

9:00-9:30	EC Welcome Mattia Pellegrini (DG ENV), Mark Nicklas (DG GROW), Jade Vetters (DG GROW)
09:30-09:55	French EPR Scheme Project for ELVs FR Ministry of Ecology, Sustainable Development and Energy: Bruno Miraval
09:55-12:30	Objective 2: Circularity: Short presentations by the consultants, clarification questions and discussion-Moderation by Gael de Rotalier • Point 2.1 - Design, Oeko: Yifaat Baron • Point 2.1.g: - Recycled content targets for plastic, JRC: Thibault Maury • Point 2.2 - Reuse, Oeko: Izabela Kosińska-Terrade • Point 2.3 - Recycling, Oeko: Izabela Kosińska-Terrade • Point 2.4 - Transparency and fair distribution of costs, Mehlhart Consulting: Georg Mehlhart • Point 2.5 - Hazardous Substances, Oeko: Katja Moch
13:30-14:30	Objective 1: Scope: Short presentation by the consultants, clarification questions and discussion (Oeko: Clara Löw)-Moderation by Jaco Huisman
14:30-15:50	Objective 3: Missing vehicles: short presentation by the consultants, clarification questions and discussion -Moderation by Jaco Huisman • Point 3.1 -Vehicle tracking; Mehlhart Consulting: Georg Mehlhart • Point 3.2 -Illegal dismantling and illegal exports, Mehlhart Consulting: Georg Mehlhart • Point 3.3 -Criteria to prevent export of ELVs. Short presentation by the consultants, clarification questions and discussion, Mehlhart Consulting: Georg Mehlhart
	The Netherlands approach on exchange of information on vehicle registration with the example of EUCARIS, NL Vehicle Authority: Idske Dijkstra
	How Missing ELVs are addressed in Belgium (Flanders) through defined recognition criteria, BE The Public Waste Agency of Flanders (OVAM): Lies Verlinden
15:50-16:00	Outlook-EC

Table 1-6 Overview of composition of Member State representatives registered* for the workshop

Austria	2	Ireland	4
Belgium	4	Italy	6
Bulgaria	2	Latvia	2
CROATIA	2	Lithuania	2
Czech Republic	3	Luxembourg	3
Cyprus	0	Malta	2
Denmark	2	Netherlands	6
España	1	Poland	1
Estonia	4	Portugal	0
Finland	5	Romania	2
France	4	Slovakia	3
Greece	0	Slovenia	1
Germany	9	Sweden	4
Hungary	2		

(*) The number relate to the registrations for the workshop. Due to changing audience and last-minute changes during the workshop, it was not possible to analyse the composition o stakeholders in relation to their actual participation.

1.3.2.7 Follow-up after the workshop and ad-hoc consultation

Discussions during the stakeholder workshop left open several questions and stakeholders were asked to provide information on certain topics at the end of each meeting. A list of associations and stakeholder groups that submitted additional input after the sectoral meetings is given below.

List of stakeholders sending input after the workshop (n=39)

- ACEA/HDVs
- ADA
- Ademe
- BASF
- BMW
- CLEPA
- Copper Alliance
- Derichebourg Environment
- ECOEURO
- ECOS
- EEB
- EGARA
- Estonia (MS)
- ETRMA
- EuRIC
- EUROBAT
- EU Aluminium
- FEDEREC
- FEAD
- FNA
- FNADE
- Galloo
- German UBA (MS DE)
- German BMUV (MS DE)
- Glass4Europe
- Holger Luehn
- INDRA
- JRC
- Milan Lauko
- Mobilians
- OVAM (MS BE)
- PGM
- PRE
- Plastics Europe
- POCES
- Renault
- RWD (MS NL)
- Sweden (MS SE)
- TERRA
- Thomas Gardin

plus one stakeholders that wished to remain anonymous.

In addition to other consultation stages, several stakeholders were consulted individually in terms of specific aspects of interest for the consultants. A list of individually consulted stakeholders and the topic on relation to which they were contacted is provided below. The information provided was used for the impact analysis of measures and policy options.

Table 1-7 Ad-hoc consultation of specific stakeholders

Stakeholders contacted ad-hoc	Contacted Person	Contacted in relation to specific topic/s
ADEME	Eric Lecointre	• Material composition of L-type approved vehicles
German UBA	Regina Kohlmeyer	• Calculation of end-of-life trucks based on the Eurostat stock data • Exchange about an UBA report in publication: Impacts of illegal end-of-life vehicle recycling. Identify the environmental, economic and business impacts of the unrecognized dismantling of end-of-life vehicles and the illegal transfer of end-of-life vehicles and derive measures to address potential impacts.
EURIC / Galloo	Olivier Francois	• Exchange of documents related to the STAKEHOLDER WORKING GROUP ON THE REVISION OF 2015 REUSE/ RECOVERY/RECYCLING TARGETS MINUTES FROM THE PLENARY MEETING OF 17 OCTOBER 2005 on the targets and alternative approaches.
EGARA	Henk-Jan Nix	• Regards existence and characteristics of EPR schemes across EU • Regarding post-shredder technologies across the EU
EUROFER	Lubor Kalafus	• Copper impurities in steel
UNEP	Francois Cuenot	• About an international initiative to define and develop an internationally unified method for carbon life cycle analysis (LCA)
EU Aluminium	Benedetta Nucci Patrik Ragnarsson Christian Leroy	• About the average weight of aluminium bumper carrier frame for the purpose to calculate the GWP for different bumpers.
MS representatives of Spain, France, Czech Republic, Belgium/Flanders, Lithuania, Italy	Fernando J. Burgaz Moreno, Bruno Miraval, Katerina Dostalova, Lies Verlinden, Kauzonas Mindaugas, Letteria Adella	• About MS specific legislation for waste management of motorcycles and/or trucks, e.g., on evaluations on changes in the material flows of waste powered-two-wheelers / motorcycles or waste trucks and/or assessments of the ecological, economic and/or social impacts of this regulation at national level

1.3.3 Key positions of stakeholders on specific topics

1.3.3.1 Circularity

Design for circularity

Statistical OPC

On the question if there should be an obligation on vehicle manufactureres to improve circularity characteristics of a vehicle during the design phase, all groups of stakeholders agreed in over 50% to this question. Support was the lowest (51 %) in the category of the automotive manufacturers, where almost 25% did not support this option. The highest support was registered by environmental NGOs (100%), waste management operators (93%) and public authorities (86%). For more details please refer to ”Analysis of open public consultations” (Oeko-Institut e. V. 2022).

Written OPC

Ten contributions mention the topic of (eco-)design specifically. One of the focus topics is the design for dismantlability which various stakeholders would like to see promoted through the new regulation (VEOLIA, EEB, Federec, INDRA, FNADE) whereas others have objections such as:

- 'Life cycle approach more efficient to promote circularity than imposing design requirements' (Volvo);
- 'Dismantling provisions must not impair the essential targets of safety, comfort, environmental performance such as fuel/electricity consumption, costs etc' (Plastics Europe); and
- 'Solutions on eco-design therefore should not be solely based on manual separation/sorting' (EuRIC) stating that PST sorting should be taken into account.

Design for circularity could be supported by sensor-based technology (ECI) and free knowledge sharing and discussion between recyclers and manufacturers (EuRIC, FNADE; see also under 'data availability').

Eco-Design is mentioned in combination with the 3R Type Approval Directive by EuRIC in terms of merging ELVD and 3RD; and by Federec and INDRA with regards to 'practicability checks' of recyclability under the 3R Type approval. Volvo suggests that 'ELVD should focus instead on requiring OEMs to have a strategy to cover the 3 Rs', which is already part of the provisions of Art. 6 of 3R Type Approval Directive.

Another focus is on the means of eco-design to phase out hazardous substances mentioned by VEOLIA. Other stakeholders mentioned hazardous substances under the topics of 'data availability', in combination with recycled content targets or with regards to 'coherence'.

Individual aspects include ethical sourcing as part of material decisions in eco-design (ECI), less different polymers ('there are currently 39 different 1types of basic plastics and polymers used to make an automobile', and a proposal from FEAD to limit the use of non-recyclable materials based on The Plastics Industry Trade Association, 2016).

It should be noted that in their contributions some stakeholders consider recycled content targets as part of the 3R targets, and some connect the recycled content targets with the topic of (eco-) design.

Interviews

Regarding non-recyclable materials, the vehicle manufacturing sector generally pointed out the benefit of using such materials for light weighting due to the benefits during the use phase in terms of emissions reduction. Stakeholders representing the waste phase referred to the obstacle that large amounts of such materials raise for achieving targets but were against their prohibitions, explaining that this would affect innovation, whereas proven materials would increase in use and at some point, suffice to develop manufacturing (with less beneficia ones being used shortly and then abandoned).

ATFs referred to the phenomenon of locking components with digital keys (e.g., window wiper motor, injector, inverter, mirror, window motor, navigation, etc.) as a problem, explaining that it is an obstacle for reuse as a component removed without the key will not be reusable. The information does not have to be free, but the price should not be prohibitive for reuse practices of ATFs. This is understood to particularly affect establishments that work with multiple vehicle models and brands and that do not have contract with specific OEMs. Vehicle manufacturers on the other side claim that the locks are of importance for the safety of vehicles, anti-theft and provision of the data could disclose proprietary. It is not clear what type of data would be at risk. Components that are interchangeable between models and brands were also raised as a type of component where OEMs are reluctant to provide data (e.g., when the same supplier provides multiple vehicles models and brands with the same component) an where this can have an effect on the ability to reuse parts.

As for IDIS, ATFs said that it contained a lot of information but that the level of detail is not always sufficient to support dismantling. Information is not available through IDIS for parts with reuse potential (the objective of IDIS is to support quick dismantling – ensuring that the component remains functional is not always in line with this objective). Though OEMs say that such data can be accessed under the RMI (Repair and maintenance information systems of the OEMs – each is individual to a certain OEM) ATFs complain about the cost of such data. Here too, the information does not have to be free, but the price should be fair to encourage dismantling for reuse.

Some stakeholders state that the 3R Directive calculation is too theoretical, recommending requiring OEMs to also specify how certain parts can be dismantled. The calculation should also reflect the ease or difficulty of recycling a part depending on whether it is a mono-material of not.

Workshop

During the workshop the issue of compliance of automotive manufacturers with diverse regulations was brought up (ACEA). Thus, new regulations should consider the other compliance demands, in particular for passenger safety and environmental protections. Vehicles typically comply the existing regulations on the day that they are brought to the market. The changes in regulations that happen during the vehicle lifetime can be covered by post-shredder technologies.

The idea to combine the ELV aspects from the ELV Directive and the 3R Directive into a single regulation was also encouraged (ECOS). Additionally, it was proposed to bring the EU ELV legislation to the level of the United Nations when looking at lifecycle provisions (UNECE).

Definitions

Statistical OPC

Most stakeholders (56%) agreed or agreed strongly that the ELV definition for **recycling** should be aligned to that of the WFD as this would support a higher level of material recovery. Aside from the automotive producers that were mainly neutral, the majority in all stakeholder categories supported an alignment. Only 3% disagreed with this statement, however there was also a large share of stakeholders that were neutral (40 individuals) or that did not have an opinion (31 individuals) making for a total of 40% together with those that did not specify an answer (13 individuals).

Status of parts to be recycled/**remanufactured** must be clearly distinguished from waste and benefit from same conditions as spare parts. EU should establish a harmonized definition of waste and non-waste for reuse/remanufacturing purpose.

Written OPC

Coherence with the WFD is referred to in a general way (WEEE AUDITS; CRM Alliance) or by pointing out specific needs, e.g., to exclude backfilling from the definition of **recycling** (FNADE) or the need for harmonized definitions of waste and recycling in order to prevent distortions of competition due to different national implementation (FORS). Also, consistency with the landfill directive is mentioned (Plastics Europe). Definition of when a car becomes an **ELV** was also raised (Febelauto) also in the context of vehicles export (FEDEREC), where it should be required to present a valid technical control certificate to authorize their export.

Interviews

It is generally agreed that the definition of **recycling** should be aligned with the WFD to exclude backfilling. Many stakeholders do not expect that this will change the achievability of the 3R targets as backfilling operations are not so common and does not cover all downcycling operations. This is particularly understood to be relevant for glass, which is mainly considered recycled through the post-shredder mineral fraction.

The need to align the definition of **reuse** with the WFD was raised in relation to the later reference to ”preparing for reuse”. Changes to the definition could affect what is considered waste and what is considered a product and need to look into how they work with the definition of ”end-of-waste” to ensure that obstacles are not created for shipments of used or remanufactured parts. A definition for **remanufactured** components should also be introduced to strengthen how such parts are perceived in comparison to reused ones and to ensure that remanufacturing practices fulfil minimum requirements.

A few stakeholders raised the need to define ELVs as compared to **second hand** vehicle so that the differences between these two categories is clearer and easier to enforce for customs to prevent illegal exports.

Workshop

As shared by a car manufacturer representative (Renault), the current legal definition of a new product does not allow inclusion of **remanufactured parts**. This means that a new vehicle currently, in legal terms, may not contain remanufactured elements; the entire vehicle must be made new, though perhaps using recycled materials. This legal issue is not specific to vehicles. However, from a technical perspective, remanufactured vehicle parts are certified as equivalent in functionality and reliability/safety/etc. to new parts and could therefore be acceptable for use in new vehicles. This legal limitation restricts the sale of remanufactured vehicle parts to the repairs market. Also, there is anyway a limited feedstock of remanufactured parts because the long vehicular lifetime means that the current ELVs do not offer many parts for remanufacture. Additionally, the term and definitions of remanufactured parts should be included in the 3R Type-approval Directive.

A definition of differentiating between **pre- and post-consumer** plastics would be helpful as well as applicable definitions of ‘open-loop’, ‘closed-loop’, etc.

In Belgium, each total technical loss means the vehicle is an **ELV**, regardless of the price of repair in the home country or elsewhere. However, total economic loss is not considered in the definition of an ELV; such vehicles may be exported from Belgium as damaged vehicles without any special conditions.

Separate Reuse target

Statistical OPC

46% of the participants either agreed or strongly agreed with the implementation of a reuse target separately from the recycled target. This included all environmental NGOs, most waste operators (53% of the category) and most public authorities (68% of the category). 22% disagreed or disagreed strongly with this option, with the automotive manufacturing sector most often providing these answers (51% of the category).

On the question on which measures would contribute to increase the reuse of vehicles parts, the most common answers were: obligation for repair shops to offer customers used spare parts as an alternative to new ones, obligation for ATFs to remove certain parts of ELVs before shredding to help increase reuse, obligation for car manufacturers to enable (e.g. the ATFs) unlocking parts so that they can be reused and dismantle, and obligation for car manufacturers to provide the dismantling centres (ATFs) information about which parts can be used as identical parts in other models of the manufacturer or even other brands.

Written OPC

When asked to explain their views, the more common views in support of a separate reuse target were that reuse is higher up in the EU waste hierarchy than recycling, also supporting circularity. Others explained that before a part is recycled it could be reused. Specific targets were explained to allow monitoring reuse, in relation to the “quantity of pieces reintroduced in the market” (an indicator of eco-design, and percentage of reuse and repairability) and as an indicator of the “efficiency of treatment operations of the authorized centres”.

Of those that disagreed with such measures it was explained that reuse was mainly economically motivated (if no one needs a particular spare part it’s better to recycle). Though reuse was stated to be important, as reuse is market driven it was questioned if targets would increase the amount of reuse. It was also said that vehicles that are recycled are often too old (20 years) for re-use of parts as well as mentioning that this was also the case for vehicles after a crash. Though reuse is said to be practiced commonly by ATFs, one stakeholder explained that it may not be reported to “avoid reporting taxable income in the ATFs”.

Additionally, separate reuse target worsening quality and safety risks witnessed in the informal refurbished vehicles market. Reuse and recycling should be considered as on par equivalents if separate targets for each were to be created.

Interviews

Regarding reuse, many stakeholders spoke against the idea of separate targets for reuse and recycling, explaining that fulfilment of the one may have negative effects on the other. Obligatory dismantling to promote the reuse of parts was explained to create significant costs while not ensured that the level of reuse would actually increase. ATFs explained that they need flexibility to look at the demand on the market and respond through deciding what components to reuse and which ones not to. This was due to fluctuations in the demand for reused components but also in the quality of components of some models. The example was given (EGARA) of the engine, where some models may have frequent malfunctions, in which case ATFs would avoid their reuse as a minimum guarantee could not be ensured. In some models, malfunctions are very rare, so that dismantling for reuse would result in the engine being stored for years, also creating large costs. Rather ATFs explain that measures should be considered that increase the demand for reused parts, with ATFs than following suit to ensure sufficient supply.

Workshops

Participants commented that decisions concerning remanufacturing are of high relevance in a circular economy, with such processes being essential for encouraging recycling. However, it is not recommendable to strictly consider reuse targets for aspects that may not have market options; ELV parts should not be required to be removed before shredding where there is no market for reselling such parts. It could be useful to consider environmental issues, market forces and overall demand in the recommendation.

A target for reuse/ remanufacturing of parts could potentially be helpful. However, it is necessary to consider the traceability of parts to know which ones would at all be suitable for reuse (as opposed to remanufacturing). It can be noted that the age of a used part may be much younger than the vehicle in which it is found. Safety should in particular be considered, especially for parts relating to vehicle safety (Romania).

Material specific recycling targets

Statistical OPC

The most common answer to this question (31 participants or 15%) supported that the establishment of material-specific recycling targets would increase the separate recycling of materials addressed by targets, their quality, and revenues from sale of such materials while also increasing the costs of recycling. 12 % (24 participants) answered that this would increase separate recycling and secondary material quality while also increasing costs. The same share of participants estimate that such targets would only increase the recycling costs. From 47 respondents in the automotive manufacturing sector, 72% (34 individuals) stated that this would increase costs, while 51% (24 individuals) state that it would increase separate recycling of materials. An increase in separate recycling was supported by all environmental NGOs, 85% (5 individuals) of which also supported that it would increase the quality of recycled materials. Public authorities supported the four options similar, with between 15 and 11 individuals (68-50%) indicating the various options. Waste management most often indicated that this measure would support separate recycling of materials (71%) but also increase the costs (60%).

The vast majority (64%) of stakeholders agreed that material-specific recycling targets have an impact on innovation. This was the most common answer in all stakeholder categories with most categories showing 60-70% agreement. Only 8% were against this, while the rest did not have an opinion (23%) or did not answer (5%).

The most common answer to this question was either no answer (79 individuals or 38%) or that material specific recycling targets would lead to an increase in high quality recycling, in innovative recycling opportunities and processes and in innovative eco-design of products (59 individuals or 28%). The distribution of answers was quite similar among stakeholder categories.

Written OPC

When asked to provide detail on answers, one stakeholder stated that “Targets for the entire vehicle proved to be effective. Splitting the target into different material-specific ones should be done only for improving the quality of recycling and the effectiveness of the directive. They should not be legally binding”. Against the measure it was said that ”some materials are recoverable but without any outlet / market”.

Materials mentioned in the context of specific material recycling were the Platinum Group Metals (PGMs). For glass and plastics, it was mentioned that the costs of recycling are higher than revenues while for electronic components it was assumed that revenues were possible. In some cases, it was stated that this would allow a greater separation of certain materials prior to shredding, like plastics.

Stakeholders provided also further details on the question on ”how material-specific recycling targets would impact innovation” and introduced negative (e.g. documentation/monitoring will be impossible: volume flows in tonnes range, versus quantities in milligram range to be documented; limits the use new materials, e.g., non-recyclables like carbon fibre composite, until a viable solutions has been developed and implemented in Europe) as well as positive sides (e.g.: increase of development of post-shredding technologies as well as processing technologies of secondary raw materials, increase use of secondary raw materials).

Interviews

When asked about the option of introducing separate material targets for reuse, many stakeholders explained that it was difficult to comment on the targets proposed as whether a specific value was achievable depended on how the targets were measured (EUROMETAUX). If recycling is to be measured based on the actual material that is included in the composition of a specific vehicle or based on a theoretical value would make a big difference. Whether reporting is on the total inputs of a materials, the amount sent by operators for recycling or the amount that is actually recycled affects the achievability of a target. Also, for some materials like aluminium, there are big differences in the total content between models. Luxury cars will have higher amounts but are also more often exported, so that an average value may be difficult to fulfil. For steel it was explained that 90% is already achieved. The rate could be increased, however every marginal increase from this level will also increase the costs significantly. On tyres, views were raised that the market is still very much developing in terms of recycling options. Some outlets could be considered to increase the total recycling, but have low acceptability with MS (e.g., rubber turf for playgrounds and sport fields):

Workshop

Material-specific recycling targets should be seen as an addition to the common targets, which are applicable for different actors at different legislative levels. The MS mainly report data from dismantlers, shredders and ATFs, data which is collected from different points in the recycling process. Ultimately, the recycling quota of the MS is reported, not dismantling rates. (Swedish EPA).

Recycled content targets

For key positions of stakeholders on a recycled content target content for plastic please refer to the respective report by the EC Joint Research Center.

Statistical OPC

There was one question on other materials (other than plastic) for which a recycled content target should be considered in the OPC. Though a few materials were mentioned in this respect by about a third of stakeholders (e.g., aluminium, glass mentioned, REE but also PGMs and steel), a larger share of stakeholders (45%) did not provide input, indicating the answers ”none”, ”no opinion” or just skipping the question altogether.

Interviews

Regarding recycled content for other materials, for most metals it was explained that recycling was already quite high, and that a recycled content target would not change this much but rather create competition between (high quality) uses, which will not result in resource savings. Recycled content targets should only be considered where there is a market failure. Positive views were raised for plastics and in some cases for glass and tyres, where high quality recycling is low and where SRM is less common for use in vehicles

Data accessibility

Statistical OPC

In the OPC, when stakeholders were asked to specify what kind of information producers should provide free of charge to ATF, a large number of stakeholders (41%) specified all of the available options, namely, information on:

- where dismantled components can be reused (which vehicle or brands, models, and types).
- how to correctly remove parts with digital components and how to appropriately prepare them for reuse/ installation.
- the duration / effort for obligatory depollution
- the duration / effort for dismantling components for reuse

There was furthermore strong agreement (over 70%) that manufacturers should provide such information in a fair and non-discriminatory manner and at reasonable prices (if any) to all ATFs. Stakeholders were also asked to indicate whether vehicle manufacturers should be obliged to provide information on the content of certain substance groups to support plastic recycling. Here there was a diversity of answers, with a third having no opinion, but also with large support for information obligations on flame retardants (66%), plasticisers (49%) and stabilisers (46%).

Written OPC

Stakeholders emphasised the importance of access to information on vehicle contents for dismantling and safe treatment of vehicles. Though some stakeholders stressed the need for data at model level, in some cases mentioning IDIS. The option to develop a Digital Product Passport was also mentioned as well as the option to use a RFID or a QR code.

Interviews

ATFs raise the difficulties that they experience with the availability of various data types. IDIS was said to include a lot of information however stakeholders of this sector complain that the level of data is not homogenous for all models and makes and that the amount of data on how to dismantle specific parts is not always sufficient to support the process. Availability to data on components that are locked with a digital key is problematic. Though data is understood to be made available by OEMs for a cost, ATFs explain that there is no harmonised system and rather that ATFs need to register for multiple systems, each with separate costs. For facilities dismantling vehicles of multiple brands (and also for repair shops) this makes the use of such data prohibitive as the costs paid for access will depend on how often a system is accessed. Access to data on the contents of hazardous substances may be available through the SCIP data base, but this is not practical to support removal of relevant parts during dismantling. Data is not available as to the contents of hazardous substance at the level of the specific component in a specific model (except data on mercury in components that need to be removed or lead in Pb-acid batteries. This is a problem for example for substances that are prohibited by the POPs Regulation (e.g., DecaBDE) resulting in the need to send plastics with a risk of containing such materials to incineration as the level of content cannot be determined during dismantling for each material part separately.

Workshop

The concern was raised that if the method for making data available to ATFs is in the form of a digital product passport (DPP), that this would probably not all the 250 million vehicles on the road that will take several decades to be treated. Either ATFs would not have data for these or IDIS will have to continue working even if it is not any more the solution and no new information is introduced. Also, in relation to the option of a DPP, it was mentioned that a single system would need to be developed, rather than having multiple DPP for the vehicle.

1.3.3.2 Hazardous substances

Statistical OPC

The OPC had two questions on hazardous substances:

The first on whether the revised ELV Directive should ban hazardous substances in vehicles, taking into account that restrictions on hazardous substances are also specified in other pieces of EU legislation (notably REACH). 66 of the responding stakeholders (32%) were of the view that all substances in vehicles should be regulated in the future under chemicals regulation. The same amount indicated that substances prohibited under ELV should remain there, but that future prohibitions should be addressed under chemical legislation. In practice this would mean that for future prohibitions, 64% of stakeholders would prefer regulation under chemical legislation than under ELV. Only 20% (41 individuals) were of the opinion that substances in vehicles should continue to be regulated under ELV. For waste management operators, public authorities, environmental NGOs and dealers and repair shopped the distribution between these answers was similar. Automotive producers had a stronger tendency to support the options where chemical legislation would be used for future prohibitions as opposed to the ELV Directive. The situation was similar for citizens and their organisations and “others”. Only 6% had no opinion or did not provide an answer.

To the second question, which, if any, additional criteria for evaluating exemptions from the list of substance prohibitions are necessary to allow a more differentiated assessment, the answers were quite variable. This is however also due to the fact that 7 different criteria were proposed as possible answers aside from “none” and “other”. Most combinations were indicated 1-2 times, in some cases having support of 6-9 stakeholders. The most common answers were to indicate all criteria (46 individuals or 22%), none (30 individuals or 14%), no answer (28 individuals or 13%) and the “Criterion on comparison of the use of the restricted substance with that of available substitutes in terms of environmental and health impacts (15 individuals or 7%). All other combinations received less support.

Asked to provide additional detail, stakeholders stated that:

- No exemption to the list of substance prohibitions in the ELVD, except for limited transition, if needed. Substances meeting the criteria for CLP & SVHC under REACH should be banned. The ELVD should allow for additional chemicals to be banned,
- The prohibitions and Annex II of ELVD needs to be aligned with other EU legislations (REACH, RoHS, Batteries) concerning hazardous substances (3 stakeholders),
- impossible to give a "single" answer to this incredibly complicated question: as for flame retardant: you prefer the vehicle burn, or the people are exposed to a possible endocrine disruptor chemical? the answer is not technical, it is political (courage)
- Other criteria mentioned:

- CO_2 footprint assessment (2 stakeholders),
- To check whether the use of the substance creates a risk impossible to manage or prevents recycling,
- Full life cycle consideration for the existing substance & substitute (2 stakeholders),
- Balanced approach for chemicals management, climate aspects and circularity (2 stakeholders),
- Technical and economic feasibility (2 stakeholders).

Interviews

Many stakeholders when asked about the options of having all prohibitions under one legislation (ELV or REACH), did not really consider this option. Though certain stakeholders prefer REACH for (further) substance restrictions (material suppliers and recyclers), they explain that they would rather leave the exemptions for the four heavy metals under ELV as the review mechanism is already established. Vehicle manufacturers were the only ones that clearly favoured the alternative of having all restrictions under ELV. Though some general statements were made as to costs of the exemption process or the environmental benefit that accrued so far from the prohibition of the 4 heavy metals, these were not quantified or e.g. explained in relation to how costs break down into specific activities.

Written OPC

with regards to the prohibition of hazardous substances, coherence with REACH and CLP are mentioned in support of less hazardous substances (Anonymous, FNADE, Swedish Government), reminding to the current obligation for reporting in the SCIP database to assist recyclers with understanding if SVHCs are present or not is also relevant here. (FNADE; Plastics Europe), for the assessment of hazardous substances, uses and exposure as established for the risk assessment under REACH should be considered (Plastics Europe). Some stakeholder raised very singular aspects.

Workshop

The discussion on the hazardous substances part was surprisingly vivid. Some participants stressed in the chat that they prefer REACH as central legislation for substance restrictions because REACH became a robust legal instrument, and that this horizontal legislation should be referred to in all product legislation that restrict the use of substances due to risks. Also the coherence issue was noted to avoid different interpretations of legislative text or different content of definitions.

On the other hand it was argued that so far REACH restriction is however barely covering chemicals in products as until now this only appears for textiles and PAH in rubber. A participant from NGOs claimed that substances that meet the criteria for SVHC under REACH and meet the CLP criteria should be prohibited in the new ELV Regulation for supporting a toxic-free environment policy purpose. Other participants however reminded that the "hazard" approach does not sufficiently support “a true circular economy” as contaminants might always remain in materials that are however embedded in the solid material and no health problem occurs. For this reason, the participant reminded to the risk approach, with exposure scenarios, which, in the case of a vehicle is relatively easy to define.

Besides, various participants reminded the difficulty of the time span until vehicles reach their end-of-life that makes the information on chemicals difficult (“How should the recycler and the automotive manufacturer know if they can use the material in a new car?” – “If you start now a digital product passport etc. the result will (perhaps) be visible/useful in 20years.”) To solve this problem it was proposed to define specific exemptions not only for spare parts but also for recycling material. Participants argued that though this would not be in line with the aim of a non-toxic environment of CSS, there is a risk that material will not be recycled because of legal risk or additional burden, which makes the circular business unprofitable.

1.3.3.3 Collection / Missing vehicles

Statistical OPC

That a charge applicable to the owner during periods of temporary de-registration would help ensure that owners follow their obligation to report any change of ownership or export to the authority was strongly supported by environmental NGOs, waste operators and public authorities. Only 11% were against this measure, mostly represented by consumers and their organisations who would also be the most negatively affected by such a measure. A vast majority agreed that better traceability should be established between the EU Member States' registration systems on a legal status of a vehicle until its final deregistration. Including a roadworthiness test as a condition was considered by the largest number of stakeholders as an appropriate measure to overcome the problem of 'illegal exports' of ELVs and of exports of ELVS as used vehicles. Compliance with certain environmental criteria was the second most favoured, followed by conditions on maximum age or on maximum mileage. Among 14 different options for reducing the number of missing vehicles, over half of the participants (52%) indicated a combination of at least 6 of the various options which shows the high support for the implementation of additional measures to reduce the problems related with missing vehicles. A total of 46 participants (22%) did not provide an answer, 17 of which were from the automotive producing sector.

Results of a stakeholder consultation held in the course of the study on the ELVs of unknown whereabouts (Mehlhart et al. 2017) can provide additional insights as to the pros and cons of the various options. Due to former public consultations on the aspect of vehicles of unknown whereabouts, exported vehicles and collection, this OPC did not put a strong focus on this topic, but only asked the questions summarized above. To display a comprehensive stakeholder feedback on the topic, the OPC results from a study in 2016 can be found in the following box:

Excurse: Open Public Consultation in 2016
The `Public consultation on potential measures to improve the implementation of certain aspects of Directive on end-of-life vehicles, with emphasis on vehicles of unknown whereabouts´ was open for twelve weeks from 29 June to 21 September 2016.
The objective of this public consultation was to receive the views of stakeholders concerned with the topics of the consultation.
The online survey covers 6 topics below:
1. Keeping track of vehicles within the EU (intra EU trade);
2. Methods to achieve more complete reporting on extra EU export and ways to distinguish between exporting ELVs vs. used vehicle;
3. Enforcement techniques to reduce illegal dismantling of ELVs at dealers and repair shops (garages) and actions to improve ATF compliance;
4. Public awareness and incentives for ELV tracking and environmental risks;
5. Aspects to improve coverage and data quality when reporting on ELVs (possible revision of the Commission Decision 2005/293/EC);
6. Persistent Organic Pollutants (POPs) and ELVs.

According to the conclusion from the OPC in 2016[12], "there is a broad and joint understanding among all stakeholders that the current procedures need further improvement to keep track of vehicles and to

[12] Mehlhart et. al (2017)

strengthen the requirement to issue and present a CoD. This applies for the provision of evidence on the vehicles fate during a temporary de-registration and also applies for fines to owners which do not provide statement of whereabouts for such temporary de-registered vehicles.

Most of the stakeholder support the implementation of economic incentives for instance fees or refund systems to ensure that ELVs are delivered to ATFs. Only car manufacturers and importers oppose such economic incentives.

With regard to the extra EU export of used vehicles (some of them possibly to be considered as ELV) the proposal to make Correspondents Guideline No 9 legally binding, many stakeholders oppose this proposal. Several stakeholders argue that the current version is difficult to apply, and adjustments are needed before making the stipulations legally binding. Also, the approach to ban the extra EU export of used vehicles was not supported by the stakeholders. Instead, the stricter enforcement of inspections (when exporting) cooperation between IMPEL, police and customs services and the adjustment of reporting on waste shipment found strong support by all stakeholders.

With regard to the fight against illegal treatment within the EU the majority of stakeholders acknowledged the need for action in particular the need for national/ regional authorities to perform regular inspections of the sector (not only ATF and shredders but with a broader scope for garages, repair shops and spare part dealers) to identify illegal operations. Comments expressed the concern that improved burden to ATF only might even cause adverse effects (more illegal operator) and inspections should carefully focus to support legal operating facilities.

The proposal to establish minimum requirements for such inspection activities is less supported and partly rejected by the car manufacturers and importers. Again, proposals to establish economic incentives to strengthen the legally operating sector are opposed by the car manufacturers and importers. The proposal to improve the reporting mechanism when issuing a CoD and upon arrival of an ELV at ATFs or shredder facilities was in general supported, including the establishment of electronic notifications to the registration authorities.

Supporting public awareness for the management of ELVs is considered as relevant by the stakeholders. While penalties to car owners not fulfilling their duties are supported by the vast majority of stakeholders, incentives based on funds/ deposits are again opposed by the car manufacturers and importers.

With regard to the very specific questions how to address aspects of the unknown whereabouts in the Commission Decision 2005/293/EC the number of contributing stakeholders decreased slightly however beyond 100 contributors provided their option accordingly and supported effectively all proposals with a vast majority or at least did not oppose."

All replies of the stakeholders to the manyfold questions in details can be found in the mentioned report "Assessment of the implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end-of-life vehicles of unknown whereabouts[13]" published by the EC in 2017.

Written OPC

The topic was of high interest for stakeholders providing written input. Of 57 contributions, 15 contained information or opinion on vehicles of unknown whereabouts, 13 on (de-)registration, and additional 6 on reporting. Contributions on these topics were received from all stakeholder groups.

Workshop

Topics discussed at the workshop following the presentation of the consultants on the topic of missing vehicles were the

- The suitability of road-worthiness test where various stakeholders have different opinions on details of the use of such test, however, it is seen a "key question";
- ELV registration competencies, e.g., a MS representative pointed out that EU-wide information exchange (database) on CoDs accessible by the EU registration authorities would be an effective tool, industry agreed. It was clarified that EUCARIS, the data exchange mechanism for vehicle data in Europe, does already have a CoD-message in place to exchange the CoD-info across Member States. EUCARIS is used by all EU Member States, however the CoD-message is currently not being used;

[13] Mehlhart et. al (2017)

- vehicles deregistration, e.g., in relation to the limitations of temporary deregistration, harmonized rules, and automotive industry requested that an automatic deletion from the registration systems after seven years for example like in some MS should not be continued
- recyclers pointed out to the responsibilities of insurance companies and
- total technical loss status, but also the definition of an ELV compared to used vehicles

In general, many stakeholders engaged in the debate. Many of the stakeholders participating in the debate shared perspectives and experiences from MS, e.g. from Sweden or Germany (MS representatives), the Netherlands (stakeholders engages in repair and dismantling and EPR), Belgium (representative of the EPR system) or Latvia, Poland, France etc. (recyclers). It was pointed out by industry that national systems may pass their competences and jurisdiction to the higher level. Further, a representative of the Dutch EPR said that a good cooperation between the Ministry of Environment and Ministry of Infrastructure/transportation (etc.) is key […] to be able to monitor ELVs. Another idea presented by stakeholders were ‘massive citizens information about legal way to dispose your ELV’ (recycler + manufacturers).

1.3.3.4 EPR System

Statistical OPC

In the OPC, most stakeholders agreed that in order to ensure a high quality of recycling, that it is necessary to compensate the ATFs for their dismantling efforts, which are not economically viable under the current conditions. This was mainly supported by included environmental NGOs and consumer organisations, waste management operators, public authorities, and citizens but also a fair share of automotive producers (32%). When asked in more detail, 56% of all stakeholders agreed that producers should compensate the ATFs for their dismantling efforts and for appropriate treatment and disposal of these wastes. Here, waste management operators were the most prominent in their support of this aspects.

Written OPC

A few written contributions addressed Extended Producer Responsibility aspects, some only as a simple need that has to be implemented and others with more elaboration. Several stakeholders explained the purpose of an EPR scheme to be to affect the design of products so that they result in less negative environmental impacts. Others see the EPR scheme mainly as a funding opportunity to e.g. to balance costs for dismantling in particularly when secondary materials are more expensive than virgin materials, to boost investment in high-quality PST through economic incentives. One stakeholder raised the concern that the creation of an EPR monopoly in which producers have power over where finances and ELVs end up could end up limiting the free and fair competitiveness of the current network of dismantlers and shredders.

Interviews

Waste management operator look at the establishment of an EPR positively, in particular where it is necessary to support the financing of components of materials that need to be dismantled and treated in a way that is not economical. Though EPRs is exist for some MS, a difficulty was raised that they are usually run by OEMs without involving ATFs in their management. The difficulties in managing funds for a European EPR were raised in light of the frequent exports between countries and also the different costs that waste management results in in each country that would make setting a single fee for an EPR fund at EU level tricky.

Workshop

Participants commented that there are concerns about what entity has authority over EPR schemes. A few stakeholders mentioned that funds have not shown big advantages to support the economic feasibility of ATFs and stated that the processes that ATFs should treat vehicles and then producers have to cover negative market value vehicles is the direction that the EPR should develop, with it being established in the Directive. In contrast it was mentioned that funds were effective in compensating unprofitable labour (material dismantling), allowing the dismantler to compete more effectively with the illegal sector and being less dependent on enforcement. A few stakeholders raised the aspect of the CoD and the need for more enforcement to lower illegal exports leading to less vehicles being treated in the EU. The EPR was mentioned as an option to address the problem of cars going to other continents and not just for ensuring financial feasibility of ELV treatment.

1.3.3.5 ELVD Scope

Statistical OPC

For almost all stakeholder categories participating in the OPC, over 50% of the individual answers were in favour of extending the Directive additional vehicles. The highest support of this option was given by environmental organisations (100%), public authorities (90.9%) and waste management stakeholders (85.7%). On the question which additional vehicles should be included into the scope of the ELV Directive, the majority was in favour of adding motorcycles and trucks with a higher preference for trucks from the waste management operators and a higher preference for motorcycles from the manufacturers.

Avoidance of environmental harms to the environment thanks to minimum requirements for end-of-life treatment, increased resource recovery and increased recyclability were the top 3 important advantages of extending the scope of the ELVD largely supported by all stakeholder categories. Individual stakeholders explained that including them in the scope would increase the supply of recycled materials and lead to better dismantling, that heavy vehicles are exported to a larger extent than cars and reuse of spare parts is not as developed. And illegal vehicle dismantling, and unfair competition take place. This should be dealt with in the legislation. One third had no opinion on disadvantages of the scope extension. The most supported individual answers were that “These other vehicles (e.g., motorcycles and trucks) have features which are different from the vehicles covered by the ELV Directive, so that the provisions of the ELV Directive are not adapted to these other vehicles” (62 individuals or 30%) and “Higher burdens for SMEs” (48 individuals or 23%). Answers were distributed relatively evenly between the various categories. The stakeholders themselves relativised their statements on disadvantages when asked to detail: Though, “motorcycles are small, so it will be a lot of work for a very small number of materials”, and “trucks are big and require specialised facilities for dismantling”, stakeholders say that “recycling facilities are suitable for all of the ELVD scope”. “Today these vehicles [it is not clear which] are already treated in authorized facilities even if they are not covered by the scope of the Directive.” Or: “The ELV change will result in some system changes and investment costs. It however involves an investment for the future. If the demand for recycled material is successfully established, it will pay itself back.”

More than one third of the stakeholders did not have an opinion on / did not know the areas where compliance for motorcycles and/or trucks would be difficult, and 15% said there are none. About 20% support that the following measures may be difficult to comply with: Material-specific recycling targets (45 individuals or 22%), reuse target (47 individuals or 23%), and recycled content target (38 individuals or 18%).

Written OPC

Various stakeholders from the motorcycles sector contributed additional information: ACEM emphasises that the sector consists of many SMEs that have no experience with the requirements of the current ELVD. Besides the quantitative results from a survey on the numbers of recycled motorcycles in Finland, SMOTO brings forward the concern that the common reuse practices could be undermined by the perceived focus of the current ELVD on recycling rather than reuse. An anonymous stakeholder (motorbike manufacturer) proposes non-reusable parts for motorcycles in addition to those listed in Art. 8 of the 3R Type approval Directive for M1 and N1[14]. FORS (a Polish recycling association) speaks for the practice of certificates of destruction for end-of-life motorcycles. A recyclability target is preferred whereas recycled content targets and reuse targets are explicitly not recommended for motorbikes (Eurofer).

For trucks, Swedish Government considers it important to distinguish between light and heavy-duty vehicles. If trucks were included, the Czech Ministry of Environment sees “problems in their size and different composition of materials”. Generally, for new vehicles in scope, the regulation should prevent the phenomenon seen for missing vehicles, i.e., the avoidance of the EU end of life treatment requirements (Swedish Governmental Agencies).

Six contributions focus on historic cars and motorcycles. Current practice of exempting historic cars should be pursued.

Interviews

Relevant interviewees are ACEA and ACEM presenting the manufacturers of trucks and L-type approved vehicles, and ANERVI/AETRAC, EuRIC and EGARA representing the EoL stakeholders. To describe the status quo of the dismantling of lorries, the main messages in the interviews were that lorries are not just bigger cars, that depollution is in practice in some MS, that lorry recycling infrastructure is different in different MS, and that ATFs that can manage a lorry also manages trailers. As for the status quo of EoL treatment of motorcycles, it was noted that reuse is important, that L-type approved vehicles have no chassis which is relevant for the definition of what is an ELV. Then, a very small number of L-type approved vehicles are returned to recyclers, and that there is no statistics on motorcycles, e.g., no separate waste code, right now.

In relation to potential regulation covering additional vehicles, the clear message was sent that vehicles different to M1 and N1 vehicles require specific rules, e.g., that the same 3R targets could not apply, and that these vehicles potentially require different exemptions from heavy metal restrictions (or new substance restrictions).

[14] wheel suspension (front / rear) incl. triple clamp, swing arm and all damping parts, handle bar, all kind/material of rims, sub-frame, all kind/material of fuel tank

Workshop

Views differed on exemptions for hazardous substances in additional vehicle categories. Vehicle manufacturers were in favour of a category specific Annex II, i.e., to review the application of existing Annex II bans per vehicle category. The issue was also brought up in relation to multi-stage built vehicles, incl. wheelchair accessible vehicles. There is also difficulty if more than one vehicle category applies to a vehicle.

Stakeholders broadly support that it is currently not foreseen to recommend applying the 3R Type approval Directive to multi-stage built vehicles.

In the workshop, various participants of all stakeholder groups commented on the presented data and/or provided additional data (on the calculation of the fleet of motorcycles and lorries, on actual fleet data from Spain and Germany,). ACEA is currently performing a study on lorry, with results expected in September 2022.

A representative from the European Environmental Bureau (Environmental NGO) stated that, if the scope of these Directives is currently being discussed, the discussion should not be limited to a scope for only on-road vehicles.

1.3.3.6 3R Type Approval and its relation to the ELVD

Current situation. Questions were asked to understand better the role of type-approval technical services', the type approval authorities', and the OEMs in the process of type-approvals in general as well as the special part of the 3R type-approval in particular. Because this is more for the understanding of the current situation, the answers are not summarised here. Stakeholder statements were used in Annex II of the main report when describing the process.

Effectiveness. Type approval authorities state that the Directive generally facilitates the achievement of the 3R targets. This is also supported by OEMs. However, this is not supported with data. Stakeholders are of different opinion in relation to whether the 3R Directive facilitates "high-quality" recycling. There is no systematic monitoring or studies that compare between the targets reported in type approval declarations of OEMs for specific vehicle models and between their actual performance at end-of-life. Quantitative feedback is scattered:

- The number of 3R Type Approvals performed per MS varies largely: Some have not performed any TAs since Directive 2005/64/EC came into force (e.g., Latvia, Finland) but do report on Regular TAs for second stage of N vehicles. Some perform 3R Type approvals regularly (6-9 per annum).
- One authority estimated the costs for the process at "< 0.25 years FTE per each 3R type approval"
- Some MS collect fees for the TA, and some do not – sum also depends on certificate type (0-600 €).
- 3 of 5 MS agreed that the 3R TA should cover all stages of multi-stage vehicles (2 did not answer the question)

A second cluster of question was asked around the possible future amendments of the ELVD. In general, little to no input is provided on impacts of introducing certain measures proposed to be changed in the 3R Directive. One stakeholder (stakeholder shall not be named) is of the opinion, that the scope of the 3R Directive should be extended to include additional vehicles. Reference to the preferred TRL level of recycling technologies accepted in the ISO calculation varied widely between 3-4, 6-7 and 9.

On the merge of ELVD and 3R Directive. Of the interviewed stakeholders, one is of the opinion that there is a missing link and missing references between 3R Directive and ELVD. No stakeholder clearly indicated that the stakeholder preferred a merge of 3R Directive and ELVD or that it would be meaningful, MS that perform 3R Tas were against a merge with ELV. At least, two times China was provided as an example where one legal instrument is in place, however, the European market would be more diverse according to stakeholders. Looking at the stakeholder groups that provided their input on this topic, it should be noted that the stakeholders rarely take the perspective of the end-of-life. An ACEA position paper (ACEA 2022) refers to the positions of the automotive industry in relation to the merge of 3R Directive and ELVD: ACEA "call[s] for the current legal framework to be maintained." Rather than focusing on recyclability, they would like to see their engagement in the field of emission reductions during the use phase, i.e., strategies focusing on light weight, acknowledged framing it Design for Sustainability.[15] Another argument put forward (stakeholder shall not be named) is that currently, the responsibilities are distributed, i.e., recyclers fulfil the ELVD, and manufacturers fulfil 3R Directive requirements. A merge of the Directives producing a legislation with joint responsibilities could increase innovation times and create longer discussion processes.

1.3.3.7 List of documents available to EC in addition to the synopsis

- **Public feedback**
  - Feedback is available to the EC
  - Already online available under https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

- **Online public consultation (OPC)**
  - Export of data from online questionnaire is available to the EC
  - Stakeholders' written contributions are available to the EC
  - Summary report already available under https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/public-consultation_en.

- **Targeted consultation (main study + 3R type approval interviews)**
  - Confirmed interview documentations
  - Additional studies or written input sent with the interviews
  - List of confidential or non-confirmed interview documentations

[15] ACEA „want to point out that, necessary new and innovative materials for achieving the ambitious goals for targeted carbon neutrality in 2050 for vehicles might not have appropriate recycling technologies on industrial scale available yet."

- **Stakeholder workshop**
  - Analysis of Slido (interactive tool) questions
  - Documentation of the chat of the online meeting
  - Lists of attendees (contains personal data)

- **Consultation of Member States**
  - Answers of MS to ad-hoc survey are available to the EC
  - List of registrations[16] of MS expert workshop (contains personal data)
  - Documentation of the chat of the online meeting

- **Follow up consultation activities after the workshops**

Stakeholders' written contributions sent after the workshop are available to the EC.

1.3.4 Data availability

1.3.4.1 Objective 1 (scope)

The analysis on the possible extension of the scope of the Directive has shown that there are many data gaps related to the issues researched for the purpose of the analysis:

- For consistency with other EU initiatives, fleet numbers from EU modelling activities, e.g., PRIMES, shall be used. This dataset does not include the full picture for category of L-type approved vehicles and trailers, see Annex I, chapter 6.1.1 on the completeness and robustness of existing data.
- There is no general comprehensive summary of data on the **material composition of the vehicles not in scope** of ELVD available but only compositions of individual models in specific studies, e.g., LCA. Thus, the conclusions drawn in relation to material-specific & weight-related aspects not covered by the ELVD are subject to high uncertainties.
- It is not only the case that there is no general comprehensive summary of data on material composition, but there is also **no specific data for the different drivetrain technologies**. The analysis in this problem area therefore has shortcomings in the sense that only one material composition is available for calculation of material-specific and weight-related conclusions, although data available for the fleet allows to distinguish, at least for buses and lorries, between different drivetrains.
- As for the end-of-life management of vehicles not in scope, **regulation is MS-specific**, if it exists, thus, reporting on ELVs not in scope of ELVD is not available on EU level. Moreover, the situation is expected to be different in different MS, e.g., due to more or less established cultures of repair and reuse, or due to the existence of EoL management infrastructure in a MS, e.g., for lorries and buses. In addition, EoL stakeholders may vary among the MS.
- Data on **good practices for circularity** of vehicles not in scope of ELD is **sporadically** available, however, does not allow to draw general conclusions on the status of circularity for ELV not in scope.

For this reason, the assessment currently relies heavily on stakeholder statements.

[16] For technical reasons, we have not downloaded a list of attendees in this case.

1.3.4.2 Objective 2 (circularity)

The analysis on possible options to improve circularity in the design, production and end-of-life treatment of vehicles has shown that there are many data gaps related to the issues researched for the purpose of the analysis:

- Data on the existing type approval process is based on input from relatively few stakeholders and was often submitted on a confidential basis. This makes quantifications challenges and results in many impacts being referred to quantitatively.
- Other chemical legislation that regulates substances used in vehicles is also under review in parallel to this study. As there is no clarity in how such legislations shall change, the analysis relating to hazardous substances is qualitative in nature.
- Data on costs and benefits related to reuse/remanufacturing of various components is only available for few components, making the estimation of impacts of various measures difficult.
- Data on dismantling costs is only available for a sub-set of vehicle components and limits the possibilities to quantify impacts at vehicle level, e.g., impacts on dismantling or subsequent reuse and pre-shredder recycling. In so far, quantifications are provided for specific components to provide an indicative quantification, however how this applies at vehicle level has uncertainties.
- Little data is available about the costs of specific treatment. In particular the lack of data on dismantling, shredder or PST treatment.
- There are some findings of shredder/PST facilities available, however their outcomes are difficult to compare, and, in some cases, they are contradicting each other.
- Very little data is available on the capacities of PST plants and their locations in the EU.

For this reason, the assessment currently relies on single statements or makes assumptions.

1.3.4.3 Objective 3 (missing vehicles and illegal export)

The data availability is assessed in 2011 and 2017 in two studies for the EC, coming to the conclusion that it is with best effort not possible to find or calculate valid date for the national whereabouts of vehicles. And the objective is here to overcome this problem of inadequate data. In this case it is that relevant as without these data it is not possible to prove that all ELVs are treated according to the requirements of the ELV Directive (and its future revisions) and thus jeopardizing or putting in question relevant parts of the legislation.

2. Current situation and potential measures

2.1 The circularity of vehicles

2.1.1 Introduction

In December 2019 the EC published a Communication on the European Green Deal[17], which among others refers to the heavy linearity of the EU's industry, which still relies heavily on primary materials ("only 12% of the materials it uses come from recycling), and where resource extraction and processing of materials, fuels and food contribute to "half of total greenhouse gas emissions and more than 90 % of biodiversity loss and water stress". The document stresses the need to accelerate the shift towards circularity and intends to "support and accelerate the EU's industry transition". The Communication further refers to some of the actions planned as part of the Circular Economy Action Plan (CEAP)[18], which are of relevance also to the automotive sector as is clear from the following sections. This includes among others:

- Support of the circular design of products,
- Prioritise reducing and reusing materials before recycling them,
- Strengthening of extended producer responsibility,
- The use of an electronic product passport to provide information on a product's origin, composition, repair and dismantling possibilities, and end of life handling,

The Green Deal Communication also states that the EC will "consider legal requirements to boost the market of secondary raw materials with mandatory recycled content" among others for vehicles.

The CEAP, explicitly addresses the revision of EU legislation on end-of-life vehicles with a view to prevent waste, increase recycled content, promote safer and cleaner waste streams, and ensure high-quality recycling. The CEAP *inter alia* aims at a reduction of waste by linking design issues to end-of-life treatment and introducing rules on mandatory use of recycled materials for the construction of vehicle components. For instance, the uptake of recycled plastics and more sustainable plastics in vehicles is a targeted measure of the CEAP. Further, it imposes efforts to promote more circular business models in the automotive industry, incentivizing innovation, among others by applying product-as-service solutions and eliminating waste and pollution. Changes towards more widely adopted innovative (eco-) design of products could promote high quality recycling particularly for specific parts and components, which should be removed safely and treated properly, along with recycling opportunities.

In the context of circularity, the recently adopted Chemicals Strategy for Sustainability also strives for a safe and sustainable-by-design approach and for non-toxic material cycles: "it is necessary to ensure that substances of concern in products and recycled materials are minimised. As a principle, the same limit value for hazardous substances should apply for virgin and recycled material". This could affect in practice the recycling of certain materials, in particular those with long lifespan that contain substances that were not regulated at the time of production, but which have since then been restricted (legacy substances) and thus may still end up in waste streams for many years to come, mixing with cleaner materials.

[17] COM(2019) 640 final

[18] COM(2020) 98 final

In the current ELV Directive, design for circularity is addressed by Article 4(1)(b) which, as a means for promoting the prevention of waste, requires Member States to encourage, "the design and production of new vehicles which take into full account and facilitate the dismantling, reuse and recovery, in particular the recycling, of end-of life vehicles, their components and materials". However, the current ELV Directive lacks coherence to other legislation regarding the circular economy. Williams et al (2020) summarise in their evaluation report on the ELVD, that "many of these provisions are not sufficiently detailed, specific and/or measurable. As a result, they have not brought about real improvements at the EU level to match the expectations that the car industry should truly become a circular industry". The Commission staff working document on the evaluation of Directive (EC) 2000/53[19], published in March 2021, also refers to these limitations, stating that "the ELV Directive needs better consistency with the objectives of the European Green Deal and the Circular Economy Action Plan. The ELV Directive does not sufficiently address key areas, notably waste prevention, including eco-design of cars to facilitate re-use, repair, remanufacturing, and recycling."

Williams et al (2020) further state that "The provisions of the current ELVD on design for recycling miss the opportunities to improve vehicle design and maximise the recovery of valuable resources". Though it is the intention of the Directive to promote design for reuse and recycling, the ELVD evaluation study concludes that the general formulation of this measure has not led to it having a significant impact and suggests including more verifiable eco-design measures in the directive. (Williams et al, 2020).

2.1.2 Current situation

To better understand the distance between how the vehicle sector is expected to develop towards circularity and the scope of activities that currently exist in the sector, affecting the flows of primary and secondary materials, it is first necessary to look at the current status of materials in the current situation. The following sub-sections attempt to shed light on how the design and end-of-life waste management of vehicles affect the flow of various materials throughout the value chain. The first sections look at this from the perspective of the value chain, starting with the design of vehicles and the background for material choices. This is complemented with a sub-section on Directive 2005/64/EC (3R Directive) which forms an interface between the design phase and other life cycle phases, in terms of ensuring that any legal requirements to design vehicles, with a view to facilitating their waste management, are complied with prior to the vehicle being approved for the European market.

This is followed by a section on reuse and recycling of vehicles, explaining how various ELVD provisions have been implemented and what is achieved under in the status quo of waste management. To complete the life cycle and seeing as the integration of secondary materials in vehicles has a reliance on the amounts and qualities of recyclates resulting from the waste management, the market conditions for recycled content in vehicles are detailed. As these sections provide only some concrete examples as to specific materials and components, a final section provides detail as to the status quo of various materials, their use in vehicles and how they are dealt with at end-of life. This background is to allow to better understand the problems and shortcomings of the current ELVD and the related 3R Directive and how they correspond to the general objective of increasing the circularity of vehicles.

[19] See SWD(2021) 61 final

2.1.2.1 Design for circularity

To promote the prevention of waste (e.g., facilitate recycling and reuse and avoid the need to dispose of hazardous waste) Article 4(1) of the Directive requires Member States to encourage vehicle manufacturers:

- to limit the use of hazardous substances in vehicles, reducing their use from the conception of the vehicle onwards,
- to design and produce new vehicles taking account and facilitating the dismantling, reuse, and recovery (in particular the recycling), of ELVs, their components and materials, and
- to integrate an increasing quantity of recycled material in vehicles and other products, in order to develop the markets for recycled materials.

Some Original equipment manufacturers (OEM) are already investigating how to introduce more circularity into the automotive business. This serves as a starting point to consider if certain measures could lead to broader benefits when applied evenly in new vehicles placed on the European market, through the EU type approval process which creates a level playing field for all manufacturers.

For example, Renault tries to integrate more circularity through using “recycled and recoverable materials” such as recycled textiles in the new Renault BEV model ZOE. They also consider how certain vehicle components could be used for other purposes, such as in the case of 2nd life for batteries.[20] Renault also refers to reconditioning of parts (or remanufacturing) to allow their use when repairing other vehicles.

With a look to the future, BMW[21] has set an aim to build a recycled electric car by 2040, referring not only to its composition from recycled materials but also to its being emission free. This is assumed to mainly refer to the use phase, as it can be understood that use of secondary materials would reduce emissions of the vehicle supply chain, but not eliminate them completely. Whereas BMW states that its new cars are currently made with close to 30 % recycled materials, the new circular-based approach should increase this to 50 % recycled content. “After the materials reach the end of the product life cycle from the car, the aim would be to reuse them once again in another model to create a circular vehicle production chain”. On the use of recycled plastics, the company states (2021) that 25 % renewable raw materials and recycled plastics were used in the interior of the BMW i3. The textile upholsteries are made of up to 100 % recycled polyester, produced using 34 % PET. A further 25 % recycled plastics are used in the exterior.

In relation to reuse, BMW claims that “by choosing remanufacture – the industrial processing of used parts to bring them up to the same standards as new parts – over the manufacturing of new parts, reductions of 85 percent of the raw material and 55 percent of energy can be made”[22]. Though reuse and remanufacturing of parts are practiced in the automotive industry, the scope of this practice and its further potential is unclear as is explained in more detail in 2.1.2.2.

In the search for innovation some trends may contribute to improving the performance of a car but need to be considered also in terms of their contribution to circularity and to the total carbon footprint of a vehicle. For example:

[20] See further detail here: https://group.renault.com/en/news-on-air/news/circular-economy-moving-up-a-gear/

[21] See further detail here: https://www.energylivenews.com/2021/09/08/a-recycled-car-bmw-says-yes/

[22] See: https://www.bmwgroup.com/en/responsibility/sustainable-stories/popup-folder/circular-economy.html

- Increased use of lightweight materials in vehicles like composite plastics, carbon-fibre, and fibre- reinforced materials may also necessitate more up-to-date eco-design strategies to be included in the ELVD. The use of lightweight materials in the BMW i3, such as a carbon fibre passenger cell and an aluminium drive module, are said to reduce the vehicle weight and thus increase also its range (BMW 2021). However, how the recycling of carbon fibre plastics can be ensured in practice or whether a trade-off between recyclability and carbon footprint of the vehicle is acceptable is still to be investigated.
- The increased use of electric components in vehicles has also become prevalent to support new functions and to improve performance. Such components often contain various critical and precious metals and are thus of interest at the end-of-life stage as possible sources for secondary materials. However, it is not clear if such components, for example printed circuit boards, are removed from the vehicle prior to shredding as it is required for example under the Waste electric and electronic equipment (WEEE) Directive. Whether this is just a matter of better design for dismantlability or also hindered for other reasons is still to be seen, however electric components are often intensive in various valuable and critical raw materials and their recycling would likely improve were they removed and sent to separate treatment or reuse. In this respect, EGARA (2020) states “What is also necessary is info how to make parts work. Today’s parts have a digital component. If the right procedure for digital installation is not followed correctly, perfectly good parts are not usable.”

2.1.2.1.1 Design for dismantling (to support reuse/recycling)

As regards materials and parts that are to be dismantled from an ELV when it arrives for treatment, clear obligations for depollution and removal of certain parts and materials are detailed in Annex I of the ELVD. Section 3 of Annex I of the Directive requires the depollution of batteries and liquified gas tanks, potential explosive components, (e.g. air bags), vehicle fluids (e.g., fuel, oils, cooling agents) and components containing mercury. Section 4 requires removal of catalysts, components containing copper, aluminium and magnesium, tyres, and large plastic components (bumpers, dashboard, fluid containers, etc) when these cannot be segregated in shredding processes, as well as of glass. Though the term depollution is not defined under the ELVD, it is assumed that it requires parts and materials to be separated from the vehicle prior to shredding and treated separately. In contrast, the term removal, also not defined under the Directive only means that the material needs to be separated from other materials at some stage but leaving more flexibility on whether this is prior to shredding or not. The directive furthermore does not make a clear relation between the need to depollute or remove a component or material and the ease or economic feasibility of doing so. Additionally, according to the rules on the monitoring of the reuse/recovery and reuse/recycling targets[23], data on various materials from de-pollution and dismantling are reported on a voluntary basis, whereas disclosure of the sum of these materials is mandatory (more information on reporting can be found in the chapter 2.1.2.2).

Though the Directive refers in Article 4(1) to the facilitation of dismantling, it does not give much detail as to how manufacturers should do this. Article 8 of the ELVD addresses ‘*Coding standards and dismantling information*’. It requires producers to “*use component and material coding standards, in particular to facilitate the identification of those components and*

[23] Commission Decision of 1 April 2005 laying down detailed rules on the monitoring of the reuse/recovery and reuse/recycling targets set out in Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles (2005/293/EC).

materials which are suitable for reuse and recovery". Commission Decision 2003/138/EC[24] was published in February 2003 and specifies which nomenclature of ISO component and material coding standards should be used for identification of certain plastic and rubber parts. However, as in the case of Art. 8, the decision only requires identification of some material parts (plastic and rubber). This can make it easier to identify parts of a certain composition and above a certain size but does not facilitate their dismantling in terms of specifying the time and tools required for supporting this process.

To address the aspects and obligations established in Article 8, the car industry established the International Dismantling Information System (IDIS). IDIS provides dismantling information to the ATFs free of charge. 26 manufacturers with 79 brands and 3477 models and variants use IDIS to provide dismantling information to close to 7000 registered users (e.g. ATFs) in 31 languages in 40 countries[25]. IDIS contains information on components that need to be dismantled according to Annex I, section 3 and 4 of the ELVD (see detail below). And yet it can be understood that not all ATFs make use of such information. According to Elliott et al. (2019) there are around 12.000 ATFs in the EU, whereas from the above, only slightly over half are registered to IDIS and it is not clear if all of these make use of the information contained within. In this respect EGARA (2021) explains that IDIS only shows information that the platform receives from the producer, and the interface is not always the same. "If you need information to access the auxiliary batteries – you need to click in different places". The system is designed form the perspective of what information the OEMs give, whereas according to EGARA it should be made from the perspective of the waste management to ensure that the interface is always the same in terms of how date is relayed and in terms of the level of detail. IDIS is full of information, but a lot of times the information stops at a level of detail that is not sufficient for ATFs. For example, data on a mercury switch in a Mercedes model was sought by EGARA. It took a lot of effort to find it in IDIS and the information stopped at the level of a dashboard in which the mercury switch was contained. That does not help understand how to depollute the component. Information needs to be presented in a more harmonised manner, structured form the perspective of the ATF and what data in needs to allow the ELV to be processed. A further example given by EGARA was a vehicle model of an OEM where the copper wiring was mounted so that there were a few points that if accessed, would allow pulling the complete wiring relatively simply. However, ATFs were not aware if this and it was not applied in dismantling and was not adopted by additional producers.

At the same time, OEMs are also required to provide repair and maintenance information (RMI) to promote the reuse of parts and components. Provision of such information by OEMs was initially required under EU Regulations No 715/2007/EC and No 692/2008/EC"[26] to ensure that independent operators have easy, restriction-free, and standardised access to vehicle RMI. The European Commission investigated the operation of the system of access to vehicle RMI. "The key issues involve challenges for repairers when accessing RMI directly from OEM websites. The wide variation in user interfaces and software incompatibilities cause great inconvenience to users, particularly occasional users or repairers that service many different brands". Additional aspects mentioned were "different interpretations by

[24] Commission Decision 2003/138/EC of 27 February 2003 establishing component and material coding standards for vehicles pursuant to Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles (Text with EEA relevance) (notified under document number C(2003) 620)

[25] See further detail under IDIS Webpage: https://www.idis2.com/index.php, last viewed 28.10.2021

[26] Regulation (EC) No 715/2007 and Commission Regulation (EC) No 692/2008 of 18 July 2008 implementing and amending Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, OJ L 199, 28.7.2008, p. 1

stakeholders of certain aspects" (COM/2016/0782 final 2016). As a result of this investigation, the requirements that were previously in these Regulations have been consolidated and are now detailed under Article 61 of Regulation 2018/858/EU[27]. This change is aimed to ensure easier access and use of RMI information by independent operators, which had struggled in the past as information was provided "piece by piece" affecting its comprehension and usability. Article 61 specifies in this respect that "Independent operators shall have access to the remote diagnosis services used by manufacturers and authorised dealers and repairers". This obligation is not understood to require the provision of such information for free nor is it clear if this will result in repair and maintenance information being included on a single platform to harmonise and simplify the access of users to information. OEMs refer to RMI information when asked whether information to support reuse is available to ATFs. "Information about removal of parts can be found in the RMI service guides, which can be purchased. A link to all RMIs can be found in IDIS" (ACEA 2021b). However, this is understood not to be practical for ATFs as each OEM has a separate platform for providing data on its vehicle models and the use of each platform is membership (cost) based[28]: For an SME ATF that serves vehicles of multiple brands, this is not manageable in terms of costs nor in terms of needing personnel to be trained to work with multiple platforms and interfaces. In consequence, as in the past, the producers currently provide ATFs with access to RMI with the same approach as for any independent operator (e.g. of a repair garage), i.e., at a cost. Some ATFs complain about this aspect (cost to the ATFs) and its effect on the removal and reuse of parts is not clear.

There have been some voices as to the option of using a digital product passport for the purpose of compiling information from OEMs for ATFs[29]. This has been discussed by the Foundation "Stiftung 2°" with companies from various sectors including the OEM Audi. For the automotive sector a product passport is said to make sense, seeing as these are complex products with over 10,000 different components. It is claimed that developing a digital product passport for vehicles would necessitate billions of Euros, though it is not clear what these costs refer to, particularly seeing as much of the data already exists (compiled by OEMs) and the main effort is thus understood to be one of compiling data in an accessible digital form.

A similar issue is that many valuable (electric and electronic) parts are coded and locked. Examples include window wiper motors, inverters, mirrors, window motors, navigation systems, sensors, ICUs, ABS computers and others (EGARA 2021) Though this may be necessary to ensure safe operation, the reuse of such parts requires that an ATF be able to unlock them for proper dismantling and that at a repair shop that they can be reinstalled with a key (and sometimes requiring certain systems to be reset) and locked to allow safe operation. As in the case of batteries, without intervention, it is probable that such components of vehicles will be locked in the future. This would limit reuse of these components to operators with access codes or at least make it uneconomic for other operators. In a study performed by EGARA[30] 20-35 pieces were identified that - when dismantled - cannot be used despite being suitable for multiple models and makes. This is also a case in which lacking access to data may hinder repair and reuse at least for some economic operators (repair shops, ATFs). It is not clear if this shall change following the consolidation of the RMI

[27] Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC

[28] Personal communication with repair shop owner of Y. Baron, January 2022

[29] See article: "Ein digitaler Pass für Pkws" in Frankfurter Rundfunk: https://www.fr.de/wirtschaft/ein-digitaler-pass-fuer-pkws-91064053.html

[30] See EGARA's contribution to the inception impact assessment (road map).

requirements under Article 61 of Regulation 2018/858/EU or other legal requirements like those specified in the Data Act to be proposed later this year.

2.1.2.1.2 Hazardous substances

The current rules on hazardous substances in vehicles are distributed over different legislation: The End-of-life vehicles Directive (ELVD) currently prohibits the four heavy metals lead, mercury, cadmium, and hexavalent chromium. These substance prohibitions as well as the exemption assessment mechanism are laid down in the ELVD in Article 4(2). Accordingly, Member States are to ensure that materials and components of vehicles do not contain lead, mercury, cadmium or hexavalent chromium, unless exemptions from the prohibitions are listed in Annex II of the Directive. Exemptions can be added to the annex in cases where the use of one of these substances is not avoidable (or they can be removed when it becomes avoidable (Article 4(2)(b)(II -III)).

In parallel, the materials used in vehicles and their substance content can also be affected by other legislation such as the Regulation 1907/2006/EC concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency (ECHA), and the Regulation (EU) 2019/1021 2019 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (POP regulation). Under REACH, certain restrictions in Annex XVII (or derogations from restrictions) also apply to vehicle components, e.g., entry 51 on the four phthalates where motor vehicles have specific provisions. The POP regulation prohibits the manufacturing and use of certain industrial chemicals, unintentionally produced chemicals (and certain pesticides which are not relevant to vehicles) and also sets waste management provisions with limits for the substances in waste. Those limits for e.g., decaBDE in waste streams have influenced the recycling of plastic in the past, leading to the disposal of material to avoid decaBDE levels above the limits. In addition, new POPs are progressively being identified under the Stockholm Convention that may also have relevance in the automotive industry, e.g., PFOA (used in motor oils and other automotive parts).

Besides, the notification requirements in the SCIP database also applies to vehicle components. SCIP is the database for information on **S**ubstances of **C**oncern **I**n articles as such or in complex objects (**P**roducts) (ECHA 2022) established under the Waste Framework Directive (Directive 2008/98/EC 2008, WFD). Articles containing a substance of very high concern (SVHC) included in the Candidate List in a concentration above 0.1% weight by weight (w/w) or complex objects (products) incorporating such articles placed on the EU market have to be notified in the database.

The Commission has proposed a new Battery regulation in December 2020. The proposal incorporates a restriction procedure, aligned to that under REACH and where the assessment is carried out by the European Chemicals Agency (ECHA).

It has to be noted that the various regulations, i.e., REACH, POPs and the Battery regulation are currently under revision as well, albeit at different stages.[31]

[31] See the timeline of the REACH revision under the Chemicals Strategy at: https://ec.europa.eu/environment/chemicals/reach/reach_revision_chemical_strategy_en.htm

A proposal for the revision of the POPs Regulation (EU) 2019/1021, and in particular its Annexes IV and V which determine how waste containing POPs must be treated, has been submitted by the European Commission at the end of October 2021 (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12411-Hazardous-waste-updated-concentration-limits-for-chemical-pollutants_en). Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020; COM/2020/798 final; at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0798

Moreover, there are new policy developments in the EU that could influence requirements for substances of concern for increasing the circularity of vehicles in relation to the uptake of recycled material in new productions: The Chemicals Strategy for Sustainability states in this respect that "*the creation of a well-functioning market for secondary raw materials and the transition to safer materials and products is being slowed down by a number of issues, in particular the lack of adequate information on the chemical content of products […] it is necessary to ensure that substances of concern in products and recycled materials are minimised. As a principle, the same limit value for hazardous substances should apply for virgin and recycled material*".

The coherence check of the ELV Directive with the other legislation shows various inconsistencies and areas for possible action related to the provisions on the prohibition of hazardous substances and how these are currently implemented. These aspects can be differentiated into three groups:

- one relating to the necessity of **prohibiting additional substances** and how this is to be addressed;
- the second relating to the **mechanism for assessing the exemptions** from the ELVD substance prohibitions and its effectiveness and
- the third on **adequate information on the content of hazardous substances in products** to achieve a desired quality and composition of recycled materials.

In relation to the possible need for **prohibiting additional substances** in the future, this was looked at from the perspective of other pieces of legislation dealing with the production, use and recovery of hazardous substances (e.g., RoHS, Batteries, WFD, REACH, POPs) but also in relation to new policy developments in the EU (e.g., CEAP, the interface between chemicals, products and waste legislation, the chemicals strategy for sustainability). The basis for possible future restrictions is already mentioned in the ELVD. The study supporting the Evaluation of the ELVD (Williams et. al 2020) states that from "*Recital 11 and Article 4 it can be assumed that additional prohibitions could be justified in cases where a decrease or the elimination of substances in ELVs would prevent "their release into the environment […] facilitate recycling and […] avoid the disposal of hazardous waste*"." It further states that it "*is apparent that the presence of substances aside from the four heavy metals in waste may also compromise the ability to recover materials in the waste management stage. The fact that additional substances have been subject to prohibitions under other legislation (e.g., REACH, RoHS, POPs) suggests that these may have negative impacts on the environment and on waste management*", i.e., that additional prohibitions may be relevant. This is also supported by the Circular Economy Action Plan (COM(2015) 614 final 2015) which refers to the general increase in the use of plastics and its advantages for vehicles in terms of weight reduction on one side, but also raises concern as to the presence of hazardous chemical additives in plastics and how this can pose technical difficulties for its recovery. This suggests that there may be a need to regulate the presence of additional hazardous substances that are used in vehicles, aside from the four heavy metals currently prohibited, e.g., certain flame retardants, plasticisers, or surface-active agents such as PFAS. This is understood to be particularly relevant where such substances could hinder the recovery of materials from ELV in waste management as well as in other practices relevant for circularity. Investigations of the prohibition of new substances could consider whether this should be done under the ELVD or under a different regulatory framework (e.g., REACH). Respectively, it may be necessary to consider how the ELVD is to support this process, by clarifying how (frequency, prioritisation of certain substances for assessment) and against which criteria it is to be decided whether additional prohibitions are to be introduced.

Under REACH, there is basically the authorisation route and the restriction route to address the use of hazardous substances.

a) Authorisation: Following the inclusion of substances of very high concern in Annex XIV of the REACH, companies are required to apply for an authorisation to continue the use of the substance.
Authorisations under REACH are considered comparable to the ELV prohibitions in terms of all uses of a substance being prohibited. However, the current authorisation requirements only prohibit the manufacture and use of the substances in the EU, but do not cover the presence of the substances in imported articles. Prohibitions could be circumvented by shifting the manufacture of parts containing prohibited substances to countries outside the EU. This creates an unlevel playing field for the European economy. However, REACH allows for a fast track on restrictions for substances included into Annex XIV (authorisation list) which are present also in articles.[32]

Authorisations under REACH to use the substance for specific applications are granted to producers. Though some applications for authorisations have been applied for by OEMs and their suppliers, one authorisation application can basically also cover several applications of the substance (e.g., several chromium plating techniques of different types of articles) which is then applicable to several companies by a so-called up-stream application. So, vehicle OEMs and their suppliers would not necessarily need to apply for an authorisation for use for each application of a prohibited substance individually.

b) Restriction: Limitations to be imposed on substances used in vehicles (termed substance “prohibitions” under the current ELV Directive), could be included under the restriction mechanism (REACH Annex XVII): REACH restrictions prohibit or establish limitations on substances in specific applications. This mechanism could be used to transfer substance prohibitions for vehicles to REACH, i.e., a restriction would be added for each substance prohibited, including derogations for specific applications where exemptions are still needed.

In this case, the concern is that there is no formalized process to apply for a derogation to the restriction nor to regularly review the derogations. However, a comparable process is basically in place, but would have to be made explicit and transparent: Before restrictions are made, there is usually a “call for evidence” process of 6 months where the concerned parties provide information that affects the scope of the restriction, e.g., on the need for derogations. This information is reviewed during the opinion making by RAC and SEAC.

Though there are a few restriction entries in Annex XVII with a review clause, it is not clear if a restriction could be reviewed for scientific and technical progress every few years, as is the case for some of the annex II exemptions. Currently, a change in a restriction entry requires a new restriction. To conclude on the current stage, REACH restrictions are not well designed for a systematic review process, although this is not impossible. It might be possible that the revision of REACH might introduce this improvement.

Both routes, authorisation, and restriction, are currently being revised and may even be merged into one system, with the option for exemptions.

In relation to the **exemption assessment mechanism**, the effectiveness of the current process was compared to the RoHS Directive. The RoHS Directive was chosen for comparison because it is part of the waste legislation acquis as is the ELVD, and because it includes substance restrictions and also has an exemption evaluation mechanism with similarities to that of the ELVD, though more developed. The comparison showed that various

[32] Article 68(2) of REACH provides for a simplified restriction procedure for substances on their own, in a mixture or in an article, which meet the criteria for classification in certain the hazard classes (carcinogenicity, germ cell mutagenicity or reproductive toxicity, category 1A or 1B), and could be used by consumers. In such cases, a restriction to consumer use can be proposed by the Commission and Annex XVII can be amended by comitology, without the need to follow the process defined in Articles 69 to 73 (i.e., without the intervention of ECHA). Such a procedure has been used to restrict the presence of a large group of substances in clothing and related accessories, other textiles and footwear. (Commission Regulation (EU) 2018/1513. https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ:L:2018:256:TOC&uri=uriserv:OJ.L_.2018.256.01.0001.01.ENG)

aspects could be adjusted in the current exemption assessment process of ELVD to make this mechanism more effective and efficient, keeping in mind that also the RoHS Directive is under revision.[33]

- Limited duration for exemptions and an obligation to apply for renewal: So far, there are no provisions on default duration periods of exemptions under ELV. Under RoHS, each exemption from the substance restrictions is specified with a limited duration. The Directive includes provisions that differentiate between most EEE categories and those that have longer design cycles, namely, medical devices and monitoring and control instruments. The maximum exemption duration for these two categories is set at 7 years instead of the 5 years relevant for other categories. This does not mean that shorter exemptions cannot be granted, however, the fact that the exemption is given a limited validity means that it will be periodically assessed if the exemption is still needed (see next bullet). The only case where exemptions are not limited is the case of spare parts, for which RoHS provides a general exclusion (RoHS Article 4) for use of the restricted substances in equipment that, at the time placed on the market, benefited from a valid exemption. ELV addresses this aspect by referring to the type approval date in relation to the expiration date.
- Application for exemptions (new, renewals, revoke): There is no standard method for an exemption application under ELV. Under the RoHS Directive, when an exemption reaches the end of its duration, it automatically expires. Where the exemption is still needed, stakeholders have the possibility of applying for its renewal, a process in which they are obliged to compile a dossier providing information and data to substantiate the justification for the exemption. This has the advantage that the process of exemption assessment has a clearer starting point in relation to what has changed since the past evaluation, and the evaluators can focus more on the verification of the grounds for justification. This process also provides more certainty for stakeholders, who can anticipate if and when an exemption could be evaluated.
- The criteria for exemption: The ELV Directive provides one criterion for the assessment of an exemption, namely "if the use of these substances is unavoidable". The RoHS Directive includes a set of criteria for the justification of exemptions. It ensures the coherence with the REACH Regulation as a threshold condition. As a next stage, it not only looks at whether substitutes have become available, but also at their reliability. Furthermore, it investigates how they compare with the use of the restricted substance in terms of environmental and health impacts. In certain cases, consideration of socio-economic aspects, LCA data and impacts on innovation or the market availability of substitutes can also be included. These criteria are more elaborate than the ELV criteria that only consider if the use of the prohibited substance has become avoidable, creating a "black and white" decision process which makes it difficult to integrate possible impacts on the environment or on society into the decision process.
- Alignment with other legislation: It is noted that ELV and RoHS have a few cases of exemptions which are similar in scope, e.g., on lead in alloys (steel, aluminium, and copper alloys). The alignment of the Directives in this respect usually focusses on the scope of the exemptions. ensuring that differences between the directives in terms of the scope of such exemptions are only recommended in cases where changes apply differently to the vehicles and to EEE (e.g., where substance applicability or reliability requirements may differ, etc. Though there have been efforts along the years to perform assessments of these exemptions in proximity (and in one instance also as a joint assessment), the fact that ELV only specifies a period for the next review and not an

[33] Review: Restriction of the use of hazardous substances in electronics; https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13137-Review-Restriction-of-the-use-of-hazardous-substances-in-electronics_en

expiration date does not facilitate further joint assessments which could save resources. However, this gives legal certainty to companies because the derogation still applies, and so does the possibility of placing on the market.

The issue of hazardous substances, however, is not only relevant when a substance has been prohibited, but also affects the waste phase in terms of the quality and composition of recycled materials. This raises the need of **adequate information on the content of hazardous substances in products**. The dismantling of cars containing complex (or hazardous) materials can lead to significant waste management costs which reduce the economic viability of ELV treatment companies. This conflict was also mentioned by stakeholders during the ELV Stakeholder Workshop on 24-25 March 2022 "Material Compliance and Circularity".

It can also lead to a loss of materials, as in the case of plastics contaminated with decaBDE. When hazardous substances present in waste are recycled into new materials, these must comply with all relevant product legislation (including chemicals legislation) in order to achieve end-of-waste status (see art. 6 of the WFD). While the POP regulation has different limits for new and recycled products[34], the Chemicals Strategy for Sustainability states that, as a principle, the same limit value for hazardous substances should apply for virgin and recycled material, although it is also acknowledged that there may be exceptional circumstances where a derogation to this principle may be necessary.

This could not only affect the contents of ELV prohibited hazardous substances in ELV recyclate in the future, but also the use of other substances, where these have been restricted under other legislation or singled out as substances that should not be contained in secondary materials. To do this, it is, however, important to have sufficient data on substances used in the manufacture at present and in the past, given that by the time a vehicle reaches end of life (EoL), it may contain materials that were allowed for use during its production but that have since been prohibited.

The example of the ban of decaBDE, which was used in the past in plastic components of cars, shows that the main challenge is to identify the components in which it is contained in ELVs and whether these need to be and could be separated before shredding (as the POP-regulations requires). There is lacking consensus on whether such plastics need to be removed prior to shredding or whether the shredder can be considered as a means of removing decaBDE contaminated streams from other streams. In the latter case, streams containing decaBDE levels below the POPs Regulation Annex IV threshold could be recycled, while other streams would need to be disposed of as allowed by the POPs Regulation. Stakeholders in the workshop mentioned a recent "*characterisation study on the content of POP substances in car shredder residues which demonstrated that the levels of POP substances are well below the regulatory thresholds set, in a campaign representative for the end-of-life vehicle fleet. Furthermore, the POP substances targeted by this study have since been progressively substituted in line with the bans in force under the European REACH and POP regulations. Regarding brominated flame retardants, their substitution has been carried out for many years. Consequently, this should ensure that concentrations of POP substances in future material streams from end-of-life vehicles remain below future regulatory thresholds*." Whereas it is plausible that the content of PBDEs is decreasing, substances that are newly added to the POPs regulation might end up in the waste phase until their substitution.

[34] According to POP regulation, DecaBDE is limited at 10 mg/kg for new products (Annex I) while the limit for waste is 1000 mg/kg. with a revision clause for 500 mg/kg (Annex IV).

As an example, "*PFAS*"[35] were mentioned in the stakeholder workshop, i.e., that they are "impossible to detect and document" and are therefore considered by practitioners in the recycling facilities as being impractical to remove; "*so here the decision might be taken to better not recycle because of the additional burden (test + documentation).*"

In result, it is today not possible for ATFs to identify parts or components in a specific individual vehicle that contains decaBDE, for example. Some Member States have discussed if the 'positive list' of components mentioned in the ELVD, Annex I section 4, might be expanded or if the car manufacturers should be obliged to provide more information on what components are worth dismantling (either for high-quality recycling or for reuse).

In any case, a separation before shredding is necessary for hazardous substances that cannot be detected by post-shredding techniques. More generally, availability of information on chemicals of concern in vehicle parts is a key determinant. Such knowledge can directly influence their recyclability or reusability. Insufficient information provided by vehicle manufacturers to dismantlers on presence and localisation of (hazardous) materials could hamper high-quality recycling.

At the regulatory level, the SCIP database has been established under the Waste Framework Directive (WFD), this is the database for information on Substances of Concern in articles as such or in complex objects (Products) (ECHA 2022). Companies supplying articles containing substances of very high concern (SVHCs) on the Candidate List in a concentration above 0.1% weight by weight (w/w) on the EU market must submit information on these articles to ECHA since 5 January 2021. Thus, with regards to economic impacts, obligations and hence economic burden already exist in the form of these notification duties for the SCIP database.

However, stakeholders noted in the interviews that the notifications in SCIP are not scrutinized and thus they questioned the quality of the entries.

Besides, it is not yet obvious how the data are made available to the ELV waste operators who need to know the single parts/components and their location in the vehicle combined with dismantling information, so as to enable these operators to separate the respective part/component for depollution purposes. Input from the stakeholders also explained that SCIP in its current form is not expected to contribute to the environmental benefits, since it is not practical for waste management operators to retrieve information on localisation of hazardous substances.

The automotive industry itself already has a profound information system in the form of the International Material Data System (IMDS)[36] established in 2000. It is designed to act as an easily accessible online system to help vehicle manufacturers and their supply chain to record and track substance and material compositions of their components. The system aims not only to achieve legal compliance but is also an integral part of the industries' quality processes. System users today include:

- Around forty name-brand manufacturers, representing more than 90 different brands of vehicles
- More than 120,000 automotive suppliers of materials and components.

Since its implementation into the automotive processes, IMDS, in conjunction with the Global Automotive Declarable Substance List (GADSL), has also become the information system

[35] In the POP regulation, PFOS and its derivatives have been prohibited since 2009, and PFOA, its salts and PFOA-related compounds have been prohibited under the POPs Regulation since 4 July 2020. Additionally, perfluorohexane sulfonic acid (PFHxS), its salts and related compounds as well as perfluorinated carboxylic acids (C9-14 PFCAs) are being considered for inclusion in the Stockholm Convention and consequent global elimination.

[36] https://public.mdsystem.com/en/web/imds-public-pages

used in practice for material declarations on the contents of declarable substances along the supply chain in the automotive industry. Furthermore, the GADSL contains more substances then the SCIP database. The list of substances which must be declared by suppliers to OEM is permanently changing due to GADSL updates to scientific progress. It is important to note that a link between IMDS and a single vehicle (e.g., via the vehicle identification number (VIN) is not included in IMDS and would be possible only via the part list for each single vehicle which is held by the car manufacturer. Today, car manufacturers argue that publication of the parts list would violate intellectual property rights. Furthermore, they argue that the parts lists (for each single vehicle thus equivalent to globally more than > 90 million vehicles per year) are not systematically stored for the full lifetime of each vehicle.

Half of the answers of stakeholders to interactive questions asked during the stakeholder meeting, indicated that OEMs document data on the content of GADSL substances in vehicles and components though the parts list of the vehicle.[37] The BMW Group explains that the "*information on the content of GADSL substances in vehicles and components is linked to part numbers, not to vehicles; a linkage to the VIN number is seen as an unreasonable effort, due to millions of potential variations (and due to the fact that the vehicle owner may have changed parts, which cannot be considered)*". The Renault Group also explains that "*it is possible to extract indirectly a maximizing list of GADSL substances for a given vehicle, i.e., a list of substances corresponding to an "envelope vehicle" that would contain the parts of all possible versions of a model (i.e., not the exact list of substances actually contained in a given vehicle/VIN).*"

The discussion on the improved communication is related to other dynamic threads such as the concept of a Digital Product Passport (DPP). Under the Ecodesign for Sustainable Products Regulation (ESPR), the Digital Product Passport shall eventually become mandatorily applicable for all (priority) products covered under ESPR but can be extended to other categories such as vehicles. The idea is that for each product, an individual delegated act should define the key elements/ features on the information that a DPP will cover. The development of such a DPP will take time as it also requires the inclusion of standardisation requests, close consultation with the industry and a synchronisation of different datasets into one info channel. There are already industry initiatives in this regard, e.g., Catena X[38], that work on creating a platform for all contributors in the automotive value chain to digitally trace material flows throughout the entire supply chain.

2.1.2.1.3 Directive 2005/64/EC type approval of vehicles with regard to their reusability, recyclability and recoverability

Considering again the expected increase in the use of new technologies and new materials, and the fact that even at present it can be difficult to achieve the ELV reuse and recycling targets, it becomes even more important to check that new vehicles placed on the market comply with design requirements developed to facilitate their EoL waste management. In other words, as a condition for putting vehicles on the market, it needs to be ensured that a vehicle has been designed with the waste management in mind in a way that facilitates waste

[37] On the Slido question "**Is it correct to assume that OEMs document data on the content of GADSL substances in vehicles and components through the parts list of the vehicle (i.e., linked to the VIN)?":** 13 individuals answered this question. Only a single answer was possible. Almost half of the participants think the assumption is correct. The rest did not have an opinion (I don't know").

[38] https://catena-x.net/en/

treatment and achieving the reuse and recycling targets in order to contribute to the achievement of the objectives of the ELV. With such aspects in mind, Article 7(4) of the ELVD required the Commission to revise Directive 70/156/EEC on type approval in order to make sure that vehicles “are re-usable and/or recyclable to a minimum of 85 % by weight per vehicle and are re-usable and/or recoverable to a minimum of 95 % by weight per vehicle”. To this end, Directive 2005/64/EC[39] on the type approval of motor vehicles with regard to their reusability, recyclability and recoverability (3R Directive) was adopted in 2005.

The 3R Directive ensures that ELVD design requirements (e.g., substance prohibitions) are fulfilled and it further increases the link between vehicle design and end-of-life, by requiring that the design of a vehicle be investigated to ensure that it will not hinder achievement of the ELVD reuse and recovery targets. A vehicle can be denied market access until its design has been approved in this respect. In this sense, under the current legislation the 3R Directive contributes to ensuring that new vehicles put on the market are reusable, recyclable, and recoverable. It also ensures compliance with the ELVD substance prohibitions and with the component marking requirements established in Commission Decision 2003/138/EC.

As the 3R Directive is part of the general process of type approval and in particular Regulation of EU 2018/858[40], its functioning is independent from the ELVD. Nonetheless, it is important to consider how the two Directives are kept aligned and how this is to be monitored in the future. For one, the ELVD Evaluation revealed some incoherencies between the two pieces of legislation. Though the evaluation of the ELV Directive showed that the 3R Directive 2005/64/EC contributes to the demonstration of the reusability, recyclability, and recoverability of vehicles, it also raised some shortcomings.

- The ELVD evaluation concluded that some of the 3R Directive provisions are unclear, leaving room for interpretation that can weaken its objectives.
- It is not completely clear to what degree the way that the ELVD end-of-life requirements are linked to the 3R Directive supports the putting on the market (PoM) of vehicles that will fulfil the waste management obligations. For example, at present, the calculation of recyclability and recoverability requires the producers to submit a specification of the vehicle material breakdown into separate materials (e.g., glass, metals, etc.) and also an estimation of the share of material that is reusable, recyclable, recoverable or both. For this purpose, a component part is “considered as reusable, recyclable or both based on its dismantlability, assessed by accessibility, fastening technology, and proven dismantling technologies” (ISO 22628: 2002). A part is considered recyclable based on its material composition, and proven recycling technologies. This does not differentiate however between different qualities of recycling. Thus, for example, as observed in the case of glass used in vehicles, the existing method enables referring to glass towards the calculation of recyclability as in principle it can be dismantled and there are techniques that would allow its recycling. However, in practice, glass is usually separated from other materials through shredding activities, leading to only a low-quality recycling (e.g., backfilling, or other forms of downcycling) being possible. A further example refers to tyres. The 3R Directive specifies (annex I (6)) that for the purposes of the 3R calculations, tyres shall be considered as recyclable, i.e., are counted to 100% towards achieving the recycling target. However, in practice, the recycling of tyres is currently far form 100% material recovery. EuRIC MTR (2022) state that from around 3 million tonne of end-of-life

[39] Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC

[40] Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC

tyres (ELT) generated in the EU annually, only ca. 1.3 Mt are recovered as material (most as granulate), while 1.2 Mt is sent to energy recovery.

- The lack of a monitoring mechanism for the 3R Directive implementation by Member States and car manufacturers before the introduction of Market Surveillance in 2020, also made it difficult to assess to what degree the 3R Directive promoted the circularity of vehicles. This may change with the new regime which includes market surveillance performed by other MS than the one providing the type approval and obliges MS to perform at least one annual market surveillance activity for every 40,000 vehicles PoM or a minimum of five[41].
- As part of the assessment of OEM compliance with the 3R Directive, Article 6(3) requires manufacturers to "recommend a strategy to ensure dismantling, reuse of component parts, recycling, and recovery of materials. The strategy shall take into account the proven technologies available or in development at the time of the application for a vehicle type-approval". 3R Directive Article 6(5) clarifies that Type approval authorities, when issuing a Certificate of compliance for a vehicle model that is regarded as type approved, need to "include the appropriate documentation and describe the strategy recommended by the manufacturer…". However, from an interview held with Stellantis (2022) the strategy provided by OEMs is understood to be general in nature and not necessarily vehicle specific. When asked if detail from this strategy feeds into dismantling information provided to the IDIS platform, Stellantis clarified that IDIS information, is vehicle specific technical information, including e.g., practical information on pre-treatment and dismantling of plastic parts or other materials, etc. The purpose of the strategy developed for the 3R directive Article 6(3) is explained to be different from the IDIS information and not practical for the dismantler. The strategies aim is "to show how we support the recycling and the process globally – how this is linked with design of the car" so that that vehicles will be treated properly. In this respect Stellantis mentions the following points as part of the strategy: how the material composition of a car is controlled, the objective of integrating recycled content, supplying operators (e.g., ATFs) with pre-treatment and assembly information and innovation considerations of effects of the vehicle composition on recycling to ensure recyclability of materials integrated in a vehicle. Another OEM also explained that the strategy does not directly relate to the information provided to ATFs through IDIS to facilitate waste management. The example was given that whereas the OEM's data for IDIS identifies (and provides data for) plastic components for theoretical recycling and dismantling, its strategy is in rather in favour of applying shredder residue treatment and recycling technologies in the treatment of vehicles. To summarise, it seems that OEMs provide rather general company strategies that do not provide detail at the level of a single vehicle, despite the 3R Directive requiring "the approval authority shall ensure that the data presentation form referred to in point 2 [Consultants addition: the calculation based on standard ISO 22628: 2002] is coherent with the recommended strategy annexed to the certificate of compliance referred to in Article 6(1) of this Directive" (3R Directive, Annex I (8)). The latter suggests that the strategy should be specific to the model being type approved or at least to models intended to be PoM in the same year. A more specific strategy is also perceived by the consultant to be more appropriate for demonstrating how the "dismantling, reuse of component parts, recycling and recovery of materials" of a type approved model is ensured.

[41] Based on personal communication of Y. Baron with DG GROW colleagues, 19.8.2022. It was also explained that at least 20% of activities must be emission tests, which would still leave a sufficient margin for performing market surveillance activities related to 3R Directive design requirements.

2.1.2.2 Reuse and recycling

The European Green Deal and the Circular Economy Action Plan emphasise the need to promote high quality recycling and facilitate the uptake of recycled materials in new products. The need to prioritise the reduction in material use and the reuse of components and materials above the recycling of materials and parts is also mentioned. The ELVD also includes various provisions to promote the reuse and recycling of vehicle parts and materials:

- Article 7 of the Directive requires Member States to ensure that economic operators attain specific targets on the share of parts and materials reused, recycled, and recovered from a vehicle. As of 1 January 2015, economic operators must achieve a total rate of 85 % reuse and recycling of the average vehicle weight and a total rate of 95 % when recovery amounts are also accounted for.
- In parallel, Annex I of the Directive specifies a number of parts that must be depolluted as well as operations to be caried out to facilitate recycling (see detail under Section 0).
- Article 7 also makes a connection between the ELVD and the type approval process of vehicles. As a result, Directive 2005/64/EC[42] requires type approval authorities to ensure that vehicles put on the market can achieve the reuse and/or recycling target of 85 % and the reuse and/or recovery target of 95 % by weight of the vehicle.

And yet, the re-use and recycling of some materials present in ELVs is currently insufficient, resulting in loss of re-usable and recyclable materials. At the moment, most vehicle dismantlers do not carry out pre-shredder dismantling of materials such as glass, large plastic parts, the wiring harness and electronic components, because the low value of the material vs. the cost of removal means it is not economically viable for them and there is no clear obligation in the Directive to remove these parts before or after shredding. For instance, it is known that the glass from ELVs can be removed to be recycled, as required by Annex I to the ELVD, but dismantling of glass is rarely done by ATFs as the effort is not compensated by the revenues for the separated glass and glass is recycled after shredding. At the same time, glass producers claim that glass from vehicles can be used for high quality recycling if removed before shredding.[43] As the vehicle producers do not compensate ATFs for the economically not viable effort, in almost all MS glass is not separated and instead directed to the shredder heavy fraction (SHF) which is (in the best case) used for construction purposes or for backfilling. The latter is not considered as recycling by the Waste framework directive (WFD), but it is by the ELVD, which is another sign for the outdated definition of recycling in the ELVD.

Furthermore, under the current ELVD, the recycling targets are not material specific but refer to the overall weight of the vehicle. As certain materials (e.g., plastic, glass) account for only a small portion of the vehicle weight, they are often discarded. There is also no effective enforcement of the existing separation or removal requirements (glass, large plastic). Technically feasible and environmentally beneficial high-quality recycling (e.g., of glass, selected plastics, electronic components) is not established as it is not profitable.

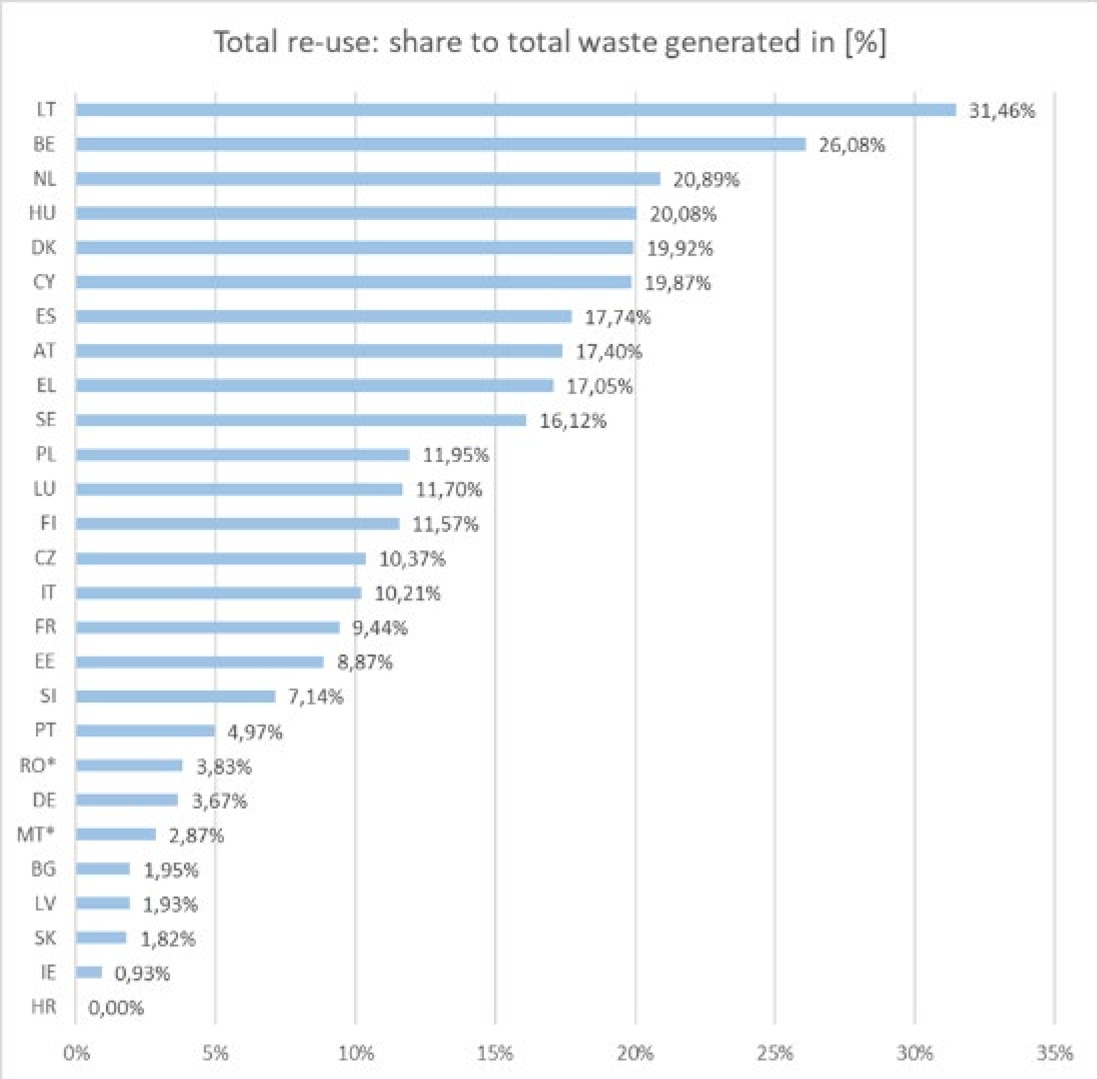
The fact that the reporting of Members States on their reuse and recycling targets is not harmonised furthermore results in non-comparable data on the actual achieved rates of reuse and recycling. Today, nearly all Member States report a certain amount of re-use, which is the highest level of the waste hierarchy according to the WFD. The level of reuse, however, varies strongly across the EU, as the ELVD does not establish a separate target for re-use.

[42] Directive 2005/64/EC on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability

[43] Bartels, Pieter (2016): ELV glass: Re-cycling or Recovery? 16th International Automobile Recycling Congress IARC 2016. FERVER. Berlin, Germany, 15.03.2016.

Williams et. Al (2020) reports that the share of reuse of parts and components from ELVs varies across the EU, from zero to 33 %, though it is not clear to what degree this reflects different reporting practices and to what degree it reflects actual differences in reused parts. The following graph illustrates the share of "re-use" to the total waste generated for the reference year 2019 reported by MS.

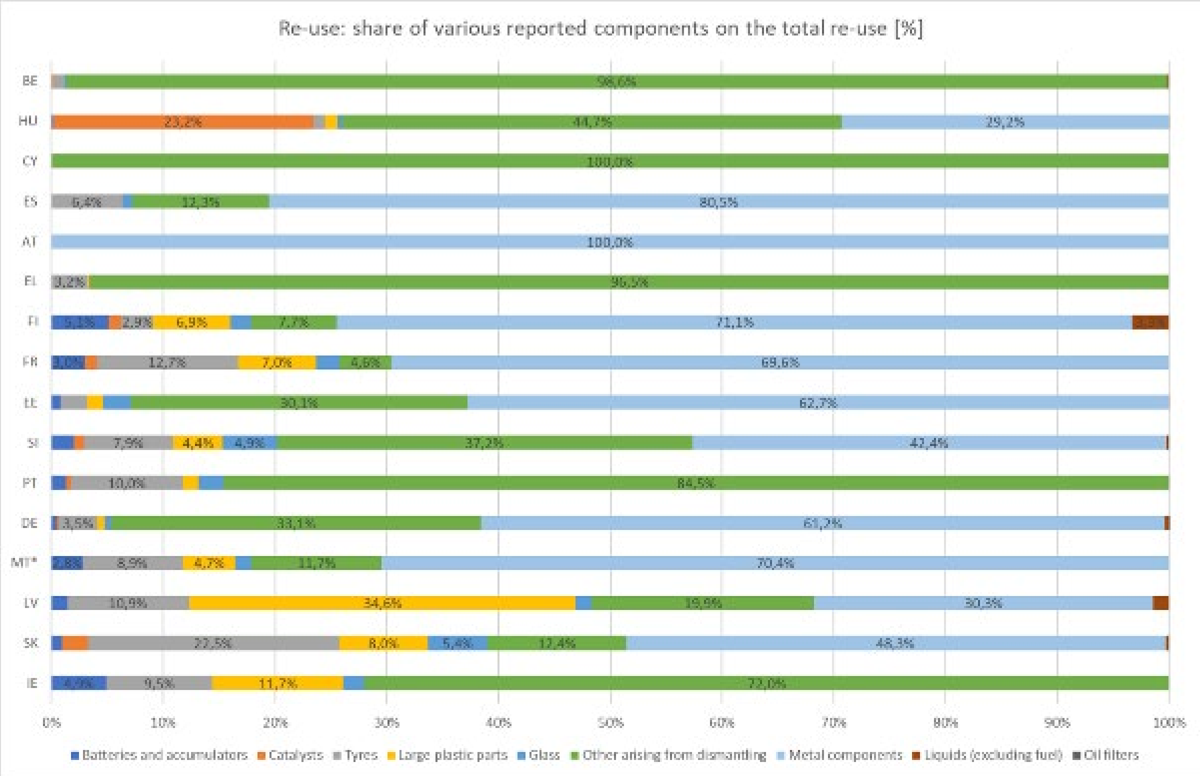
Figure 2-1 Total re-use currently reported by MS as a share to total waste generated. Reference year 2019 (* data for reference year 2018)



Source: own illustration of ELV data in Eurobase (Eurostat online data code: env_waselv), Oeko-Institut

Reporting on various components according to the Commission Decision 2005/297/EC is voluntary, therefore there is no data on each kind of components for re-use from ELV for all MS available. The following graph illustrate the share of components for re-use for various components.

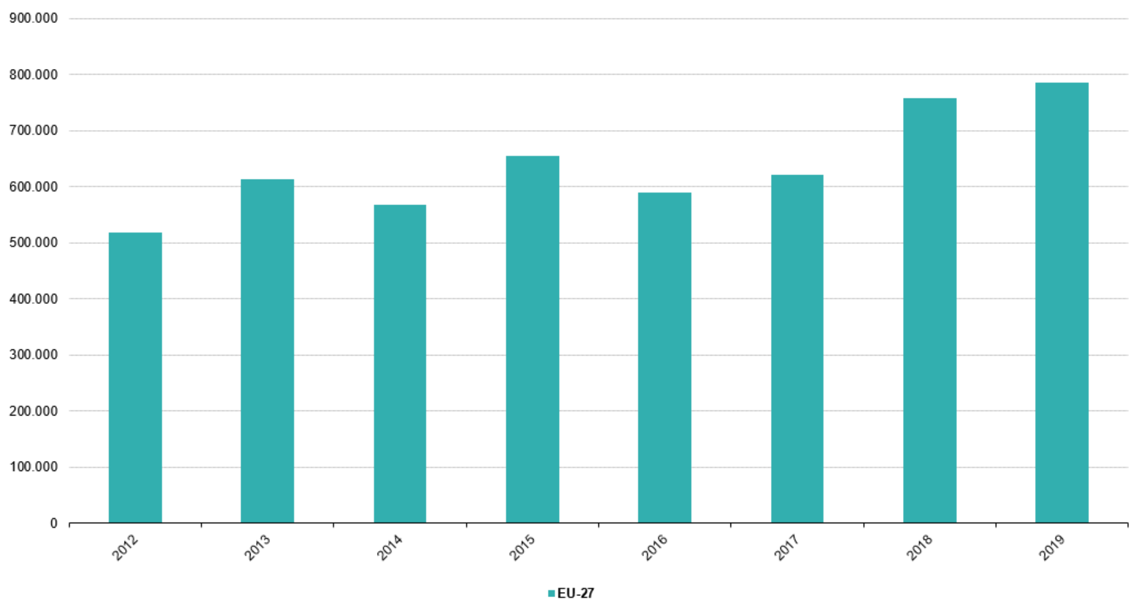
Figure 2-2 Re-use currently reported by MS as a share to total waste generated with split on various reported components (according to current reporting scheme). Reference year 2019 (* data for reference year 2018)



Source: own illustration of ELV data in Eurobase (Eurostat online data code: env_waselv), Oeko-Institut

The change over the years of the total re-use is illustrated in the following figure.

Figure 2-3 Total re-use from ELVs, 2012-2019.



Source: own illustration of ELV data in Eurobase (Eurostat online data code: env_waselv), Oeko-Institut

The current ELVD allows two different calculation methods which cause significantly different amounts of reuse reported by the MS. MS not using the metal content assumption (MCA) shall calculate reuse (A) on the basis of the subtraction method[44], Member States using the MCA shall determine reuse (excluding the metal components) on the basis of declarations from the authorised treatment facilities. The reuse of metal components will not be displayed separately if the MCA is applied but reported together with the metals recycled (in Table 2 of Commission Decision 2005/293/EC). In result, it is not possible to compare the reuse between MS applying the MCA and MS that do not. In some MS the reuse reported is calculated based on subtraction of shredded fraction from the complete vehicle weight, i.e., including those fractions depolluted or removed prior to the shredder. However, some of these are sent to recycling, i.e., where the part is not fit for reuse or where there is no demand.

As the target is also a combined target for recycling and reuse, the MS are not encouraged to support (or even monitor) reuse separately (as it should be when following the waste hierarchy).

Article 7(2) sets out obligatory targets for the reuse, recycling, and recovery of ELVs to be achieved by ELV waste operators. The current targets in force are the as follows:

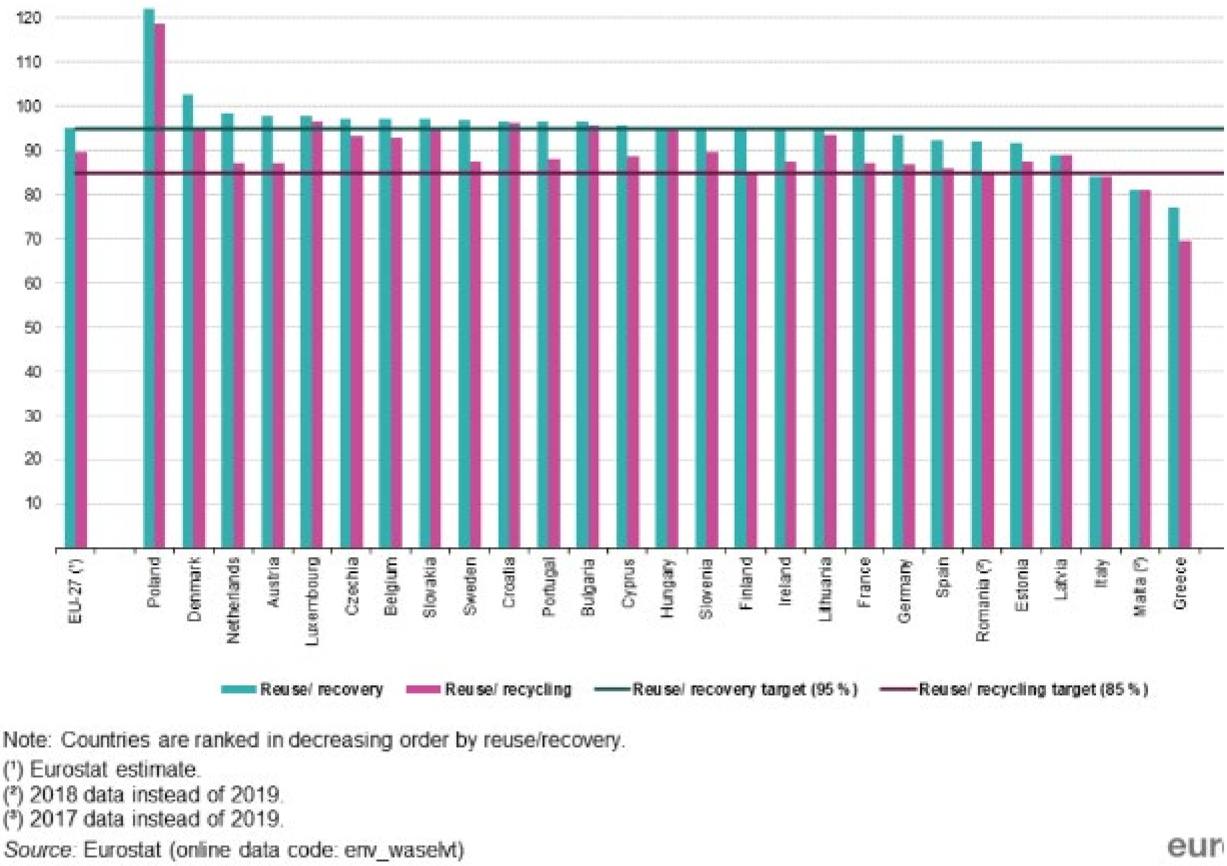
- a target of 85% re-use and recycling of the average weight per vehicle and year (meaning only the fractions prepared for reuse or recycled), and
- a target of 95% reuse and recovery of the average weight per vehicle and year (effectively meaning that at least 10% of the fractions not reused or recycled need to be recovered while the rest may also be disposed of as waste).

The following figure illustrate the reuse/recovery and reuse/recycling rates obtained by MS for the reference year 2019. An average EU-27 re-use and recycling rate is: 89.6 %, whereas 3 countries did not reach this target in 2019 (+ 2 countries based on data from ref. year 2018). An average EU-27 re-use and recovery rate is: 95.1 %, whereas 6 countries did not reach this target in 2019 (+ 2 countries based on data from ref. year 2018).

As the Member States do not report on the treatment capacities (in particular the information of post shredder treatment (PST) plants would be needed), it is also not possible for the EC to assess if the reported data on recycling rates is valid or not (more about the shredder and PST technologies under 2.1.2.3). To our knowledge, some MSs report high recycling rates without having PST plants. However, without PST plants it is difficult (or even not possible) to achieve such high recycling rates. Additionally, the reporting data to calculate rates is collected in the diverse stages of treatment process, incl. de-pollution, dismantling, shredding, as well as exported waste. Countries can also apply MCA method what excludes comparability of data among countries.

[44] The individual vehicle weight (Wi) minus weight of the de-polluted and dismantled end-of-life vehicle (body shell) (Wb) minus the weight of the de-polluted and dismantled materials sent for recovery, recycling or final disposal (footnote 4 to table 4 of the Commission Decision 2005/293/EC

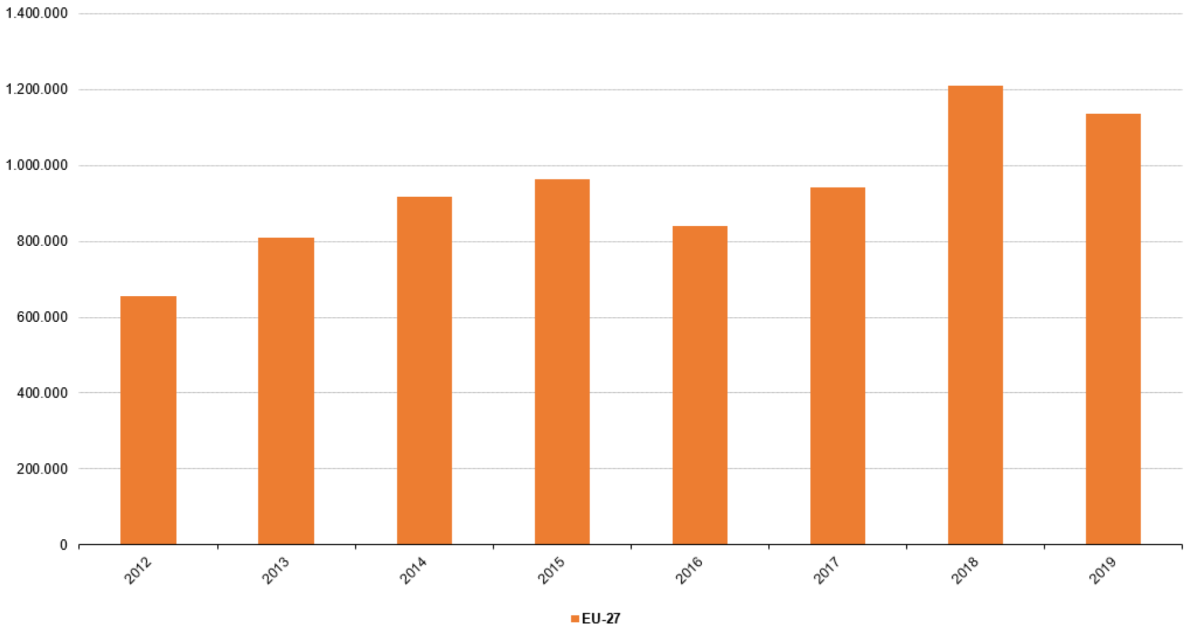
Figure 2-4 Obtained by MS reuse/recovery and reuse/recycling rates for the ELVs[45]. Reference year 2019.



Source: EC, ELV Statistics Explained

[45] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=End-of-life_vehicle_statistics#Number_of_end-of-life_vehicles

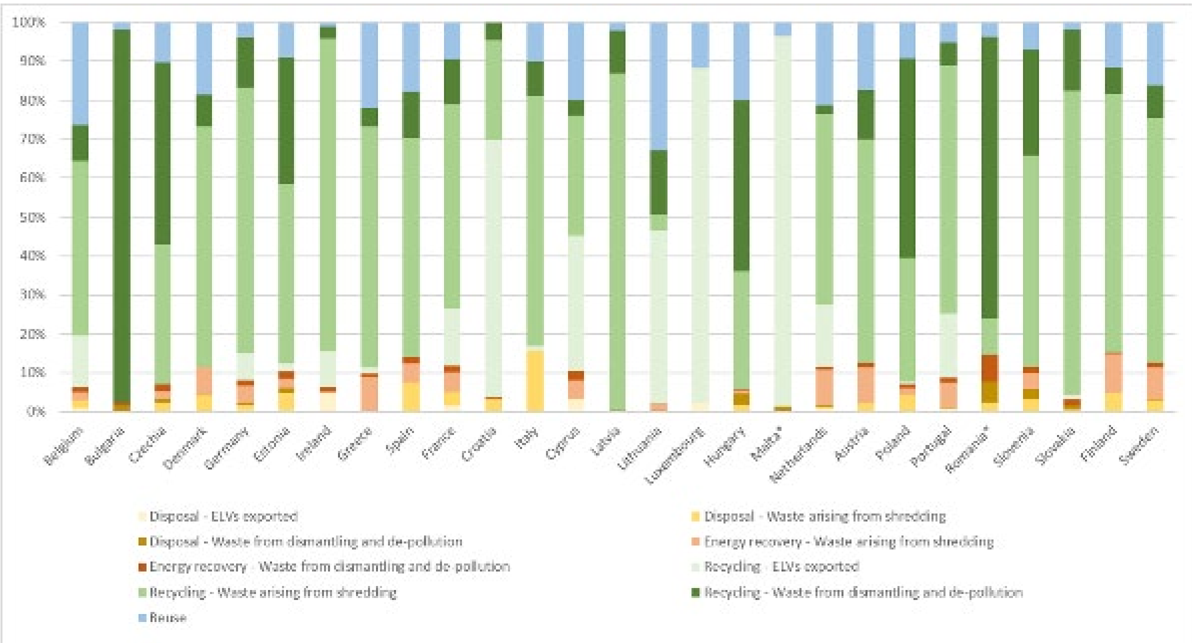
Figure 2-5 Total recycling from ELVs, 2012-2019.



Source: own illustration of ELV data in Eurobase (Eurostat online data code: env_waselv), Oeko-Institut

For the majority of countries the share of recycled output from shredders plays a major role in calculating re-use and recycling rates (illustrated on the figure below). Only for few countries does the recycling of dismantled components play a significant role in the calculating re-use and recycling rates. The share of re-use varies widely among MS.

Figure 2-6 Reported data on ELV treatment, 2019.



Source: own illustration of ELV data in Eurobase (Eurostat online data code: env_waselv), Oeko-Institut

2.1.2.3 Common treatment of ELVs

The treatment flow of ELVs seems to be quite similar in EU countries. The process of ELV treatment starts with depollution, defined in current ELVD under point 3 in the Annex I. This stage covers removal of e.g. batteries and liquefied gas tanks. Further treatment (to promote recycling) according to point 4 in Annex I of the ELVD should cover the removal of:

- catalysts,
- metal components containing copper, aluminium, and magnesium if these metals are not segregated in the shredding process,
- removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,
- glass.

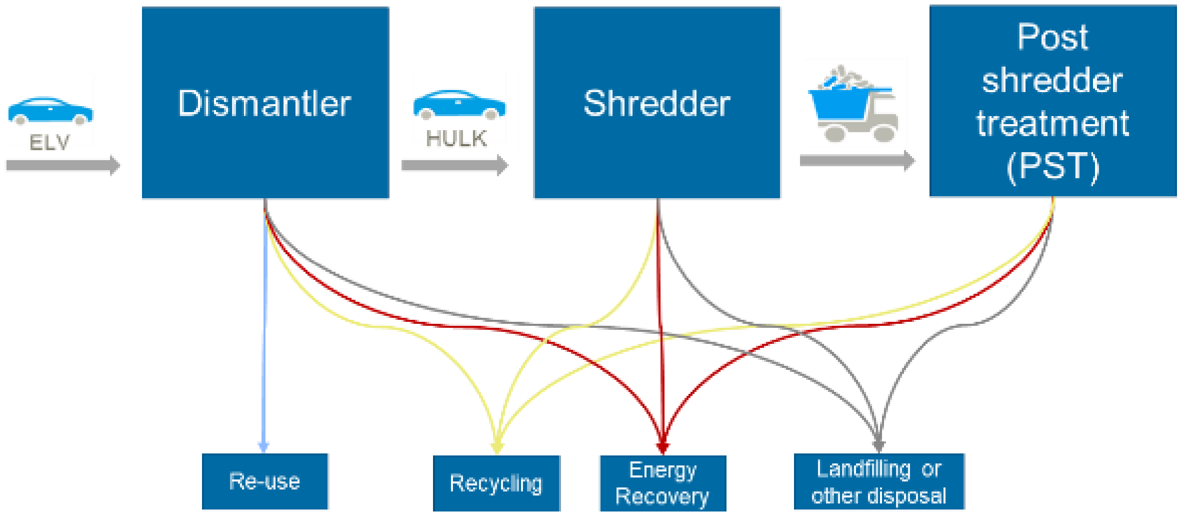
In practice, the dismantling of further components from the ELVs depends on the market demand for the components and the level of revenues that can be obtained by the ATF by selling the removed components. These revenues should optimally at least cover the dismantling costs (depending a lot on the region). Optimally dismantling shall aim to obtain components for reuse/remanufacturing. However, when there is no demand for components that have already been dismantled, they can be subsequently sent to the recycling process, avoiding the shredding process. In some cases, components are removed with the intention to be sent directly to the recycler (e.g. engines). This can be the case when the obtained revenue is higher than the one an ATF would get when the component is not removed and thus sent to the shredder in the hulk. In reality, removal of glass is not common, mainly due to high dismantling costs and low revenue of dismantled material (more about this in the chapter 2.1.2.5.4).

At this stage, ATFs are to store depolluted parts or fluids as well as components for reuse/remanufacturing or recycling in the appropriate conditions and not causing any damage on them.

Removal of materials from ELVs prior to shredding can maximise their recovery from ELVs. It prevents mixing of materials at the shredding stage and preserves their value, and recyclability and reusability properties.

The figure below illustrates typical stages of the ELV waste management and treatment processes performed on the outputs of each stage.

Figure 2-7 Stages of the ELV waste management and treatment processes performed on outputs of each stage.



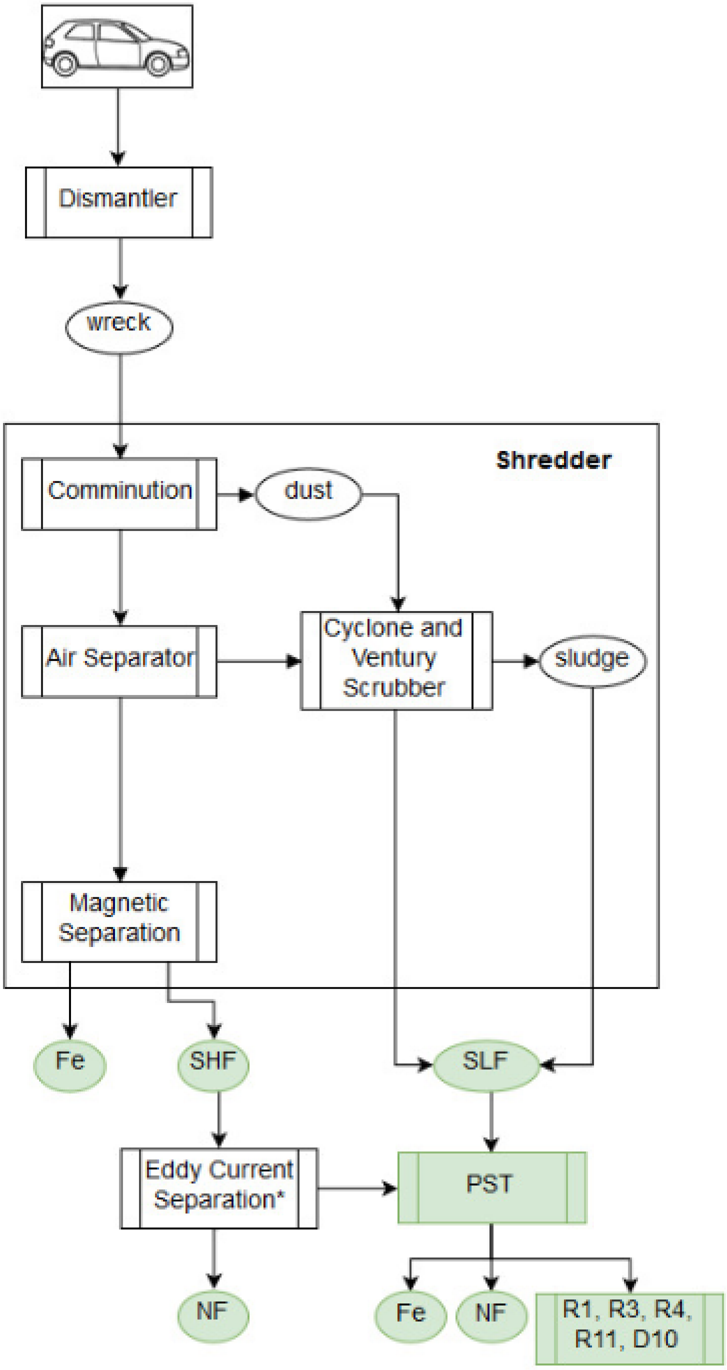
Source: own illustration, Oeko-Institut

Up to 35% of total mass of ELVs can be removed (according to the data reported by the MS, please see Figure 2-1) before the vehicle hulk is sent to the shredder. The figure below illustrates schematical presentation of typical processes of ELV treating in shredders (details might differ with regard to dust treatment or sieve cut) (Mehlhart et al. 2018). During shredding, the vehicle is broken into smaller parts to be sorted the various fractions. The main output of the shredder process is quality steel scrap (with high density, high degree of purity and predominantly homogenous size) which is separated from the shredded input material by magnetic separator. The obtained ferrous stream might still contain non-ferrous pieces, causing a certain degree of impurity in stream, e.g., with copper wire from electric motors that remains attached to ferrous components in the ferrous stream. These pieces can be removed manually to obtain higher-quality steel scrap. The resulting ferrous scrap is the finished product of the ferrous stream. Remaining steel scrap can be used directly in metal works to produce steel.

The other fraction obtained after magnetic separation is Shredder Heavy Fraction (SHF) that can be additionally classified to several fractions whereas the smallest one (< 10 (15) mm) is similar to post-shredder treatment plant (PST) and treated together with it (Mehlhart et al. 2018). The biggest fraction (> 100 mm) can be handpicked to remove Al alloys, Cr-Ni-steel-Fe/Cu composites. The rest is treated in Eddy Current. The outcomes of this process are non-metallic and metallic fractions, where the last contain mainly aluminium but also Mg, Al, Cu, brass, Zn. Some shredding companies ship this product to companies specializing in the further separation of these metals, other process these non-ferrous metals through a heavy media station[46] (high density technic) and sensor-based separation to separate the Al, Mg, Cu, brass, Zn and remaining stainless steel. The rest of this process is a non-metallic fraction that together with SLF can be further treated in the (PST).

[46] It is a heavy medium such silicon or sand and take advantage of the low density of aluminium, which causes the aluminium to float and the other metals to sink. (Brahmst 2006).

Figure 2-8 Schematical presentation of process of ELV treatment in shredders



Source: (Mehlhart et al. 2018)

Whether the shredder residues are to be disposed, depends on the national regulations. 7 MS (out of 13) declare that the disposal of untreated SLF and SHF are allowed in their country (EU MS ELV IA Survey 2022). In 4 countries it is also allowed to consider untreated SLF/SHF for the purpose of road construction (e.g., on landfills). For 3 of those countries this process is considered as recycling.

Some but not all shredders have integrated post-shredder technology (PST) or separate PST on site; other shredders send residues of the shredding process to offsite PST plants while some operators send shredder residues without PST for disposal e.g., at landfills.

The outcomes of PST are ferrous and non-ferrous fractions and fractions for further treatment under some recycling operations or for final disposal, e.g. incineration (Mehlhart et al. 2018).

In 4 MS the disposal in landfills of fractions from post-shredder treatment is not allowed. In some countries where disposal in landfills of fractions from PST is allowed, the costs for disposal are higher than the costs for recycling or thermal treatment. Some countries admitted that due to a disposal ban in their countries the recycling rates of ELVs increased. Some countries defined certain criteria for acceptance of waste at the landfill that have to be fulfilled (e.g. POP content in the residues or that the residues intended for landfill cannot be recycled or incinerated anymore).

The average allocation of the input material to the products of shredding process could be (Sander et al. 2020)[47]: 70 % is allocated to ferrous fraction with Cu-contamination, 11 % in SHF, 18.5 % in SLF and less than 0.5 % are losses.

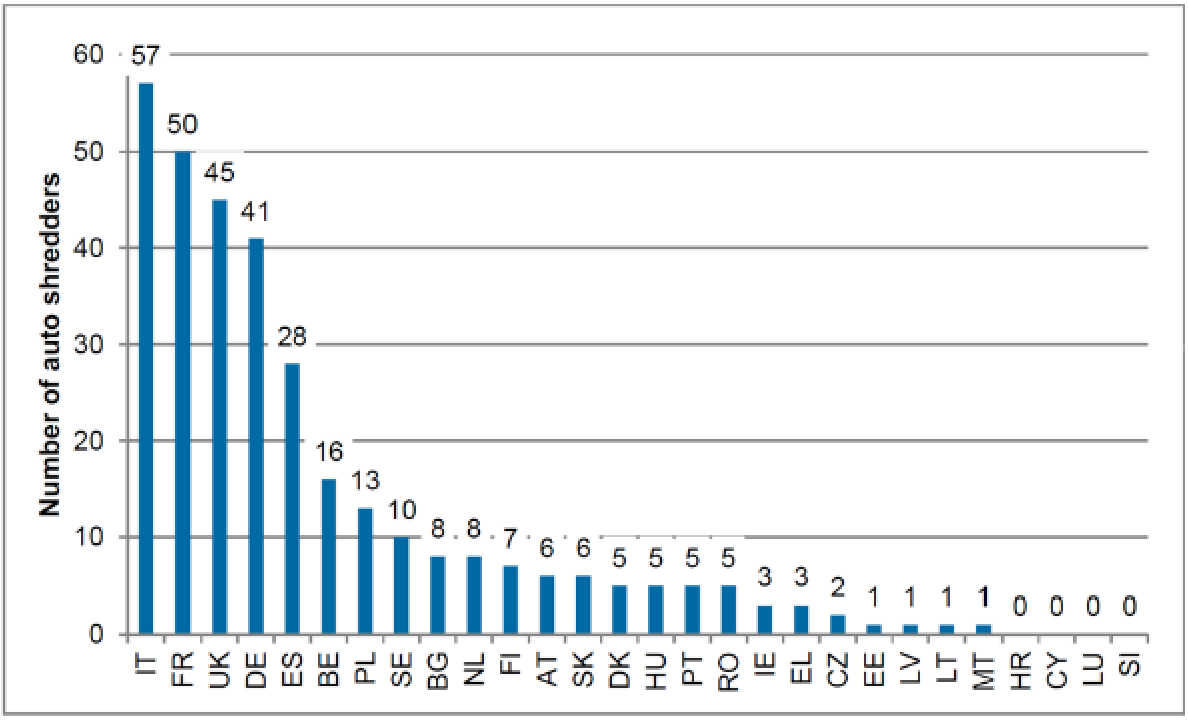
The composition and purity of the resulting products largely depends on the fraction of items that enter the process. In practice, ELVs are often mixed with other materials, e.g., as an outcome of eight surveyed shredding companies, shredded material at these companies consisted of 45-80 % automotive, 15-80 % appliances and 5-15 % other items. (Brahmst 2006)

As demonstrated in several studies untreated SLF contains several percent of residual metals with up to 7.8 %, respectively 6.3 % or according to studies performed more than a decade ago and up to 11 %. A German study (Sander et al. 2017) on SLF concluded that the recovery of metals in SLF should be more ambitious and should be targeted towards technical possibilities. The removal of metal from the shredder light fraction at least to below 1 % metal content by means of post-shredder separation is considered to be feasible. In Switzerland, such an approach is already implemented: According to Article 21 of the Swiss Waste Ordinance, metal pieces are to be removed and recycled from the lightest fraction that occurs during the comminution of metal-containing waste (light fraction).

According to (Mc Kenna 2014) a total of 352 “automotive shredders” were operating in the EU-28 and Norway in 2014. Most of these were in Italy (62), France (50), UK (47), Germany (43) and Spain (31). The remaining 33% of this type of shredder are distributed across 20 countries. Almost all Member States have at least one shredder for ELVs. The findings of (Mc Kenna 2014) are not fully in line with the reporting of the MS to Eurostat: Only Malta and Luxembourg report to Eurostat not having a national shredder (source: Statement of Eurostat, 18 April 2020). Compliance with BAT and capacity for post-shredder treatment are unknown.

[47] Trials that were performed within the study on two shredder treatment plants.

Figure 2-9 Number of auto shredders per country.



Source: (Mc Kenna 2014)

2.1.2.3.1 Shredders and PST – standards

Under "non-normal operating conditions" in shredder facilities smoke, dust and possibly dioxins may be released, e.g., by deflagration and or fire. Such conditions can be caused by fuel residues or Li-ion batteries left in end-of-life vehicles. The number of deflagrations varies from one shredder site to another. For poorly managed shredders, 50 deflagrations per year are reported. An efficiently managed shredder is able to reduce the number of deflagrations to one per year.

The ELV Directive defines minimum technical requirements for treatment operations for depollution of ELVs (Article 6(3) and Annex I (3)) as well as for treatment and for storage, which refer to the dismantling processes performed by ATFs (Annex I (1) and (2)), nonetheless no such requirements for shredder processes (incl. post-shredder plants) exist in the current Directive. (Pinasseau et al. 2018) defines detailed rules for the operation of shredders to minimise emissions under standard conditions and to minimise deflagrations and fires.

2.1.2.3.2 Treatment of Persistent Organic Pollutants (POPs)

As reported in a study funded by ACEA[48], for several components of ELVs, diverse literature mentions concentrations of POPs (including decaBDE) beyond the allowed 1000 mg/kg. A more recent analysis for the German Federal Environmental Agency confirms that decaBDE

[48] Mehlhart et.al (2018): Effects on ELV waste management as a consequence of the decisions from the Stockholm Convention on decaBDE; study commissioned and funded by ACEA, the European Automobile Manufacturers Association

occurs in the SLF with concentrations beyond 1000 mg/kg[49]. A study for the Norwegian Ministry of Environment[50] concludes that "*The fine and coarse ELV shred fractions however contain medium levels of MCCP (30 - 210 mg/kg) and at least occasionally high levels of decaBDE (e.g. 1650 mg/kg). Both concentration levels are considered reasonable due to the expectable presence of PVC cables containing chloro-paraffins and flame retarded materials like textiles or cable tubes. Due to the presence of these pollutants and the fact that these shredding materials contain unfavourable mixtures of plastics […* they*] are not considered for recycling*."

According to the POP-Regulation Annex V, POPs-containing-components must be separated: "Pre-treatment operation[51] prior to destruction or irreversible transformation pursuant to this Part of this Annex may be performed, provided that a substance listed in Annex IV that is isolated from the waste during the pre-treatment is subsequently disposed of in accordance with this Part of this Annex. Where only part of a product or waste, such as waste equipment, contains or is contaminated with persistent organic pollutants, it shall be separated and then disposed of in accordance with the requirements of this Regulation. In addition, repackaging and temporary storage operations may be performed prior to such pre-treatment or prior to destruction or irreversible transformation pursuant to this part of this Annex."

Unfortunately, no data is available as to which components containing POPs are contained in the individual vehicles reaching end-of-life and as to where these components are located. In this respect, it is not feasible to dismantle such components prior to shredding with the current level of information. Even if such information were available, such dismantling would entail very high dismantling costs.

Instead, the majority of these POPs are directed to the Shredder Light Fraction (SLF) and, when Post Shredder Treatment (PST) is applied, to the granulate with a specific weight > 1.3 g/cm^3, which includes the PVC fraction as well.

Considering these facts, and according to the current POPs Regulation, it is not allowed to dispose of SLF, respectively the PST granulate to which the POPs are intentionally directed to. Not only because the concentration of decaBDE might exceed the limit in the POP regulation, but simply due to the fact that components containing decaBDE are not separated before shredding (see underlined citation above) and thus the subsequent fraction is considered contaminated. However, the POPs Regulation is to some extent not coherent as on the one hand it requires dismantling of components containing POPs and on the other hand it allows by way of derogation in Article 7(4a) that "*waste containing or contaminated by any substance listed in Annex IV may be otherwise disposed of or recovered in accordance with the relevant Union legislation, provided that the content of the listed substances in the waste is below the concentration limits specified in Annex IV;*[52]"

[49] Sander et.al (2020) Evaluierung und Fortschreibung der Methodik zur Ermittlung der Altfahrzeugverwertungsquoten durch Schredderversuche unter der EG-Altfahrzeugrichtlinie 2000/53/EG, published by Umweltbundesamt UBA Texte 15/2020

[50] Ramboll / Fraunhofer IVV (2021) Environmental Pollutants in Post-Consumer Plastics; study for the Norwegian Environment Agency

[51] Shredding is considered as a pre-treatment operation. Shredding is not a final treatment operation but a separation with subsequent final treatment (recovery or disposal) operations.

[52] The current "upper level" in Annex IV for the listed PBDE (including decaBDE) is "Sum of the concentrations of tetrabromodiphenyl ether, pentabromodiphenyl ether, hexabromodiphenyl ether, heptabromodiphenyl ether and decabromodiphenyl ether: 1 000 mg/kg. The Commission shall review that concentration limit and shall, where appropriate and in accordance with the Treaties, adopt a legislative proposal to lower that value to 500 mg/kg. The Commission shall carry out such review as soon as possible and, in any event, not later than 16 July 2021."

2.1.2.4 Market condition for recyclates (recycled content)

The production of cars continues to largely rely on primary materials, which have a much higher environmental footprint than recyclates. To change this, materials need to be recycled in larger volumes and or at similar (e.g. equivalent alloy quality) or higher qualities to that of the material initially used in the vehicle (e.g., vehicle grade or equivalent). In the context of circularity, the recently adopted Chemicals Strategy for Sustainability (CSS) strives for a safe and sustainable-by-design approach and for non-toxic material cycles: “As a principle, the same limit value for hazardous substances should apply for virgin and recycled material”. This will affect in practice the recycling of certain materials, in particular those with long lifespan that contain substances that were not regulated by the time of production but are currently restricted (legacy substances) and that may still end up in waste streams for many years to come, mixing with cleaner materials. The related EU polices (CEAP, CSS, etc..) should look to complement one another and ensure a smooth interface between chemicals, waste, and product policies.

To further promote the use of secondary materials instead of primary ones, it may also be necessary to foster the market for such materials, i.e., in cases where the cost of recycling materials at equivalent or higher quality may be prohibitive in light of fluctuations in the market price of recyclates. The same counts when the external costs of primary production are not properly reflected in the market prices or when there is lack of economies of scale in secondary production to compete with primary raw materials. The CEAP *inter alia* aims at a reduction of waste by linking design issues to end-of-life treatment and introducing rules on mandatory use of recycled materials for the construction of vehicle components. For instance, the uptake of recycled plastics and more sustainable plastics in vehicles is a targeted measure of the CEAP.

For example, for plastics and tyres, EuRIC (2022a) and EuRIC MTR (2022) refers to the option of a recycled content target as a means of ensuring the demand of recyclate. This is understood to be important to give certainty to waste operators as to the economic feasibility of developing capacities, in particular where there are fluctuations on the market prices of virgin materials that could lead to an inconsistent demand for secondary materials.

As regards the use of secondary metals, most stakeholders do not agree that recycled content targets would be needed to support the uptake of secondary raw materials (SRM) nor that this would promote more recycling. “Metals are in demand and are cost competitive as secondary materials. We will need more metals in the future to fulfil the demand […for aluminium] around 92-95% is recycled” (Eurometaux 21 Feb 2021). EU Aluminium (2022) further emphasize the relevance of different qualities of secondary materials. It is explained that with the shift towards electric vehicles, that the amounts of wrought alloys used in vehicles are expected to increase, whereas the amounts of cast alloys used will decrease. Without intervention in treatment quality and separation of various alloy types, this and other market developments are expected to create a surplus in the supply of low-quality cast alloys, which are the result of recycling today, when ELVs are shredded, and aluminium scrap separated therefrom. In this case, all alloys are mixed and the secondary aluminium in terms of quality (impurities) can only be applied for applications of cast alloys where the quality requirements are lower. However the increase in the use of wrought alloys and vice versa will create a higher dependency on primary materials if not dealt with in the waste management in a way that shall ensure recycling of more wrought alloys. Of an opposite opinion are some of the Original Equipment Manufacturers (OEMs) e.g. Volvo and Tesla, which suggest that the use of cast and wrought alloys will grow at the same rate (personal communication with DG GROW).

EUROFER explains that increasing recycled content makes sense to stimulate the demand for recyclate in cases where there is no market e.g. plastic. However, in the case of metals like steel, EUROFER states that "more primary steel will be needed in another product. Steel scrap might be diverted from one product to another without any overall environmental benefits" (EUROFER 27.10.21).

In short, looking at the different materials used in the manufacture of cars and how they are treated at end-of-life, suggests that in some cases the current practices may create market failures that need to be addressed in the coming years to promote circularity in the vehicle sector. To do this, it may be necessary to introduce new measures that affect the design of vehicles or their treatment at end-of life (e.g. through technical requirements, administrative requirements, etc.). Such measures could help decrease the dependency of the European market on the supply of materials for vehicle manufacture from non-EU countries and thus increase the general resilience of the Union.

2.1.2.5 The current situation of specific raw material in vehicles and their waste management

The sections above provide an overview of the design and waste management of vehicles and provide some insights for specific materials. As the material flows are affected by all life cycle phases of a vehicle (manufacture, use and EoL), it is difficult to refer to specific materials without providing a complete overview of the situation. How the different materials are affected by the current legislation and by different policy developments can differ. In some cases, a market failure such as the fluctuating costs of virgin plastics can have a significant impact on investments in recycling technologies. In others, like glass, the lack of alignment with other legislation in terms of the quality of recycling deemed acceptable leads to glass being treated differently by different branches at EoL. For this reason, an overview at the material level is provided in this section for a selection of materials used in vehicles to provide more detail to some of the aspects raised above as well as data for the analysis to be carried out later on.

Table 2-1 shows the material composition of passenger cars in 2020 according to the model (see model description in Annex I. The data from JRC-RMIS[53] on the composition of European passenger cars was used for metals, supplemented by data from the Greet model (Argonne 2021) on North American passenger cars for other materials. The percentage composition was calculated down to the average weight of ELVs in the EU according to Eurostat.

Table 2-1 Material composition of End-of-life vehicles (passenger cars) for 2020 in kg after depollution, battery weight excluded

Material	ICEV	HEV	PHEV	EV
Steel	653	660	621	642
Cast Iron	101	101	96	16
Wrought Aluminium	40	58	76	108
Cast Aluminium	79	91	93	77
Copper	14	20	23	35
Magnesium	5	5	5	1
Manganese	8	8	8	7
Glass	24	21	22	26

[53] https://rmis.jrc.ec.europa.eu/apps/veh/#/p/viewer

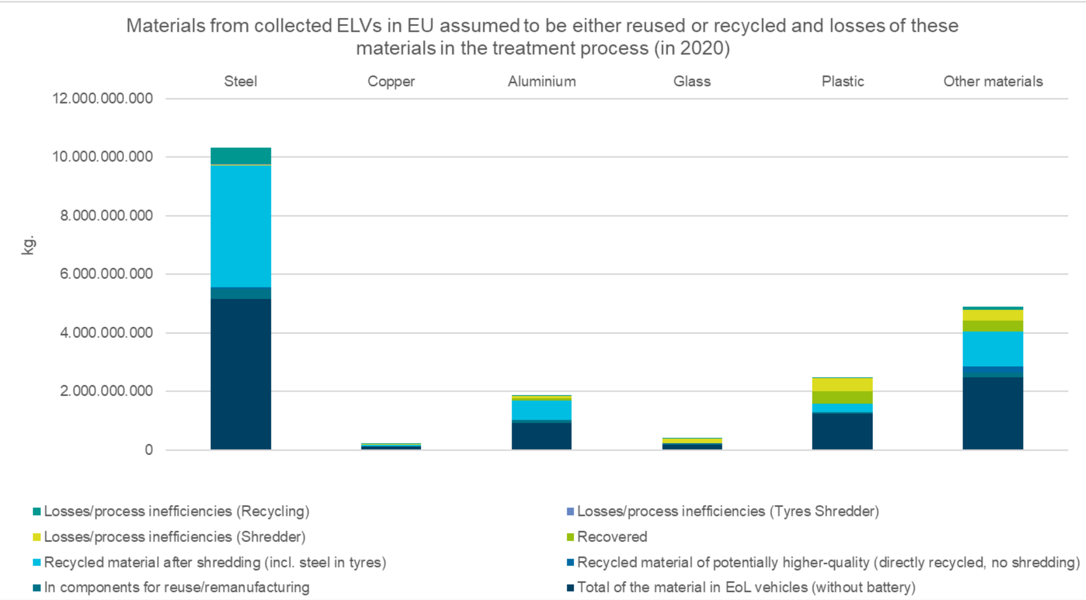
Material	ICEV	HEV	PHEV	EV
Silver	0.008	0.009	0.010	0.013
Gold	0.001	0.009	0.002	0.002
Nd	0.034	0.135	0.151	0.159
Dy	0.003	0.063	0.072	0.075
Average Plastic	159	129	143	166
Rubber	41	34	38	39
Glass Fiber-Reinforced Plastic	9	4	5	5
Others	5	6	7	14
Total	**1 137**	**1 137**	**1 137**	**1 137**

Source: Calculated with data from JRC-RMIS (for metals) and Argonne 2021 (for other materials) and average weight according to Eurostat

Observed trends of use of certain materials in the shift from conventional vehicles to EV based on the above table and on available information in general:

- Changes of use of ferrous metals in EV – slight reduction in use of steel, significant decrease in use of cast iron,
- Changes in use of aluminium in EVs in comparison to conventional vehicles – shift from cast Al being main type of al alloys to wrought Al being the more significant group of Al alloys – mainly attributed to engine.
- Increase in use of copper in EV – in part higher due to battery (excluded in the data shown above) and due to the increase in use of power electronics in vehicles.
- Increase in use of critical metals, like rare earths due to magnets in electric engines and cobalt due to battery (excluded in the data shown above) or precious metals like gold and silver. due to the increase in use of power electronics in vehicles.

Figure 2-10 Materials from collected ELVs in EU assumed to be either reused or recycled and losses of these materials in the treatment process (in 2020)



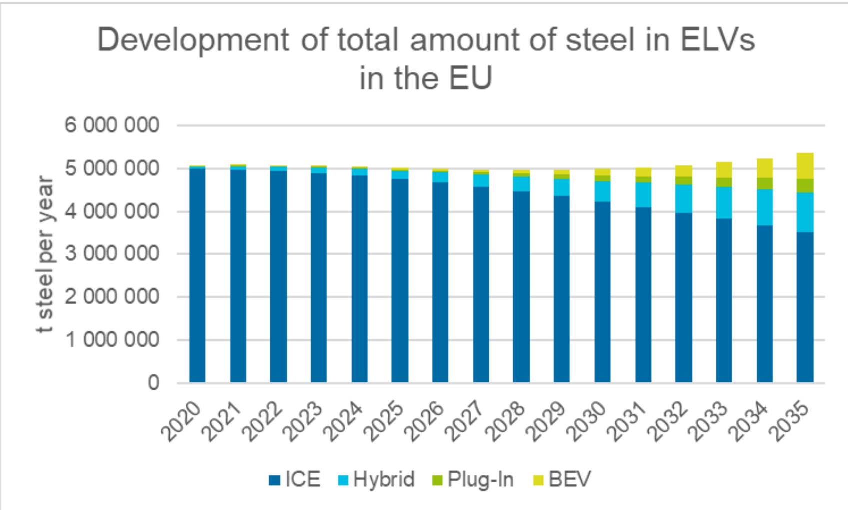
Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

2.1.2.5.1 Steel

The automotive sector is responsible for the use of 12 % of the steel worldwide. At European level, the automotive sector is responsible for the consumption of 16 % of the steel in the EU (23.077 million of tons in 2020). (EUROFER 2021a)

Figure 2-11 shows the development of the total amount of steel from ELVs in the EU from 2020 to 2035.

Figure 2-11 Development of total amount of steel in ELVs in the EU from 2020 to 2035



Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

On average, 650 kg of steel is used per vehicle. Steel is mainly used in body structure, panels, doors and trunk closures for high-strength and energy absorption in case of a crash[54], see Table 2-2.

Table 2-2 Distribution of total amount of steel on the different parts of End-of-life vehicles (passenger cars) in % after depollution

Steel	ICEV	HEV	PHEV	EV
Body	58%	49%	47%	57%
Powertrain System (Including BOP)	11%	18%	20%	4%
Transmission System/Gearbox	3%	5%	5%	6%
Chassis (w/o battery)	28%	24%	23%	28%
Traction Motor	0%	1%	2%	4%
Generator	0%	1%	2%	0%
Electronic Controller	0%	0%	0%	1%
Total	**100 %**	**100 %**	**100 %**	**100 %**

Source: Calculated with data from JRC-RMIS (total amounts of steel per vehicle) and Argonne 2021 (distribution on the different parts) and average weight according to Eurostat, see model description in Annex I 6.9.2

[54] https://worldsteel.org/steel-topics/steel-markets/automotive/

Over the last decades, previously used mild steel (with a relatively low strength-to-weight ratio) has been increasingly displaced by various types of conventional high-strength steel (HSS), advanced high-strength steel (AHSS) as well as alloys based on aluminium or magnesium alloys and polymer materials. A significant shift away from steel in modern vehicles has been the switch from cast iron to cast aluminium engine blocks. According stakeholder communication, there is also a shift from steel to aluminium expected in the future. In the model for this study this is not taken into account. This is driven by increasing safety demands, light-weighting and manufacturing cost reductions. (Peck et al. 2020)

According to the American Iron and Steel Institute, on average the steel used in car bodies is made with about 25 % secondary material. According to EUROFER, the amount of secondary steel used in vehicles (and other applications) is limited in relation to the quality requirements of the alloy needed and does not reflect a lack of supply. All steel has at least a little amount of secondary material (scrap), which is always included, for metallurgical and thermodynamic reasons.

The amount depends on the intended application and can range between 5-85 %, depending on the application in the vehicle (EUROFER 27.10.21):

- External components – the steel sheet must be relatively pure with no copper contamination. Usually 5-10% scrap will be included, depending on its purity. 30 % is the higher limit with 20-25% scrap already indicating very clean scrap that can be used at higher shares, but respectively higher recycling costs.
- Long parts are used in the internal body (a bar) – here 80-85 % steel scrap can be applied as input.

In other words, though secondary steel can be integrated in large amounts in structural parts, parts made of steel sheet have a much lower tolerance to impurities and thus allow integration of much smaller share of secondary steel.

Steel in ELVs is understood to have a high recovery rate – considered to enable above 90 % recycling. Higher levels are possible but at higher costs. (EUROFER 2021a)

EU wide, the commonly applied method to treat steel are shredder/PST facilities (process described under 2.1.2.3).

Alternatively, according to (Mehlhart et al. 2018) massive scrap is increasingly treated by scrap shear, not shredders, especially if the scrap is exported to steel plants working under lower environmental standards and producing lower level steel qualities. Hence, big shredders (high throughput) are often not economically sensible in many parts of Europe.

Brokers connect the processors to individual scrap consumers (mills and foundries)[55]. Scrap is classified and sold by grades. The existing classification schemes[56] specify the dimensions of the scrap piece, the origin of the scrap, and define limits on impurities and residual elements, which make a distinction into different categories, linked to the compositional information required by the final product, e.g. different content of copper. The final composition is not typically measured until scrap has been mixed with other raw materials and melted. When copper control is critical, the scrap processors can adjust their preparation for steel, frequently by hand-picking of copper parts from the line. (Daehn 2019)

[55] Scrap and brokers tend to establish long term relationship and agreements with mills and steel makers. This partnership is based on specifications of the mill on the scrap delivered.

[56] Institute of Scrap Recycling Industries (ISRI), EUROFER, Japanese Ferrous Raw Materials Association

Most steel scrap contains other metals. If these metals cannot be extracted from the Electric Arc Furnace (EAF)[57] melt, then they are known as "tramp elements", e.g., Cu, Ni, Sn, As, Cr, Mo, Pb and others. According to (Nakajima et al. 2011) the most important tramp elements in steel recycling are copper (Cu) and tin (Sn), both causing hot shortness, a phenomenon leading to surface cracking in hot rolling and forming. In the case of copper this phenomenon occurs when the concentration of copper is over 0.1 wt % and for tin even at concentrations as low as 0.04 wt % (Daehn et al. 2017a).

Copper in end-of-life scrap originates mostly from copper wires and motors in automotive (more in following chapter 2.1.2.5.2). Tin is in packaging tinplate and makes up a much smaller portion of the scrap stream (less than 1 %). In contrary to tin, that can be isolated and treated more readily prior to melting, copper is currently the main barrier to producing high quality steel from end-of-life scrap.

Nominal tolerance on the copper concentration in steel defines the applicability of recycled steel. Reinforcing bar has a nominal tolerance of 0.4 wt % copper, whereas flat products (e.g. steel sheets) have more stringent limits (less than 0.06 wt % copper from drawing steel). The copper concentration in ELV scrap (shredded) can be between 0.23 and 0.7 % (Daehn et al. 2017b). A shredded scrap sorting trial performed by ArcelorMittal demonstrated the Cu content at 0.6 % (Russo et al. 2011).

In recycling of steel, the commercially practiced solution for reducing the concentration of tramp elements (also copper) in the steel melt is dilution with primary iron source or with less contaminated scrap sources (Björkman and Samuelsson 2013). Steelmakers can also modify processing. Contamination of copper can also be managed by globally trading scrap for use in tolerant applications. However, considering the Cu-contamination in the end-of-life scrap in the long-term, extensive dilution and careful allocation of scrap at a global scale would become increasingly impractical after 2050 (Daehn et al. 2017a).

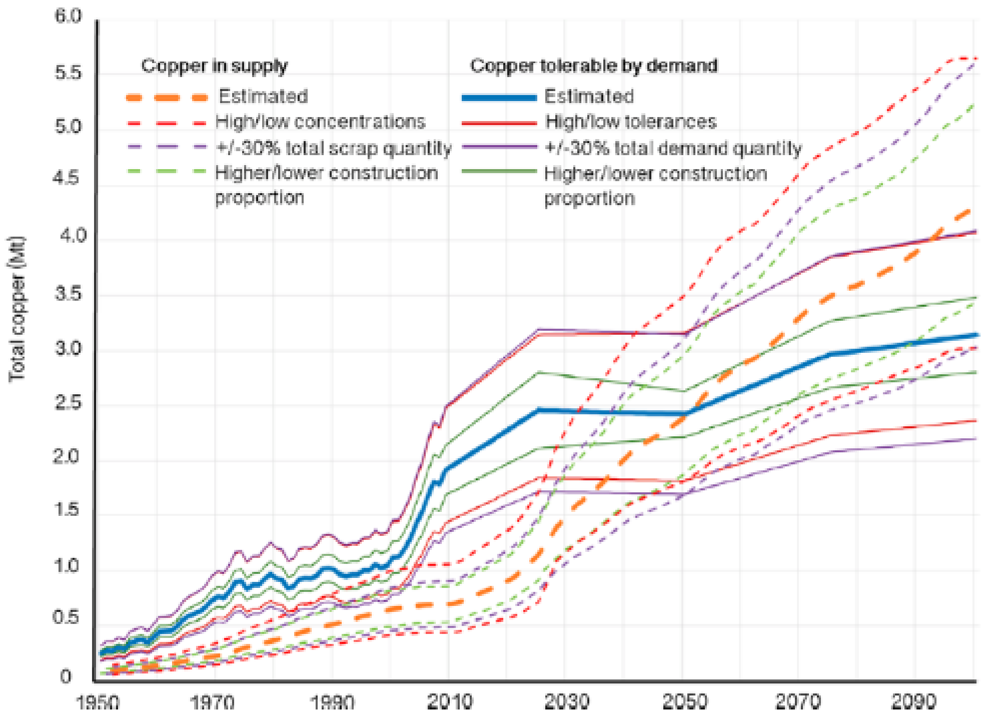
Existing models assume that demand for copper-tolerant products is likely to grow at a slower rate than demand for higher-quality steels. Additionally, incoming scrap will have a higher concentration of copper due to past accumulation. Thus, this will lead to copper excess and in consequence to increase of dilution and potentially to accumulation of stocks of unusable steel scrap. (Daehn et al. 2017a)

A further motivation for the removal of copper is also possible increases in the demand for copper. This can also be related to supply limitations that can occur due to geo-political developments such as the case of Ukraine which is a key supplier of copper and which has had difficulties in ensuring the supply since the war.

The figure below illustrates the estimated mass of copper in the end-of-life scrap supply and copper that can be tolerated by end-use products from 1950-2100. The figure includes also curves varying from the estimated case. By 2050 the total copper in supply shall be about the same as the maximum that can be tolerated across all products and to match supply with demand.

[57] Electric Arc Furnace (EAF) is commonly used to make steel from scrap. This process leads to around on-third the greenhouse gas emissions associated with steelmaking from ore. (Yellishetty et al. 2011.

Figure 2-12 Mass of copper in the end-of-life scrap supply and copper tolerance by demanded products between 1950 to 2100 at a global scale (Daehn et al. 2017a)



Legend: Sensitivity curves apply high and low values for copper concentration across all categories, vary the total quantities of end-use steel demand and scrap supply across all sectors ±30%, and vary the proportion of the construction sector by ±30% (while other sectors decrease/increase by 30%, respectively).

Source: (Daehn et al. 2017a)

The copper concentration in vehicles will increase together with the electrification of the vehicles (more details in chapter 2.1.2.5.2), if the treatment of vehicles at end-of-life does not change to accommodate this situation this trend could influence the Cu-concentration in steel scrap recovered from ELVs.

Nevertheless, (Daehn et al. 2017b) states that the future copper concentration in ELV steel scrap could be influenced by (a mix of) serious interventions: more disassembly, better shredding, better sorting, chemical extraction, increase in copper tolerance, reduction in copper content in new cars[58] supported by policy provisions (for more details please refer to chapter 2.1.2.5.2).

There is also the possibility of intervening in the design of vehicles to promote a reduction in copper content in future cars. For example, research into alternative materials for the wire harness is looking into aluminium and optical fibres as light weight options[59]. Implementation of such alternatives could affect the design of the vehicle, for example where this results in a thicker wire harness and would need to be integrated into design before its implementation but could provide relief for the difficulties encountered in steel recovered from should the level of copper impurities continue to increase.

[58] For instance, design exist for use of weight-saving aluminium wire harnesses instead of copper wires Daehn et al. 2017a. Thus, upstream techniques have the potential to prevent copper from entering the scrap steam.

[59] See for example: https://sumitomoelectric.com/sites/default/files/2022-05/download_documents/sei_id002.pdf and https://www.marketsandmarkets.com/Market-Reports/automotive-wiring-harness-market-170344950.html, last viewed 20.12.2022

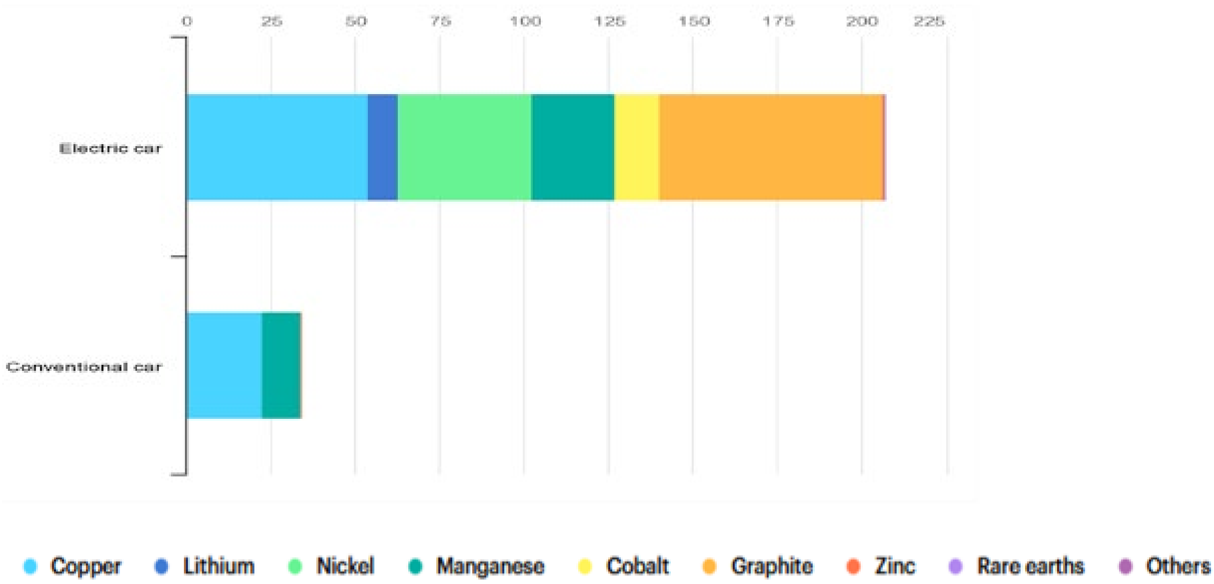
According to (Nakamura et al. 2014) only 7 to 8 % of recovered car steel is recycled back into the automotive sector. (Daehn et al. 2017a) estimate a mass of copper that would be required to remove from ELV steel scrap to allow its use in production of main intermediate products in cars that require either 0.06 or 0.1 % copper. The authors expect that using ELV scrap for the production of new vehicles (a theoretical closed loop) would reduce the amount of iron ore required from 136 to 78 Mt, accounting for 32 Mt of fabrication scrap generated in car manufacturing.

(Willman et al. 2017) analysed the possible trends and improvements in the steel scrap sorting process through increased information about the alloy content within the scrap category E40. The results of this thesis conclude that it may be possible to separate alloy enriched scrap and purified scrap. In consequence, it is to expect an increase of the market value of steel scrap, a decrease of use of virgin materials to produce steel from steel scrap, and a decrease of environmental impacts from production of steel from steel scrap. The authors also claim that it is economically beneficial to have a separation between an alloyed enriched scrap and a purified scrap for the steel scrap category E40. These products, within scrap category E40, contain valuable elements such as Cu, Cr, Ni and Mn that can be treated. Thus, these economic profits could cover some of the expenses from the investment in automatic sorting technology. However, the authors defined further required investigations in this field to successfully implement possible investment models: more random sampling of the scrap flow to obtain more data on alloy content in scrap, more research about a possible automatic sorting solution.

2.1.2.5.2 Copper

The comparison of the use of copper in electric and conventional cars in Figure 2-13 shows that an average amount of 53.2 kg is present in each electric vehicle, while 22.3 kg is the average quantity in traditional cars. The increase is mainly related to the use of copper in EV batteries (excluded in the figure), electric power control and electric motors.

Figure 2-13 Composition of EV and Conventional car[60]



[60] https://www.iea.org/data-and-statistics/charts/minerals-used-in-electric-cars-compared-to-conventional-cars

Conventional cars have 8-22 kg of copper, hybrid electric vehicles (HEV) contain approximately 39 kg, plug-in hybrid electric vehicles (PHEV) use 60 kg, battery electric vehicles (BEVs) contain 83 kg, a hybrid electric bus contains 89 kg, and a battery electric bus contains 369 kg, most of which is used in the battery[61].Table 2-3 shows in which parts of the car the copper occurs. According to (Villanueva-Rey et al.) the wire harness is the largest part of copper, ranging from 15 kg to circa 30 kg depending on car size.

Table 2-3 Distribution of total amount of copper on the different parts of End-of-life vehicles (passenger cars) in % after depollution

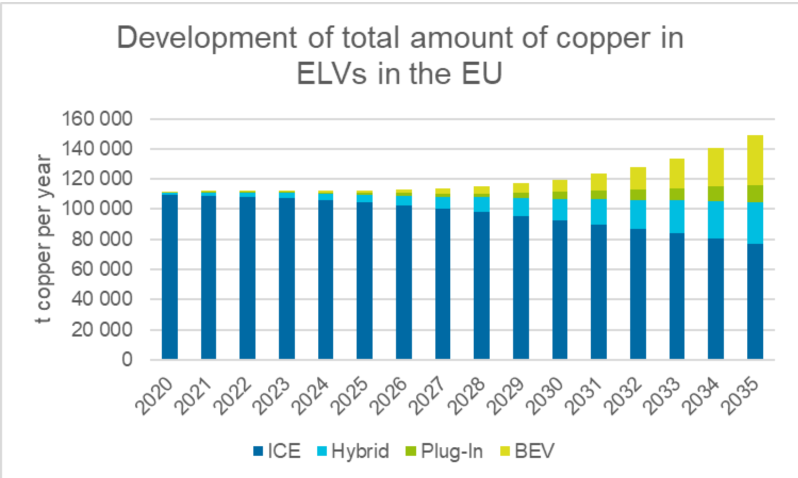
Copper	ICEV	HEV	PHEV	EV
Body	42%	21%	18%	17%
Powertrain System (Including BOP)	44%	15%	15%	17%
Transmission System/Gearbox	0%	24%	19%	18%
Chassis (w/o battery)	14%	7%	6%	6%
Traction Motor	0%	15%	20%	34%
Generator	0%	15%	20%	0%
Electronic Controller	0%	4%	3%	8%
Total	**100 %**	**100 %**	**100 %**	**100 %**

Source: Calculated with data from JRC-RMIS and Argonne 2021 and average weight according to Eurostat, see model description in Annex I 6.9.2

Together with the increase of use of EV vehicles, copper demand is expected to increase (Betz et al. 2021). However, design exists for use of weight-saving aluminium wire harnesses instead of copper wires (Daehn et al. 2017a).

Figure 2-14 shows the development of the total amount of copper from ELVs in the EU from 2020 to 2035.

Figure 2-14 Development of total amount of copper in ELVs in the EU from 2020 to 2035



Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

[61] https://www.copper.org/publications/pub_list/pdf/A6191-ElectricVehicles-Factsheet.pdf

Common practice on recovery of copper is a stepwise process in which first the residues of shredder process are separated (magnetic separation) into two fractions: ferrous and shredder heavy fractions (SHF). The SHF contains most of the non-ferrous metals, which separation can be done by use of Eddy Current Systems (ECS). The obtained second fraction after ECS can be send to PST to treat it further. The potential to remove additional copper in the PST relies on the PST equipment or additional eddy current technologies.

Some components that contain Cu, like wheels, transmissions, and engines may be removed prior to shredding for re-use. Others, like wire harnesses, smaller motors that are difficult to remove and are not interchangeable with other vehicles remain in hulk and together with steel bodies are hammer shredded and copper wires become enmeshed such that magnetic separation is only partially effective.

Alternatively, copper-containing parts can be removed manually from ELVs prior to shredding (dismantling process), what is more in practice in countries where lower labour costs exist. An alternative to hand-picking is automatic dismantling, however its efficiency depends on the design of a vehicle[62] (e.g., convenience of access to the wire harness).

Alternative shredding processes exist to help sort copper-rich pieces as well as to more precisely determine the composition[63] of a batch before melting, e.g. laser-induced breakdown spectroscopy, X-ray fluorescence, neutron activation analysis, or image processing of a conveyor belt of scrap. (Daehn 2019) defines various techniques for copper separation and evaluates their potential to remove copper. It also analyses these techniques to show that copper could be removed to below 0.1 wt % (enabling the production of high-value flat steel products).

2.1.2.5.3 Aluminium

The amount of aluminium in an average car has increased from 50 kg in 1990 to today's 151 kg. The average Al use in today's vehicle vary from 62 kg in small segments to 610 kg in high segments (e.g. Range rover sport). Table 2-4 shows in which parts of cars aluminium occurs.

Table 2-4 Distribution of total amount of aluminium on the different parts of End-of-life vehicles (passenger cars) in % after depollution

Copper	ICEV	HEV	PHEV	EV
Body	13%	12%	11%	13%
Powertrain System (Including BOP)	32%	26%	25%	0%
Transmission System/Gearbox	15%	8%	7%	9%
Chassis (w/o battery)	40%	35%	32%	38%
Traction Motor	0%	6%	9%	20%
Generator	0%	6%	9%	0%
Electronic Controller	0%	7%	7%	21%
Total	**100 %**	**100 %**	**100 %**	**100 %**

Source: Calculated with data from JRC-RMIS and Argonne 2021 and average weight according to Eurostat, see model description in Annex I 6.9.2

[62] Vehicle design changes could reduce the need for downstream interventions (Daehn et al. 2017a.

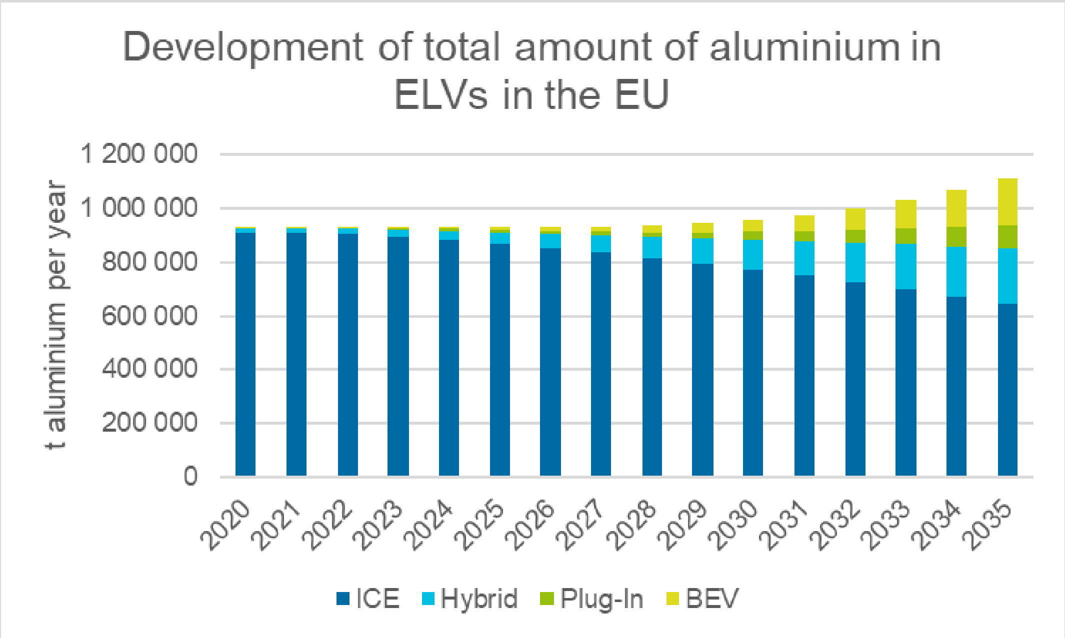
[63] The copper concentration of a batch currently might not be definitively known until it is melted and chemically analysed. This requires steelmakers be conservative when producing steel with stringent copper limits. This technical limitations could be an area for future development. Daehn et al. 2017a.

According to JRC-RMIS, in 2016, cast aluminium accounted for an average of 66% of the total aluminium content per vehicle, extruded aluminium 11%, forged aluminium 5%, and rolled aluminium 18%.

Experts project that the amount of aluminium could rise to 196 kg by 2025. Other sources (Kelly 2018) expect a rise of the aluminium share in a car by weight from 8 % to 16 % between 2018 and 2028. The increase of aluminium in new vehicles will be mainly due to wrought aluminium, especially series 5000 and 6000[64] (Kelly 2018). Estimates from (Buchner et al. 2017) predict the amount of wrought aluminium in a vehicle to jump from 40 kg to 150 kg whereas the amount of cast aluminium increases slightly from 100 kg to 110 kg. The drivers of this development are the electrification[65] (Løvik et al. 2014) and the desire for lighter and hence more energy-efficient components, e.g. aluminium sheets (Løvik et al. 2014). The expected increase of aluminium demand for semi-finished aluminium in Europe in the transport sector is 55 %[66] of the overall aluminium demand by 2050 (Circular Aluminium Action Plan[67]).

Figure 2-15 shows the development of the total amount of aluminium from ELVs in the EU from 2020 to 2035.

Figure 2-15 Development of total amount of aluminium in ELVs in the EU from 2020 to 2035



Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

[64] There are seven different alloys commonly used in aluminium manufacturing. Different alloys have different benefits, including workability, corrosion resistance, heat treatability, electrical conductivity, strength, and flexibility. The most common alloying elements are copper, manganese, silicon, magnesium, silicon, zinc. 5000 series is alloyed with magnesium whereas 6000 series is alloyed with magnesium and silicon.

[65] Future increase in Al content in battery box, body closures, electric motor housing, body structure and chassis

[66] From slightly more than 5000 in Ktonnes in 2017 to almost 8000 Ktonnes in 2050

[67] https://european-aluminium.eu/media/2903/european-aluminium-circular-aluminium-action-plan.pdf

More than 90 % of the metal is recovered after the end of the vehicle's life cycle and re-used to create new aluminium products (European Aluminium[68]).

The current recycling process for ELV – shredding and post-shredder sorting – results in the production of aluminium scraps containing a mix of alloys (cast and wrought), and sometimes small amounts of other undesirable materials. Today, this scrap quality fits the requirements of European refiners for recycling into cast alloy ingots, which can be remelted to produce parts for the automotive industry. Most wrought alloys are produced from primary aluminium and usually contain lower alloying elements. However, the increasing share of wrought alloys in cars will increase the loss of these alloys if recycling practices remain unchanged (European Aluminium[69]). Without intervention, the automotive sector will turn from a net-consumer of aluminium scrap into a net producer in near future. This will lead to surplus scrap that cannot be used in recycling (Løvik et al. 2014).

For aluminium it can be understood that recycling results in a fraction (termed zorba) which has a high Al content but is also rich in impurities as it is a mix of different alloys. It can be applied in higher amounts in alloys which are more susceptible to impurities (e.g., used for casting). However, to enable use in alloys with higher quality specifications, dismantling would need to be improved: aluminium parts would need to be sorted prior to shredding for example into cast alloy parts and wrought alloy parts. Eurometaux (Eurometaux 21 Feb 2021) mentions bumpers, doors and the engine block as parts of relevance for removal prior to shredding. This statement is in line with the Circular Aluminium Action Plan[70].

Another option to reduce the amount of surplus mixed scrap are intelligent sorting systems (ISS). These comprise x-ray transmission (XRT), x-ray fluorescence (XRF), and laser-induced breakdown spectroscopy (LIBS). None of these ISS have been adopted on a large scale and more research is required. However, their efficiency has been tested on a small scale with LIBS being the most promising candidate. Alloys from the series 3000, 5000, 6000 and 7000 can be separated from cast aluminum with rates of recovery and purity all larger than 96 % (Kelly 2018).

The following graph from (Løvik et al. 2014) gives an overview of the potential of alloy sorting, better dismantling by comparing the amounts of primary and secondary, as well as cast and wrought aluminum in different scenarios in the automotive sector. Of special interest is whether, and if so, when the surplus scrap appears. The first line reflects the current practice of de-magging (reducing the amount of magnesium in the scrap) and without using scrap from safety-relevant components[71]. Frame a.1 shows a business-as-usual scenario. It shows the onset of a scrap surplus in 2025 which will make up 28% or about 6 Mt of scrap by 2050. Other studies estimate the global surplus scrap to be 5.4 million tons by 2030 and 8.7 million tons by 2040 (van den Eynde et al. 2022). The occurring of the surplus scrap can be delayed to 2033 by a higher rate of dismantling (b.1) and 2047 by alloy sorting via LIBS assuming an efficiency of 90 % and a uniform false ejection to all other alloy groups (c.1). The fourth scenario (d.1) of high dismantling additionally to alloy sorting only shows a slight improvement compared to c.1 where there is low dismantling. The second line of plots shows the positive effect of using scrap from safety-relevant components in any of the four discussed scenarios. Due to the high standards for safety-relevant components, using scrap in its production would require an effort for intensified coordination between the players involved in their production.

[68] https://www.european-aluminium.eu/about-aluminium-in-use/automotive-and-transport

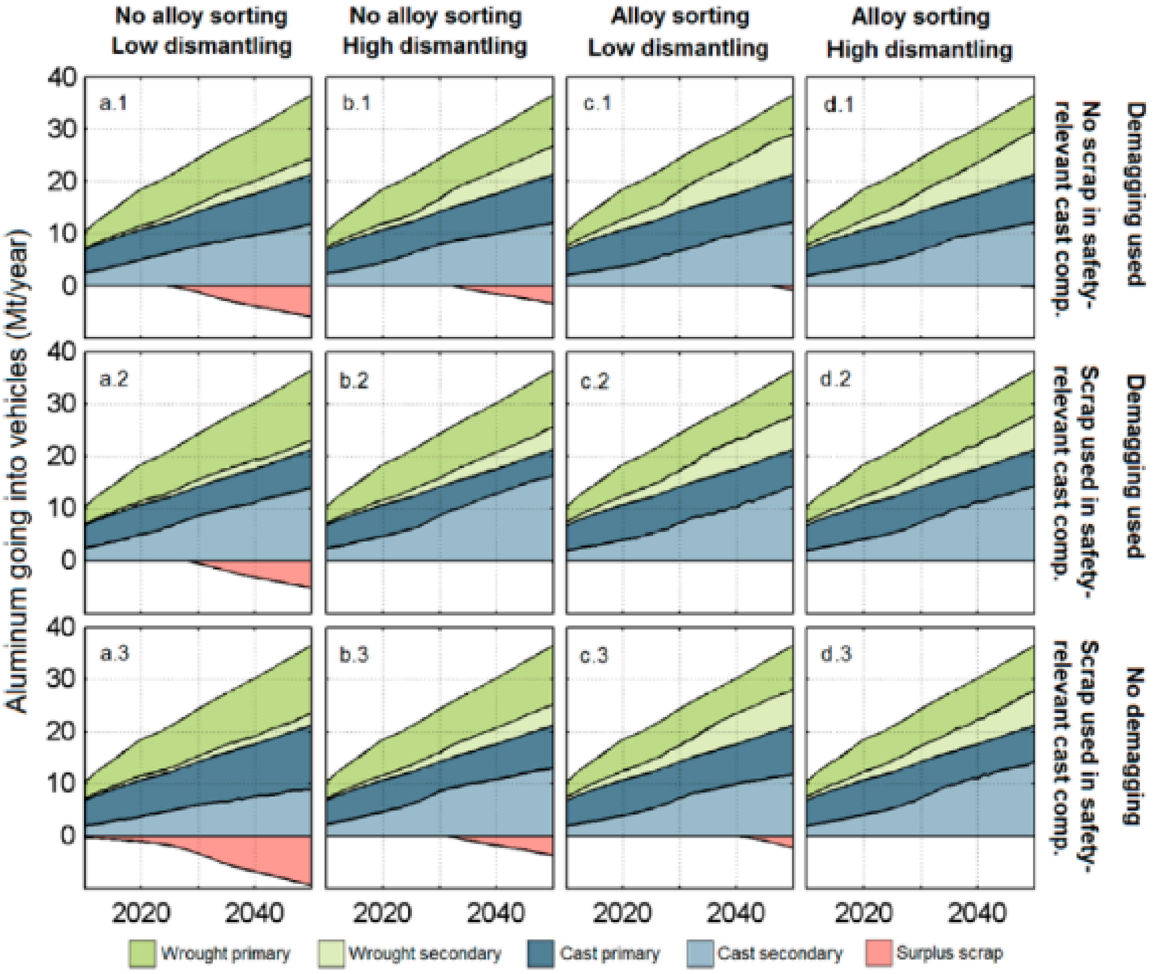
[69] https://www.european-aluminium.eu/media/3172/irt-m2p-executive-sum-20210412-final.pdf

[70] engines, heat exchangers, doors, bonnets, fenders, bumpers and gearboxes

[71] Today safety-relevant components (wheels, space frame nodes, etc.) are made from primary material. Allowing secondary aluminium into these components is deemed possible but only in case of close collaboration of manufacturers and foundries and refiners regarding their respective intern alloy specifications.

At the bottom, it was investigated under which circumstances the controversial[72] practice of de-magging could be stopped. Magnesium increases the strength of an alloy and is more common in wrought aluminum, especially series 5000 and 6000 (Zhu et al. 2021). For this reason, de-magging efforts should in fact be intensified while trying to reduce the downsides of the procedure such as reducing the use of chlorine (Løvik et al. 2014).

Figure 2-16 Simulated future production of wrought and cast aluminium for vehicles, and the relative share covered by primary and secondary sources under combination of interventions in ELV management and scrap sorting (columns) and restrictions in aluminium/auto manufacturing industry (rows). (Løvik et al. 2014)



Legend: The pictures display the amounts of different types of aluminium (cast/wrought and primary/secondary) as a function of time in different scenarios. Especially, it becomes apparent under which circumstances surplus scrap, that cannot be used in recycling, can be avoided.

Source: (Løvik et al. 2014)

[72] Demagging is controversial due to the chlorine that is released in the process. Moreover, the high value of magnesium and the costs of the procedure make it financially desirable to minimize the extent of demagging.

The simulations of (Løvik et al. 2014) make out a trend for the share of magnesium in mixed shredded scrap increasing whereas the share of copper and silicon will decrease, all due to the increase of wrought over cast aluminium. (Zhu et al. 2021) emphasize the importance to investigate the composition of the mixed shredded scrap in order to determine the requirements for an intelligent sorting system. They conclude that at least series 5000 and 6000 must be separated from the scrap in order to allow for automotive body sheet production without extensive dilution with primary material.

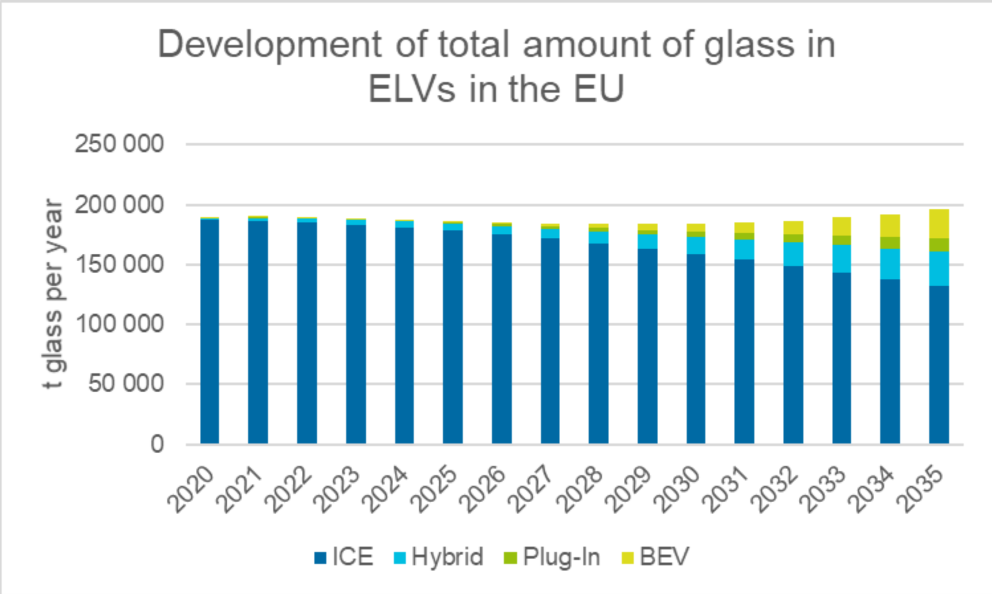
A shift in alloy as it happened in bumper technology from series 7000 to 6000 could potentially hamper the recycling process and could not be justified solely based on alloy properties but availability would also need to be taken into account (Løvik et al. 2014).

Multiple sources like (Løvik et al. 2014) and (van den Eynde et al. 2022) have shown the likely occurrence of surplus scrap of aluminium in near future in the transport sector, to a large extent due to the electrification and the desire for light-weight components. One option to mitigate the problem in the short-term is to intensify dismantling by removing parts made from different alloys before shredding. Furthermore, intelligent alloy sorting systems are required in order to avoid the occurrence of surplus scrap. To this end, further investigation is needed to implement such systems on a large scale. Of special importance is close cooperation between the dismantlers, companies, and manufacturers to maximize the use of secondary aluminium while maintaining high quality standards. An emphasis needs to be on research on whether the required properties for a certain component can be achieved with different alloys that are more commonly found in secondary aluminium and on the possibility to recycle scrap from safety relevant components. From an economical point of view, the incentive to maximize the share of secondary material will increase when its availability increases, that is when there is already surplus scrap. However, hoping to avoid surplus scrap, the previously proposed measures should be incentivized additionally, be it financially or through regulations. From an environmental perspective, the advantage of secondary over primary aluminium is evident: 1 kg of recycled aluminium can be produced with 9.2 MJ of energy, compared to 144.6 MJ for primary aluminium (van den Eynde et al. 2022) and emissions drop to 5 % when using recycled aluminium (Zhu et al. 2021).

2.1.2.5.4 Glass

Figure 2-17 shows the development of the total amount of glass from ELVs in the EU from 2020 to 2035.

Figure 2-17 Development of total amount of glass in ELVs in the EU from 2020 to 2035



Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

Glass is used in vehicles for windows (windscreen, side and back windows and sunroofs) and mirrors. Laminated glass is used for the windscreen and back window and tempered glass for side windows (see detail in annex 3.3.1.1). The percentage of glass used in vehicles is constant within the entire automotive industry and said (Intertek RDC & OVAM 2013?)to be in the range of 2.5 - 3% of the reference-weight of a vehicle: The individual weights are in a range of 10-20 kg for windscreens, 2-5 kg for each side window and 3-10 kg for rear windows, globally 20-40 kg altogether. According to Glass for Europe (2022a) automotive glazing parts increasingly integrate other materials than glass to fulfil extra functions, such as plastic interlayers for laminated safety and acoustics, ceramic inks for design, silver printing electrical connectors and sensors, encapsulation materials, fixing clips, and even solar PV modules in electric or hybrid cars, which means that recycling (after dismantling) requires the sorting of materials.

There are different methods to dismantle glass from a vehicle. Intertek RDC & OVAM (2013?) presents different methods, explaining the differences in terms of time consumed, logistics and the amount of glass typically removed (see in particular section 2.3 on “Dismantling of automotive glass on ELV” and table 2 in (Intertek RDC & OVAM 2013?)). Where glass is dismantled and sorted, it can be used for manufacturing new glass. Glass for Europe (2022a) estimates that replacing 1.2 t raw materials by 1 t of cullet saves a total of 625 kg of CO_2 emissions: 310 kg CO_2 at the manufacturing site (process emissions) and 315 kg CO_2 by the non-production of primary raw materials. Thus, Glass for Europe members look for ways to continuously increase their use of cullet. As explained in the following, it can however be understood that the use of ELV glass cullet is more relevant for the manufacture of some types of glass than for others.

Ferver states that requirements in automotive industry standards and safety requirements mean that the quality of glass is critical for it to be allowed for use in vehicles. “The global demand of the glass industry for used/ recyclable automotive glass is rather high since it is a rather pure waste stream (assuming the glass is separated pre-shredder). While it is possible to recycle glass from vehicles (flat glass) back into new flat glass, this is not standard; most flat glass is recycled into packaging. Conversely, packaging glass cannot be recycled for flat glass because of its impurities (colours, etc.).” (FERVER and Denuo 2022). FEAD (2022) states that there are no technical limitations to recycling the front and rear windows into container glass (or equivalent). However, detailed data as to the cost and technical practicability of recycling glass into flat glass was not made available during the course of this study. In this regard, Glass for Europe (2022b) contend that an assessment of the recyclability potential could be useful for the ELV Directive review but is missing when it comes to flat glass. They explain that because of the very high purity of flat glass cullet (e.g., ELV cullet), it is subject to fierce competition among all glass sector producers. It is especially sought after by container glass and glass fibre producers.

However, according to Glass for Europe (2022a), automotive glass pieces are rarely removed from vehicles before ELVs are shredded. Consequently, most automotive glass does not enter the (high quality) recycling route. It is further understood from stakeholders (Glass for Europe 2022a; Intertek RDC & OVAM 2013?) that there is not a technical limitation for recycling of ELV cullet into container glass or fibre glass but that this is mainly limited by the supply of such cullet, i.e., by the fact that glass is often not removed from ELV. Though in some cases the glass is missing from the vehicle when it arrives at the ATF due to accidents or breakage during the transport of the ELVs , the main reasoning for glass not being dismantled is understood to be financial as the costs (dismantling, logistics and transport costs) are higher than the revenue retrieved by ATFs for the cullet. According to EGARA (2021) the cost to transport the glass is higher than the cost of it on the market (ca. 30 €).

There is very little data as to the amounts of glass that are removed. OVAM (2012?) performed an analysis of the legislation and practice in other European countries in the past that shows that selective glass removal is not widely applied. At the time, glass removal was practiced in six member states: the Netherlands, Austria, Poland, Portugal and, to some extent, Spain, and Sweden. In two out of these six countries – the Netherlands and Poland – dismantlers receive an allowance for glass removal alone, or for the complete depollution process and dismantling of the ELV. The OVAM (2012?) report also mentioned that in France and Hungary the legal obligation to remove glass was approved at around the same time, but the consultants are aware that in Netherlands the obligation to remove glass is no longer in force and it is possible that there have been other changes. Only some data is available as to the amounts of glass removed in specific EEA countries:

- Italy – EGARA (2021) stated that glass dismantling is practiced in Italy.
- France – According to Deloitte & ADEME (2019b) very little glass is removed from vehicles at ELV centres, while most of it is sent with the hulk to the shredder which generally does not enable its recycling at high quality. 12% are reported as recovered at ATFs (meaning reused or recycled) and 60% is sent for material recovery at shredders and 28% is stored (it is not clear what the destiny of stored glass is). Moreover, in the full report it is stated that “Removal of glass for recycling remains limited and concerns on average national only 6% of the mass of glass present in an ELV (i.e. approximately 2 kg of glass extracted per ELV on average for recycling)” (Deloitte & ADEME 2019a).
- Netherlands – EGARA (2021) stated that glass dismantling was practiced in NL until 10 years ago. According to Maltha Glasrecycling, a recycler of both flat and hollow glass in the Netherlands, “only a few dismantling companies in the Netherlands supply car glass for processing at Maltha. Most car glass in the Netherlands still ends up in the large residual waste flow, which is used for things such as a base material for road construction” (ARN 2022a).
- Norway - In 2021, 122,212 CoDs were issued for vehicles associated with the EPR Autoretur. In its annual report, it was reported that 122 tonnes of glass were dismantled with 60 sent to reuse and 62 to recycling auto (AUTORETUR 2022). Assuming that there are 30 kg of glass per vehicle would mean that glass was removed from around 4000 vehicles, probably with the aim of reuse (e.g., when removed together with a door).

To conclude it is assumed that in 2020 the situation is similar and that there are only a handful of countries where glass dismantling is practiced.

When glass is not dismantled, it remains in the vehicle and is sent to the shredder with the vehicle hulk. Though the "treatment operations in order to promote recycling" specified in Annex I of the ELVD refer to the removal of glass, there are no conditions for the quality of recycled glass, meaning that shredder operations qualify for the recycling of this material. It is noted that though shredders accept vehicles with glass, it accelerates the wear of the shredder. There is no data as to respective financial costs, but in an ARN article (ARN 2022b), the shredder company HKS is cited, stating "As a shredder, we prefer to receive end-of-life-vehicle shells without glass". It is explained that in the Netherlands, ATFs can register with ARN as glass dismantlers, in which case HKS only accepts ELVs without glass from that company but giving a higher pay-out for the hulks. It is understood that ARN arranges the transport of glass in such cases from the ATF to a glass recycler, meaning that the transport costs are carried by the Netherlands EPR.

During shredding, the vehicle is broken into smaller parts and sorted first to shredder heavy fraction (SHF) and shredder light fraction (SLF) which go through further treatment stages. The glass is diverted to the mineral fraction which is a residue of the various sorting processes and includes glass, sand, and rust. The mineral fraction is usually used as a filling material in backfilling or construction. Such uses are considered as material recovery but basically remove the glass from the material cycle and can thus be considered of a lower recycling quality as compared to use of the cullet in manufacture of flat glass, container glass and glass fibre. Nonetheless, as the definition of the ELVD does not exclude such operations, these uses are accounted for in the MS reporting on fulfilment of the Directive target for reuse and recycling.

In this respect it can be understood that in the current situation, the share of vehicle glass reused or recycled at higher quality is very low. The main obstacle for increasing the recycling of such glass is not the lack of demand but rather the limited supply, as in most cases the glass is not dismantled from the vehicle prior to shredding, limiting the applicability of the resulting recycled fraction. As for increasing circularity of glass in vehicles (closed loop recycling), this may be technically possible, but seems to be more costly, given that ELV cullet can be used for other high-quality uses that are more relaxed regarding the glass quality.

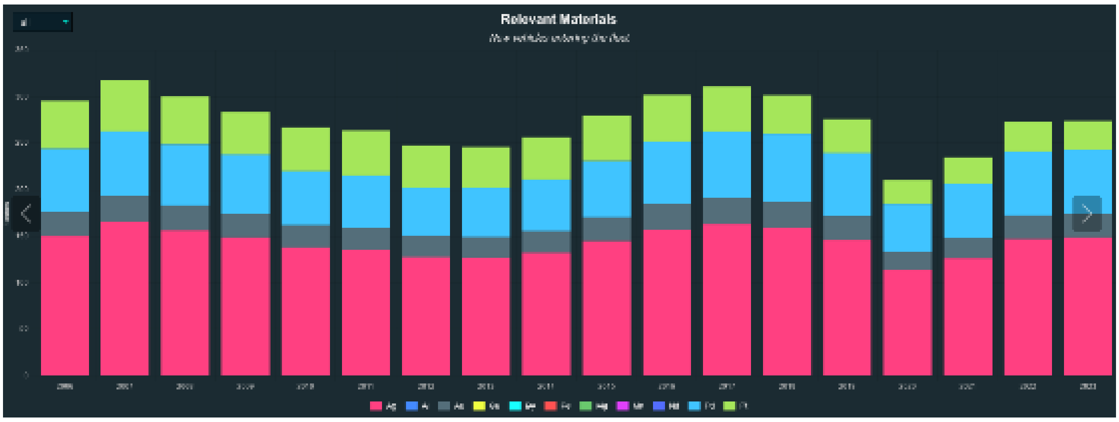
2.1.2.5.5 Critical raw materials (CRM) and precious metals

According to data on the RMIS portal developed by JRC[73], magnesium (Mg), manganese (Mn), molybdenum (Mo), niobium (Nb) and silicon (Si) are used as alloying elements for different types of steel, aluminium alloys, and magnesium alloys. Permanent magnets used in traction motors contain neodymium (Nd), dysprosium (Dy), terbium (Tb) and other elements. Catalytic converters reducing exhaust emissions depend on metals such as platinum (Pt) and palladium (Pd). Electronic devices contain a large variety of rare metals, such as palladium (Pd), neodymium (Nd), dysprosium (Dy), copper (Cu), gold (Au), and silver (Ag), as well as other elements. The mass of electronic devices varies with heavier and often more luxurious cars at the higher end. Electrical and electronic devices (labelled EE system), power electronics and battery management systems (BMS) are key components of a vehicle that contain silver, which is used often in combination with gold and other precious metals on printed circuit boards. The use of silver and gold in vehicles increased until 2007 due to an increase in the number of electric and electronic components (EEC) in all vehicles (Figure 2-18).

[73] See: https://rmis.jrc.ec.europa.eu/apps/veh/#/p/new_vehs, last viewed 20.8.2022

From 2007 onwards, the level of silver and gold per vehicle stabilized. The use of electrical and electronic devices in cars continues to increase, but this is considered to be mitigated by miniaturization and integration of functions. Metals are also required for other EV specific components, for example, battery casings, battery management systems, power electronics (inverters, converters, on-board chargers, and controllers) and drive motors (e.g. induction). The reduction of combustion engines and catalytic converters leads to less use of metals needed for these components in the vehicle fleet between 2006 and 2023. However, the use of copper, silver, gold, silver, palladium, neodymium, and dysprosium increases between 25% and 1700% in this period. These increases can be attributed to various degrees to the introduction of EVs and other technology changes.

Figure 2-18 Total mass of precious metals in new vehicles in EU27+3 from 2000 to 2020 and as projected in 2021 – 2023



Source: Raw Materials in Vehicles (RMIS): https://rmis.jrc.ec.europa.eu/apps/veh/#/p/new_vehs

Data from a study performed in Switzerland (Restrepo et al. 2017) is assumed to reflect the situation of critical raw materials and precious metals in vehicles at present and in the future, as the vehicle fleet in Switzerland is considered similar to that of the EU. Among others the study investigated the content of CRMs in various vehicle components with a view to understand the total amounts of these materials used in vehicles. Restrepo et al. (2017) infer from their calculation of the stock, flows and distribution of critical metals in embedded automotive electronics, that passenger vehicles in Switzerland contain a significant stock of critical metals. In comparison to critical metals in household and consumer electronics, the vehicle fleet in stock contained (as of 2014) similar amounts of neodymium (Nd) (mostly found in magnets) and approximately one fifth of the silver (Au) in WEEE. However, the mass flow of critical metals in ELV is only a fraction of that of critical metals in WEEE, because vehicles tend to have a longer lifetime than EEE. The authors assume that “the amounts of critical metals in ELVs are likely to rise over the coming decades”. The reason for this forecast is that the amount of embedded electronics in vehicles is bound to increase further and that newer generations of cars contain more critical metals intensive EEC. Larger amounts of rare earth metals (REE) are expected to be used as electric vehicles contain REE-rich electric drive motor/generator instead of conventional starter motor and alternator. Moreover, integrated electronic control systems are expected to contain more precious metals than the EEC contained in older vehicles.

Printed wiring boards (PWB) are also understood to be relevant components in relation to their contents of CRM and precious metals. PWB, also such used in vehicle electronics, typically consist of a rigid glass fibre plate base that contains a flame retarded resin (FR4). In addition, small flexible PWBs, which can be integrated into other components such as sensors, consist of a polyimide film. The PWB is lined with thin copper strips that serve as electrical conductors between the individual electronic components. The latter include a variety of metals, some of which are critical or precious metals.

The following table gives a rough overview of the components in which the respective elements are found in EEE. This information is also assumed to be applicable for the most part for electric components used in PWB of vehicle.

Table 2-5 Important metals used EEE (many also of relevance to EEC in vehicles)

Metal	Main applications in EEE
Ag	Contacts, switches, solders, heat conductor
Au	Bonding wire in integrated circuits, contacts
Pd	Multilayer capacitors, connectors
Pt	Hard disks, thermocouples, fuel cells
Ru	Hard disks, plasma displays
Cu	Cables, wires, connectors, heat sink,
Sn	Solders
Sb	Flame retardants in plastics
Co	Rechargeable batteries
Zn	Solders, capacitors, heat sinks
Se	Electro-optic devices, solar cells
In	LCD glass, solders, semiconductors
Ta	Capacitors
Al	Heat sink,

Source: (Böni et al. 2014)

The UBA ORKAM report (Groke et al. 2017) refers to various sources as to the elements contained in a vehicle PWB. All sources are dated 2014 and earlier. Data for PWBs from vehicles are reproduced below:

- PWBs contain antimony trioxide (Sb2O$_3$) as a synergist flame retardant. Based on 5 ICE vehicles and 14 hybrids an average of 1,300 mg/kg was estimated (range: 540-2100 for ICE and 30-5300 for hybrids).
- Du et al. (2014): 0.1 % neodymium was found in circuit boards (vehicle dismantling tests).
- Cullbrand & Magnusson (2012, p. 37): refer to rhodium (<0.01 g) in circuit boards of the brake system and engine system) and to indium, neodymium, and palladium for PWBs (no values referred).
- Rodrigo & Castells (2004) refer to 16 % copper, 0.05 % silver, 0.03 % gold and 0.01 % palladium in PWBs, however, values are not car specific.
- Schmid (2014) refers to various elements in PWBs from vehicle models from 2010-2013 (see table below), values for tantalum fluctuate and were thus considered to have low reliability.

Table 2-6 Composition of printed circuit boards according to Schmid (2014), concentration in g/kg

	Au	Ag	Pt	Pd	Ru	Cu	Sb	Ge	Te	Ta
Konzentration in g/kg	0,12	1,17	< 0,01	0,02	< 0,01	240	0,8	-	-	0,4

Source: Reproduced from (Groke et al. 2017)

Partially in contrast to this predicted increase in use of CRMs are statements of vehicle manufacturers. ACEA contends that new studies from one OEM for vehicles of model year 2020 show, that the content of gold, palladium, antimony, and tantalum in electronic control units has decreased significantly since the last study from the same OEM for model years

2010-13. This might be the result of miniaturisation and the attempt to reduce expensive materials like precious metals. (ACEA 2021a)

As to EoL, during the waste management of vehicles, only some CRM and precious metals are recovered in a way that allows their use in EEC or in other vehicle components:

- Dismantling of the platinum group metals (PGMs) contained in the catalytic converter is supported by a dismantling obligation in Annex I(4) of the Directive as well by a high market value of these materials, as explained in section 2.1.2.5.7 below.
- Though antimony is not recovered as a separate material, it is recycled together with the lead that is contained in starter batteries, and thus allows to recover a large amount of antimony from vehicles (CEWASTE Consortium 2021). This is however not the case when antimony is used as a synergist flame retardant in certain vehicle plastics and in PWBs (Baron et al. 2020). Even when such components are dismantled from vehicles, it is not common practice to recycle the antimony from these uses.
- The same is true for other CRMs that are applied in PWBs but also in other EEC. Though in some cases, like that of neodymium magnets, the lack of recovery is also related to a general lack of recycling capacities (see section 2.1.2.5.6) (also a matter of economies of scale as at present the amounts of the EV drive motors arriving at end-of-life is still small). In many cases, such materials are not recycled as the components in which they are contained are not dismantled prior to shredding, whereas their recovery from ASF is not economically feasible. In an interview held in the course of this study, Eurometaux (21 Feb 2021) explains this in part being due to most CRMs being contained in small quantities in vehicles. Requirements for retrieving a very small amount of a material (the case for many CRM) may mean that more energy needs to be applied, creating more emissions. The fact that shredders are not always ELV dedicated, but rather operate with mixed waste (ELVs but also for example E-waste such as white goods) makes the recovery of small volume fractions like CRMs even more complex and dilutes the fractions in cars further.

Andersson et al. (2019) conducted an analysis of the technological innovation system framework of valuable metals in printed wirings boards (PWBs) that are contained in ELVs treated in Sweden. Vehicle electronics (i.e. PWBs) were found to contain a variety of precious (gold, palladium, silver) and minor metals (e.g. gallium, tantalum). They conclude that recycling of precious metals from PWBs found in ELV is economically challenging as the current business models in the ELV recycling industry are focussed on the recovery of bulk metals (e.g. FE, Al, Cu).

The recovery of CRM is hampered by both internal and external factors in the ELV recycling industry. Next to the external factors, i.e., unfavourable market prices for recycled metal and long-term price trends, innovations in CRM recycling are hampered by the industry`s lacking capability and goals, as well as a policy framework that does not sufficiently incentivize and boost CRM recycling from ELV. To improve the recycling of minor metals from PWBs contained in ELV Andersson et al. (2019) recommend learning from the WEEE recycling system. In WEEE dismantling, long-term investments have been made in automated treatment facilities that are larger and more efficient. Moreover, the costs of dismantling WEEE are partially compensated by additional financing based on the EPR system, which relieves dismantlers of the financial risks arising from the increasing complexity of materials and structures and fluctuating market prices for secondary raw materials. The authors suggest a set of policy interventions that mitigate the innovation blocking factors of the ELV recycling industry by supporting capability building in the recycling industry, aiming at building new value chains. (Andersson et al. 2019)

Under the WEEE Directive (Annex VII), printed circuit (or wiring) boards must be dismantled if their surface is greater than 10 square centimetres. Such components are thus removed and treated separately. Due to the integrated design of PWBs, the electromotive components are usually soldered together on a more or less densely populated PWB surface. It is therefore hard to recover individual components from PWB. The standard recycling practice is thus to send the PWBs in their entirety to the copper recovery process. In copper recycling, the PWBs and all components on them are metallurgically treated in a copper smelter. In this process, all organic materials (plastics) burn while copper and other metals (except iron, nickel, etc.) are melted and removed. Many precious metals such as silver, gold and PGM pass into the molten copper, which serves as a carrier metal. REE, on the other hand, do not pass into the molten copper but remain in the slag, which is normally disposed of. The recovered copper contains other metals as impurities. Therefore, the raw copper is subjected to electrochemical refining. In this hydrometallurgical process, the raw copper is electrolytically dissolved at the anode and deposited in pure form at the cathode. The cathodic copper is the refined end product of the recycling process and can be sold. Other metals contained in the raw copper remain in the electrolytic bath either in dissolved form or as anode slimes. From there, they can be recovered and refined through further hydrometallurgical processing.

As PWB in ELV are thought to contain roughly a similar inventory of the critical materials contained in WEEE PWB (see Reuter, M. et al (2013)), the above-mentioned recycling route for WEEE PWB is also assumed suitable for the recycling of PWB from ELVs.

2.1.2.5.6 Neodymium

According to the RMIS data[74], the rare earth elements neodymium and dysprosium are mainly found in permanents magnets (PM) that are used in actuators (small motors) in all vehicle types and in traction motors in EVs. ICEVs still dominate the use of neodymium in the period between 2006 and 2023, but the introduction of EVs adds significantly to the use in the later years. This indicates that future quantities of neodymium are linked to PM traction motors for e-mobility, but that all types of vehicles will contribute, assuming no radical changes in vehicle designs.

95 % of EVs use rare earth magnets containing traction motors; quantities required worldwide will grow from 5,000 tonnes in 2019 to up to 70,000 tonnes per year by 2030. Considering the European EV automotive market, in 2020 1.4 million cars were put on the market, requiring 2,000 tonnes of NdFeB, with an average of 1.5 kg of NdFeB per car. In 2030, when it is estimated that 7.3 million EV will be placed on the market, 10,400 ton of NdFeB will be required. (Gauß et al. 2021)

Normative requirements developed by the CEWASTE Consortium (2021) foresee the removal of NdFeB magnets prior to shredding operations to facilitate their separate collection and treatment. In the final treatment, the requirements prescribe either recycling the REE contained in the magnets or a process for recycling waste NdFeB magnets into new ones. Though technologies have been developed for the recycling of such magnets, capacities currently do not exist in the EU.

Apart from collection and pre-treatment approaches, no recycling process for REE magnets has been established in the western world. The collected wastes are sold to China and Japan for metallurgical recycling. If REE-bearing motors enter shredding, this leads to lowered and inefficient recovery of some of the contained metals. Especially the cost intensive REE magnets can hardly be separated by mechanical techniques due to their magnetic properties.

[74] See source 73.

They usually count towards the iron fraction (magnetic separation) although a considerable share is disseminated over the other fractions, dust, and ferrous equipment parts. The REEs that enter iron or steel recycling are transferred to the slags during smelting due to their ignoble character. In order to direct the magnets into a dedicated REE recycling, the motors must be extracted prior to shredding and dismantled down to the rotor/stator level. After dismantling, the surface-mounted permanent magnets and integrated permanent magnets have to be removed from the rotor. (Elwert et al. 2017)

As long as there are no stocks of separated magnets, there will be little motivation to develop recycling capacities, but without such capacities there is also little interest to remove and store magnets. A long-term material based recycled content target could be helpful in promoting the development of such capacities in the EU, though it is possible that a component-based recycling target for NdFeB magnets would achieve a similar effect.

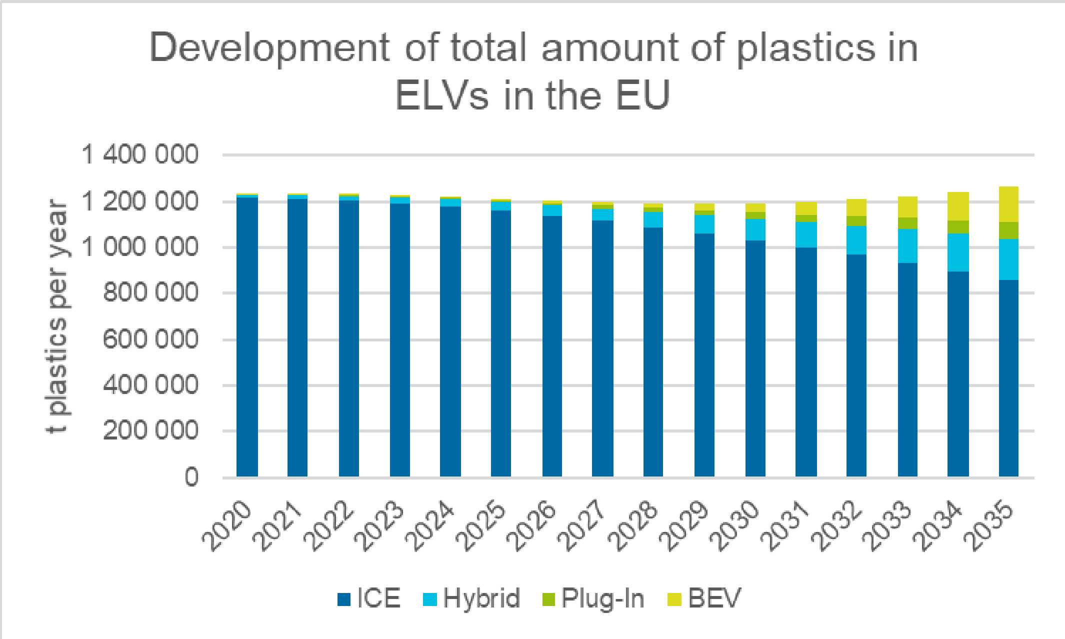
2.1.2.5.7 Platinum group metals (PGM)

The platinum group metals (PGM) are applied in automotive catalytic converters. These components have a high market value and can be assumed to always be dismantled from the vehicle and treated separately. In fact, according to (EGARA 2021), in some cases “cars with no catalysts arrive at the dismantler as the owner cuts it out and sells it himself”. As catalysts are used in conventional vehicles but not in EV, it is expected that the demand for PGM for their manufacture will decrease. An Oeko-Institut study (Oeko-Institut e. V. 2021) estimated that the consumption of the platinum group metals (PGMs) for automotive catalytic converters will fall sharply by 2035 for vehicles on the German market. In a scenario where only EVs are registered in Germany in 2035, consumption was said to drop to zero. As PGMs from automotive catalysts represent an important secondary metal source through recycling, the recovered PGMs can be used to supply material for future applications such as fuel cells and the hydrogen infrastructure in the medium term. This trend is expected throughout the EU due to the shift from ICE to EV, as is also reflected in the RMIS data.

2.1.2.5.8 Plastic

Figure 2-19 shows the development of the total amount of plastics from ELVs in the EU from 2020 to 2035.

Figure 2-19 Development of total amount of plastics in ELVs in the EU from 2020 to 2035



Source: Own calculation with data from Euro 7 Impact Assessment, JRC-RMIS and Argonne 2021, see model description in Annex I 6.9.2

Plastic production in Europe was 57.8 million tonnes in 2019 (EU28+NO/CH) with the automotive sector in 3rd position in terms of consumption of plastics, representing around 10% of the plastics demand and accounting for 5.1 Mt of plastics consumed per year. In the last two decades the plastic content has increased in new ICE vehicles placed on the EU market from around 12% to around 16% on average. It is expected that future ELVs reaching ATFs around 2030-2035 will have the plastic composition of the vehicles produced in the previous years, i.e. ranging from 13 to 16% for BEV and equivalent ICEV, respectively (HEV and PHEV have the same plastic composition as ICEV) (Maury et al. 2022).

EuRIC (2022a) explains that modern cars contain several plastic parts and components (e.g., dashboards, bumpers, handles, buttons, casings, ceiling fabric, seats, seat belts, airbag, carpeting, etc.). The use of plastics in the car manufacturing industry presents several advantages, such as a vehicle mass reduction, which leads to lower fuel consumption and a decrease in emissions of Green House Gasses (GHG). Plastics are furthermore explained to have several important technical properties, “such as impact strength, thermal insulation, noise reduction, and corrosion resistance”.

There are currently about 39 different types of basic plastics and polymers used to make an automobile. The most common ones (approx. 74% of the plastic used in cars) are polypropylene (PP) (35%) (e.g., bumpers, cable insulation carpet fibres, etc.), polyurethane (PU) (19%) (e.g., foam seating, insulation panels, suspension bushings, cushions, electrical compounds, etc.), polyamides (PA) (11%) (e.g., battery casings, brake hoses, oil sumps, etc.) and polyvinyl chloride (PVC) (9%) (e.g., instrument panels, electrical cables, pipes, doors, etc.). A variety of other plastics and polymers, including engineering plastics, are also used and combined for other automotive parts (e.g., acrylonitrile butadiene styrene (ABS), polystyrene (PS), polyethylene (PE), polyoxymethylene (POM), polycarbonate (PC), acrylic (PMMA), etc.). (EuRIC 2022a)

According to EuRIC (2022a), assuming that an average car weighs 1,300 kg and that plastics content represents 12-15% of its mass (50% of car volume), this amounts to 150-200 kg of plastic per vehicle, and this is expected to increase in the coming years due to a growing demand from the market for high-performance, lightweight and fuel-efficient, safe vehicles.

At EoL, some plastics are dismantled from the vehicle before it is sent to the shredder. This is in line with the Directive requirements (Annex I(4)), that requires the removal of larger parts (dashboard, bumper, fluid containers) when these cannot be segregated in the shredder to allow effective recycling. However, it seems that the main motivation for dismantling is potential reuse, whereas, once removed, larger components will be sorted according to composition and sent to separate recycling.

- According to EGARA (2021) **bumpers** are understood to be dismantled and separated into different fractions according to compositions before being sent to recyclers. This however does not apply to bumpers with foam filling for which it was explained that these can be dealt with in the mechanical separation. The consultants assume that bumpers are often removed due to their potential for reuse, as the front and back of the vehicle are often damaged during accidents, providing a relevant market for reuse. In their annual report on ELVs for the year 2017, ADEME (Deloitte & ADEME 2019) reports that on average 3.14 kg of polypropylene bumpers were removed per vehicle in that year, 3.13 kg of which were sent to recycling and the rest to recovery. In total 3,562 tonnes of polypropylene bumpers were sent to recycling in 2017. A further 0.65 kg per vehicle was dismantled in parts sold for reuse per vehicle.
- Though interest was raised in the past regarding the dismantling and separate recycling of the **fuel tank**, this is understood not to be practiced. Until 2000 the tanks in the EU market were produced from mono layer HDPE, especially for diesel cars. After the introduction of Euro 5 the production changed to a multilayer construction to accommodate new requirements on fuel contents and storage. Older mono-layer tanks are assumed to already have left the material cycle for the most part, most having been incinerated. Mechanical recycling of multilayer fuel tanks does not ensure sufficient purity of HDPE (>99%) and thus does not allow the use of such recyclate for producing new tanks. (KAUTEX TEXTRON GMBH & CO. KG 2022) FEAD (2022) agrees that fuel tanks are not dismantled for the sake of separate recycling. ADEME (Deloitte & ADEME 2019) reports that on average 1.32 kg of polyethylene fuel tanks were removed per vehicle in that year, 1.31 kg of which were sent to recycling and the rest to recovery. In total 1,489 tonnes of polyethylene fuel tanks were sent to recycling in 2017. A further 0.47 kg was dismantled in parts sold for reuse per vehicle. Considering the above information, the consultant assumes that these were mono-layer fuel tanks placed on the market prior the shift to multilayer to comply with Euro 5.

ADEME (Deloitte & ADEME 2019) further reports the following types of plastics to have been dismantled for reuse or recycling in 2017:

- Polypropylene – other parts: 0.49 kg per vehicle were sent to recycling; in total 559 tonnes of polypropylene (other parts) were sent to recycling in 2017. A further 2.60 kg per vehicle was dismantled in parts sold for reuse.
- Polyethylene – other parts: 0.06 kg per vehicle were sent to recycling; in total 72 tonnes of polyethylene (other parts) were sent to recycling in 2017. A further 0.30 kg per vehicle was dismantled in parts sold for reuse.
- Polyurethane foam: 0.01 kg per vehicles was sent to recycling; in total 15 tonnes of PU foam were sent to recycling in 2017. A further 1.18 kg per vehicle was dismantled in parts sold for reuse.
- Polyamides: = kg per vehicle is specified as dismantled and sent to recycling, but this is assumed to be due to the rounding of the number as it is also specified that in total 2 tonnes of polyamides were sent to recycling in 2017. A further 0.59 kg per vehicle was dismantled in parts sold for reuse.

- ABS, PVC, PC, PMMA, PS, etc.: 0.02 kg per vehicle; in total 26 tonnes of these materials were sent to recycling in 2017. A further 1.30 kg per vehicle was dismantled in parts sold for reuse.

Though this makes up for only 7.09 kg/vehicle for reuse and 5 kg/vehicle of plastic dismantled and sent to recycling (Deloitte & ADEME 2019), it gives an overview of what types of plastics may be dismantled for reuse or recycling (in some cases sent to separate recycling). Looking at the quantities it is assumed that the main motivation for dismantling plastic parts is to allow their sale for reuse (the report mentions that in France in 2017 over 300 dismantlers did not engage in dismantling for reuse) whereas plastic then sent by the ATF to recycling (assumed without shredding) are a result of components that were not sold in the end for reuse or what were damaged during dismantling and could not be reused.

FEAD (2022) state that though most polymeric materials in vehicle can be recycled with simple mechanical processes if correctly separated, the presence of many different polymers is a challenge to recycling.

According to EuRIC (2022a) the development of mechanical and thermal recycling of plastics from Automotive Shredder Residue (ASR) in the EU stems directly from the ELV Directive which imposes high weight-based recovery targets, namely 85% of material recovery and 10% of energy recovery. State-of-the-art post-treatment technologies enable the recovery of ELV plastics' fractions which are then separated per polymer using different separation technologies, such as sink-float[75] tanks (i.e., density separation), or laser and infra-red systems used to separate plastics based on colour. The final recycling steps consist in shredding and extrusion, which results in the production of post-industrial pellets by polymer-types meeting industry specifications for their re-incorporation into new cars. In addition, polymers containing volatile and solid contaminants that need to be thoroughly extracted in order to produce high-quality re-granulate suitable for reuse, are re-processed by special vacuum degassing extruder modules. The increasing complexity of multi-material vehicle design has created several challenges for vehicle recycling. For example, the wide variety of plastics used in automobiles (incl. a large number of resins, different additives, etc.), or the presence of reinforced plastics (containing fillers such as glass fibre, carbon fibre and glass beads) that are difficult, if not impossible, to recycle. Mainly due to those challenges and the lack of incentives to encourage an increased demand of recycled plastics in the automotive sector, only polymers present in higher amounts (e.g., PP, ABS, PS) are currently being recycled. […] Technical plastics recyclers have proven for the last decade that the technology to recycle the most commonly used polymer types (PP, PE, PS, ABS) in ELVs is mature enough to deliver the quality required by the car industry at a competitive price except if oil prices drop significantly.

Plastics Europe (2022) explains that the quality of the output from recycling is essential for replacement of materials from primary feedstock. Looking at the effect of the long use phase of vehicles on polymer quality (such as polymer chain length reduction), Plastics Europe sees mechanical recycling as an important part of EoL treatment but does not think it can provide a sufficient amount of high-quality material to secure the quality demand from the automotive sector especially should a post-consumer, closed-loop system be foreseen. Chemical and mechanical recycling can be complementing technologies to jointly enhance the circularity of plastics in the automotive sector.

[75] PRE (2022) refers to innovative processes to separate fractions containing PBDEs from the mainstream, such as the sink/float technology. This technology is explained to enable the separation of e.g. plastics containing POPs form plastic free ones.

A few vehicle manufacturers report on the use of recycled plastics in their vehicles (or plans for its integration), referring among others to PP used for shielding, wheel arches and other parts and PUR used for foam of seats. Nonetheless such practices are understood not to be widespread.

2.1.2.5.9 Rubber

Rubber is used in a wide range of vehicles interiors[76] and exteriors[77] made entirely or with a considerable share of this material. The highest share of rubber contained in vehicle is used in tyres. Tyres have a mixed composition of carbon black, elastomer compounds, steel cord, fibre, in addition to several other organic and inorganic components. Natural rubber used to produce tyres, has been recognized as a CRM by the EU.

The most common way of treating end-of-life tyres (ELTs) is their material recovery. Currently, rubber from tyres is recycled to qualities that are not equivalent to vehicle grade, however this appears to be a result of available recycling technologies. The materials with larger particle sizes, i.e., whole tyres shredded into rubber chips, are well suited for typical applications in civil engineering. The smaller materials, granulates and powder, are used in the industrial products, compounds in bitumen or varnish. Examples of use of granulated rubber are synthetic turfs fields, where the rubber usually is mixed with a polyurethane resin and casted into a mould in order to obtain panels with the desired dimensions. However, recently, the European Committee for Risk Assessment (RAC) has presented the proposal for a complete ban of the use of rubber granulates in artificial turfs to limit the release of microplastics in the environment. Also, the European Chemicals Agency (ECHA) has indicated health risks associated to the exposure to rubber granulates through skin contact, inhalation, or ingestion. The risk was mainly related to the presence of polycyclic aromatic hydrocarbons (PAHs) within rubber granulate derived from ELTs. It was considered as very low based on the concentrations of PAHs; however, it was decided that starting from August 2022 the maximum concentration of PAHs in granulates and mulches used in artificial turfs or playgrounds will be limited to 20 mg/kg[78].

About 20 % of the output of the ELTs treatment process are “not clean textile fibres”, which contain variable percentages of 40-60 % in weight of rubber residues. Currently, works are ongoing to improve the treatment process of tyres in order to obtain “clean textile fibres”. New treatment processes would increase the amount of obtained rubber powder as well as enable application of ELT fibres in the industrial sector as the compound in plastic and modified asphalts. Energy recovery is an important and valuable form of exploiting used tyres. According to ETRMA[79], energy recovery of ELTs includes 75 % by weight of ELTs sent to cement kilns as the energy fraction of co-processing.

In respect of the above, potential targets for rubbers shall depend on the recycling definition as well as on the progress in design of tyres to facilitate their remanufacturing (retreat of tyres). Currently, work on future recovery of tyres is in progress. Its development needs to be monitored (new treatment technologies and improved retreat process) to consider introduction of new provisions. A review clause would be envisioned to allow complementing targets in the future for rubber, similarly, like for glass. However, setting of this provision would

[76] E.g. body seals, bumpers, wheel arches

[77] E.g. acoustics, carpets, pedal covers

[78] Reduction of around 80 % in comparison to the previous limit.

[79] https://www.etrma.org/wp-content/uploads/2020/09/Copy-of-ELT-Data-2018-002.pdf

require in-depth analysis if chemical recycling could account as recycling for tyres. A similar approach should be applied for textiles.

2.1.2.5.10 Non-recyclables

The term “non-recyclables” refers to materials used in vehicles which, at least at the time the vehicle is put on the market, cannot yet be considered to be recyclable. This raises the question of how recyclability is to be defined, in particular as vehicles have a relatively long lifetime and thus it is often argued (e.g., by OEMs) that even if a material is not yet recyclable at the time a new vehicle is introduced, it could be by the time it arrives at EoL waste management.

Currently the provisions in the 3R Directive requiring the demonstration of dismantlability and recyclability refer to “proven technologies”[80],[81]. ISO 22628 defines “proven technologies” in the introduction as follows: “Recyclability/recoverability rates depend on the design and material properties of new vehicles, and on the consideration of proven technologies — those technologies which have been successfully tested, at least on a laboratory scale, in this context”. This level of maturity of the technology is sometimes referred to as its technology readiness level (TRL)[82] and a laboratory scale level is considered to be level 4, whereas the establishment of a technology on the market is considered to be at level 9. In other words, the legislation currently assumes that if a technology is available that is capable of recycling a material and is at laboratory level or higher, that the material can be considered recyclable.

And yet, ELV waste operators raise concern that in some cases, materials that are allowed for application in vehicles when put on the market despite a low TRL of the recycling technology are still not recyclable when the vehicles reach EoL. This is raised for materials like composite plastics, reinforced plastics (EGARA 2021) and coco fibres, cellulose fibres (i.e. plant-based fibres) (EuRIC 2022b). EuRIC (2022b) explain that plant based fibres are argued as being “green”, but in fact you mix something which is melting and something with is not melting. Such materials create difficulties in PP recycling. EuRIC also refer to the practice of gluing of plastic parts. The glued parts cannot be separated, e.g. PP glued with ABS, as there is no de-gluing mechanism. Such practices also hinder recycling.

Though composites and reinforced plastics are currently used in only few vehicles in large amounts, it is assumed that their use could increase, as many of them are used to reduce the vehicle weight (EGARA 2021).

According to Maury et al. (2022) the use of new and more composite materials, such as glass (GFRP) or Carbon fibre reinforced plastic (CFRP) has been expanding rapidly in recent years due to their contribution to reduce weight, design flexibility and competitive mechanical properties compared to metals, such materials were included for instance up to 49% in the BMW i3 body structure . However, a wider use of composite materials as well as multi-layer materials is not expected to increase too much in the future: this is mainly due to their limited economic added value. Such declaration was also confirmed by consulted OEMs.

[80] Recital (8): treatment of end-of-life vehicles. The manufacturer should therefore recommend a strategy for the treatment of end-of-life vehicles and should provide details thereof to the competent body. This strategy should be based on proven technologies, which are available or in development at the time of applying for the vehicle approval.

[81] Article 6(3): 3. For the purpose of paragraph 1, the manufacturer shall recommend a strategy to ensure dismantling, reuse of component parts, recycling and recovery of materials. The strategy shall take into account the proven technologies available or in development at the time of the application for a vehicle type-approval.

[82] HORIZON 2020 – WORK PROGRAMME 2014-2015 General Annexes Page 1 of 1 Extract from Part 19 - Commission Decision C(2014)4995 G. Technology readiness levels (TRL); https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

It is possible that the use of GFRP and CFRP will not increase in the future, however other materials currently not used in vehicles could be introduced with similar difficulties in recycling, creating similar problems. This appears to particularly be relevant for materials that could be applied for light-weighting of the vehicle, as these tend to be used in larger amounts so as to achieve a significant reduction in vehicle weight. As the use of light-weight materials can be expected to have a positive effect on vehicle emissions during the use-phase, the question is how these balance against increased emissions at EoL.

2.1.3 What is the problem and why is it a problem?

2.1.3.1 Description of the problem

Design

Design for dismantling

Changes are observed in the manufacturing of vehicles that contribute to the complexity of vehicle waste management.

For ICE vehicles, this is related to the general need to reduce emissions, but in electric vehicles, weight reduction is also important to reduce the total vehicle weight to compensate for the heavier traction batteries. As a consequence, an increased use of plastics and new materials for which recycling capacities are not sufficiently developed or at times do not yet exist, affects the general recyclability of vehicles and could result in a heavier dependency on primary materials.

In the assembly of vehicles, the use of more adhesives instead of mechanical bonding technologies (e.g., screws) and sealants makes the dismantling of vehicle parts more complicated. This affects in the worst case the likelihood that parts will be dismantled and subsequently can lead to a decrease in reuse or less dismantling for separate recycling. For example, vehicle glass which was embedded in the past with retractable rubber profiles is more often glued into place, making dismantling more time intensive or resulting in material losses when the glass is broken.

Even in cases where manufacturers apply new technologies to facilitate better dismantling, for example for a quick dismantling of the copper intensive wire harness, information on the most efficient method of dismantling does not always reach ATFs and thus does not lead to expected results. With the increase in electrification and automatization, there is an increase in the integration of electric and electronic components, intensive in precious and critical materials. Some of these are locked with digital keys for different reasons, which when not accessible to dismantlers and repair shops prohibit their reuse. Concern has also been raised as to the safe dismantling of Li-Ion batteries, which shall become more common with increase in electric vehicles and for which the little experience with dismantling suggests time intensive dismantling. It is not clear if potential problems here stem from lacking information and training for ATFs or form the experience yet to be gained.

Over time, the contribution of the production and dismantling of cars to the ambitions of the Green Deal, in particular to the circular economy objectives of reuse, repair and recycling is expected to decrease without intervention.

Hazardous substances

The aim of the ELVD, according to its recital 11, is to reduce and control hazardous substances in vehicles in order to prevent the release of these substances into the environment, to facilitate recycling and to avoid the disposal of hazardous waste. The ELVD has anticipated important issues of the CSS, but at some points, the ELVD needs adaptations, e.g., in order to ensure the protection of the environment and human health.

Regarding the extent of hazardous substances, the ELVD restricts the four heavy metals lead, mercury, cadmium and hexavalent chromium. However, no additional substances have been added since its adoption in 2000, whereas under REACH restrictions of substances used in vehicles and that also apply to them have been added. This refers to another problem in this area, i.e., that current rules on hazardous substances in vehicles are distributed over different legislation. It was expressed by stakeholders that this is burdensome to follow.

The presence of hazardous substances in ELV waste fractions can result in loss of re-usable and recyclable materials, can obstruct the waste management of vehicles (e.g., decaBDE), or limit the use of recyclates that result from treatment processes (e.g., when lead is present in recycled alloys above a certain level). So far, insufficient information is provided by vehicle manufacturers to dismantlers on the presence and localisation of (hazardous) materials, which hampers high quality recycling.

3R Type approval

The type approval process, that aims at ensuring that the reuse, recycling, and recovery targets can be achieved at the EoL of a vehicle, through the submission of a calculation of these parameters is too simplified. In accounting for recyclable quantities, it does not differentiate between the actual amounts that can be recycled for a specific material (i.e., consideration of efficiency losses of the waste management) but rather assumes a digital approach that a material is either recyclable (accounted for as 100% towards the target or not. A material is considered to be recyclable when the technology readiness level of its recycling is at laboratory scale or above. Though vehicles have a relatively long lifetime, it is observed that in some cases, particularly when a material is not commonly used, that its recyclability does not necessarily change by the time that vehicles arrive at the waste management, hindering the actual achievement of targets. Furthermore, though the 3R Directive refers to the target of reuse and the calculation method of the type approval process refers to indicators as to whether a component can be considered as reusable or not, in practice little heed is taken to the actual reusability of components in the process. Though it is difficult to assume the actual reuse of components from ELVs as this is subject to the demand on the market, the fact that the availability of information on dismantling is not considered as part of the process means that the potential for reuse is not investigated and may be too low.

Existing provisions on the removal of parts to promote reuse and recycling (Article 6(3) and Annex (I) of the ELV Directive) are not sufficiently clear to ensure removal of materials before shredding in a way which would maximise recycling and re-use. In some cases, this results in components no being removed despite marginal feasibility of dismantling and either hinders the reuse of components or results in a loss of materials that could otherwise be recycled in higher amounts or with higher quality. The provisions also do not refer to all components or materials, the dismantling of which could result in higher reuse and recycling rates(or higher recycling qualities). In this sense, the potential of vehicles on the EU to contribute to the circular economy is not exploited.

For example, looking at the data on average vehicle composition:

- Glass removed from ELVs (ca. 30 kg or 3% of the vehicle weight) is often “lost” as filling materials instead of being recycled into new glass as its dismantling and separate recycling is not economically feasible.

- Even though around 90% of the average 150 kg of aluminium used in a vehicle are recycled, this is done after the shredder, resulting in a mix that can only be used for cast alloy applications due to the level of impurities as well as losses to the steel fraction.
- The low efficiency of the removal of copper from the shredded fraction results in high impurities in steel and aluminium that at worse case affect the range of applications for which secondary steel can be used.

To summarise, the recycling of materials, used in significant amounts in ICEs and expected to increase in use in EVs, is not always optimal. In some cases, this results in a lesser quality of recyclates like aluminium and glass, in lower recovery of materials like copper and aluminium due to losses to the steel fraction.

Market conditions for recyclates

The recycling of some of the materials contained in vehicles in significant (rubber in tyres) or increasing amounts (see above, plastic and magnets due to electrification) can be considered a loss of material when they are not recycled at EoL in sufficient quantities and thus hinders circularity. In some cases, market failure may affect the likelihood of the recycling to improve. In others, the current market situation may hinder the development of recycling technologies as there is a lack in certainty regarding the market for secondary materials and this affects investments in the further development of appropriate waste management. For example:

- For both plastics, the fluctuations in the prices of virgin materials create uncertainties as to the future demand for recycled plastics. As waste operators are uncertain as to the returns on investments in improving the recycling processes, the market supply of recyclates form ELV origin remains low. Subsequently OEMs hesitate to use such recyclates as they need a stable and sufficient supply in terms of amounts and quantities for them to be considered in the design of a vehicle.
- For rubber, the level of recycling is currently only around 50%, however R&D of future recycling technologies is not sufficiently advanced to be able to determine what types of recycling could lead to high quality recyclates. As chemical recycling technologies are also considered in this regard, the uncertainty as to their accreditation for recycling adds to uncertainties. As explained in section 2.1.2.5.9, there are also a number of proposals made by the ECHA which could affect the allowed content of PAHs in rubber granulate (recyclate) or its future use altogether in the manufacture of certain goods due to its potential to release microplastics. Such proposals add a further level of legal uncertainties related to the potential use of recycled rubber granulate.
- Rare earth containing magnets which are increasingly used in vehicles due to electrification of the fleet and the shift to EVs are currently not recycled. This is related the fact that recycling capacities currently do not exist in the EU, however as such components are currently not dismantled, the stock of magnets that could be recycled also does not support the development of such capacities, and it is not clear when it will. Nonetheless, REE are considered to be critical materials in terms of their supply, and the fact that they are not recycled contributed to the dependency on primary materials that are sourced from outside the EU.

2.1.3.2 Description of the problem drivers

Problem drivers with a nature of regulatory failures can be summarized as follows:

The ELVD does not address the design of vehicles in a way that is sufficient to facilitate the waste management of ELVs:

- The definition for dismantling information in article 2(13) refers to "all information required for the correct and environmentally sound treatment of end-of life vehicles". The definition does not require information to be made available in a harmonised way, resulting in information on dismantling of parts for reuse being provided on multiple platforms (e.g., RMI) and OEMs providing different levels of detail in information they provide (e.g., in IDIS where at least there is a single platform). Article 8(3 & 4) further requires dismantling information to be made available that is needed by ATFs to comply with the ELVD provisions with a view to achieving the 3R targets. It is also specified that appropriate information concerning dismantling, storage and testing of components which can be reused should be provided upon request. Whereas OEMs provide information on components with depollution/dismantling obligations (annex I (3 & 4) free of charge through IDIS, information relating to components which can be reused is only provided through individual RMI platforms of the OEMs for varying costs. Lacking harmonisation and in some cases, costs considered to be inappropriate result in some ATFs regarding information as unavailable (particularly the smaller ones that treat a high variety of vehicles of different OEMS) and decreasing the number of components reused.
- Article 4(b) requires MS to promote vehicle design that facilitates the waste management of vehicles, however, is too vague on the type of activities that this should result in. Consequently, vehicle design may result in inclusion of materials or use of fastening and assembly technologies that hinder reuse and recycling of ELVs.
- Article 4(c) requires MS to promote the integration of an increasing quantity of recycled materials, with a view to developing the market for such materials, however the provision is vague and in result we see that the market for recycled content is not well developed for all materials recycled form vehicles (e.g., plastic and tyres where market failures hinder the improvement of recycling technologies to begin with, but also materials with high recycling quotas like steel and aluminium, where the quality of recyclates limit their applicability in for use in vehicles.

The ELVD has a limited scope in regulating hazardous substances.

- The general provisions in Article 4(1)(a) only focus on environmental impacts of hazardous substances in vehicles, but the protection of human health should also be covered there.
- The ELVD since its publication in October 2000 only restricts four heavy metals (lead, mercury, cadmium, or hexavalent chromium). Although additional restrictions of substances are understood to be intended in principle, there are no provisions specifying the process for the restriction of other substances. Consequently, additional substance restrictions were not introduced under ELVD.
- The provisions on dismantling information are not sufficient to achieve dismantling and segregation of waste. As a consequence, insufficient information provided by vehicle manufacturers to dismantlers on the presence and localisation of (hazardous) materials hampers high-quality recycling.

The current rules on substances in vehicles are distributed over different legislation. These refer to different criteria in relation to the prohibition of substances and derogations therefrom and are based on different procedures for prohibiting new substances or for obtaining derogations from existing prohibitions, creating inconsistencies and burden for stakeholders.

The current legislation of substances in vehicles may not address all substances that should not be used in vehicles.

The scope of waste management operations as specified in the ELVD does not sufficiently promote circularity:

- The ELVD definition for recycling under Article 2(6) is not consistent with principles of "end-of-waste" and "preparation for reuse" applied in other waste legislation and leads to uncertainties as to the legal status of components processed for reuse, in particular as to whether the shipment of such components is to be considered as shipment of a product or of waste. The ELVD also does not define remanufacturing and remanufactured components, here too creating leal uncertainties as to the legal status of such components, e.g., when shipped.
- The definition of recycling in Article 2(7) of the ELV Directive has a lower ambition level than the definition in other waste legislation and allows accounting for the recycling targets with amounts of material that have been downcycled.

New technologies have emerged since the adoption of the ELVD. For example, the share of electric vehicles is increasing on the market, related to the need to reduce emissions. However, the composition of EVs differs from that of ICE vehicles and it is not clear whether this could result in difficulties in achieving the 3R targets or if the current practices of ELV waste management would be sufficient to treat the electric ELV in a manner appropriate to support the circularity of the market and reduce the reliance of vehicle manufacture on primary materials. This is in particular the case for aluminium, where an increased use of wrought alloys is expected that at present would not be recycled to an equivalent quality. This is also the case where non-recyclable materials are used in large quantities for weight reduction and where this results in insufficient recycling at EoL. In this respect such technology developments may result in some cases in conflicts between regulations, e.g., between the need to reduce weight and energy consumption/km vs. the need to ensure recyclability at a time when the use phase is the dominant phase for environmental impacts of vehicles.

The problem drivers with a nature of market failures can be summarized as follows:

The way that ELVD addresses the use of recycled content has not led to sufficient developments in the market of secondary materials sourced form ELVs:

- Article 4(c) requires MS to promote the integration of an increasing quantity of recycled materials, with a view to developing the market for such materials, however the provision is vague and in result we see that the market for recycled content is not well developed for all materials recycled from vehicles. For example, for plastic and tyres market failures exist that hinder the improvement of recycling technologies to begin with. In areas where materials used in vehicles are recycled to a high degree, such as steel and aluminium, the quality of recyclates limit their applicability for use in vehicles and insofar limits the level of circularity (closed loop).
- The 3R Type approval process is aimed at ensuring that vehicles placed on the EU market can comply with the 3R targets. Vehicles have been placed on the market in the past despite the containing large amounts of materials understood to have had a limited recyclability (e.g., the BMW i3 and other vehicles making use of large volumes of composites and/or of reinforced plastics. It is not clear whether the type approval process of such vehicles showed their compliance with the 3R targets or not. However, OEMs claim that use of such materials have a benefit during the use phase as they result in a reduction in vehicle emissions. However, the current type approval process does specify that in cases where the targets may not be met that derogations could be possible under specific conditions. This could hinder the market entrance of vehicles that have significant environmental benefits e.g., related to other than EoL phase, without it being reviewed whether such benefits would set-off related costs of non-recyclables at EoL.
- The ELV does not provide a definition for remanufacturing and remanufactured components, creating an unlevel playing field for remanufacturers that have different practices regarding the scope of remanufacturing processes applied to a component, the

conditions of warranty on the same component sourced from different remanufacturers. This also affects the competitiveness of such components with reused ones and with new ones.

- Article 7 of the ELVD sets targets for reuse, recycling, and recovery of materials from ELVs. The current reporting on the achievement of these targets is insufficient to allow a comparison of the level of compliance in the various MS. Where MS have different interpretations as to which fractions are to be accounted for towards reuse, recycling, and recovery (e.g., backfilling) this results in an unfair playing field. As the provision of some types of information is voluntary (e.g., level of reuse), for some aspects it is not possible to obtain an overview whether the level of compliance is sufficient or not. Furthermore, as MS report on the volumes of materials sent to recycling (e.g., inputs), the results do not sufficiently reflect whether materials are recycled efficiently, i.e., with limited losses of material. Finally, the cumulative reporting of reuse and recycling disincentivises waste avoidance and re-use of components and materials, as achieving a minimum level of reuse is not required, resulting in some ATFs not dismantling parts for reuse at all (e.g., Deloitte & ADEME (2019) report that over 300 ATFs in France did not dismantle parts for reuse in 2017).
- The environmentally favourable dismantling of components for re-use or recycling before the shredding of ELVs is not profitable for many components. This can be related to the market value of the component or material at hand or the level of logistic costs (for example, glass is rarely recycled as the costs of dismantling and logistics are not set-off by revenues from the sale of glass cullet to recyclers). The ELVD only requires removal of materials or components in the few cases specified in annex I (3 & 4) and even then, it is not always clear what level of recycling is considered sufficient to alleviate the necessity of re-shredder dismantling. As results, ATFs only dismantle other materials and components when this is anticipated to result in a profit. Furthermore, it is uncommon for financing to compensate non-profitable activities is provided, e.g., through EPR schemes. Consequently, the level of reuse of some components can be expected to be low and recycling of some materials is carried out with losses in quality (e.g., glass aluminium) or quantity (e.g., precious, and critical metals.
- As the 3R targets and their reporting do not always promote the high-quality recycling of materials, where post shredder treatment is not profitable and where the targets can be complied with without advanced PST, capacities are not developed or not developed to the level of the best available technology by all MS. In parallel, though some MS are understood to have developed higher capacities than is required to accommodate their own needs (e.g., NL), this does not ensure that the full potential of existing capacities is realised.

The problem drivers with a nature of lacking enforcement can be summarized as follows:

- Article 7(4-5) requires the European Union to amend Directive 70/156/EEC so that the type approval process ensures that vehicles put on the EU market are design so that they can comply with the ELVD 3R targets and so that parts dismantled for reuse do not give rise to environmental or safety hazards. This provision led to the introduction of the 3R Directive and the related 3R type approval process. The process has a dynamic link to the exemptions form substance prohibitions listed under Annex II of the ELVD ad in such it is considered that vehicles placed on the market comply with the ELV substance prohibitions. Nonetheless, despite market surveillance requirements, exchange with type approval authorities and type approval service provides clarifies that at least in some MS states that are involved in 3R type approvals, there is no monitoring as to the effectiveness of the type approval procedures and the level to which they indeed ensure that the 3R targets can be complied with by vehicles placed on the market. Consequently, at least in a few cases (e.g., BMW i3) it seems that vehicles have been placed on the market with large amounts of non-recyclable materials.

- Article 6 requires facilities active in the treatment of ELVs to be authorised to do so and sets minimum requirements to ensure the safe and environmentally sound operation of such facilities (ATFs) as well as specifying how certain treatments should be performed. The article requires MS to perform yearly inspections of such facilities, and to ensure that facilities active in the specified treatment types confer to conditions and requirements. However, illegal activities continue to be common, resulting for example in ELVs arriving at ATFS after removal e.g., of the catalytic converter, and in sales of parts for reuse that have been removed illegally. The enforcement is understood to be too low, and this results in unfair competition and reduced financial stability for ATFs.
- As part of the reporting stipulated in the ELVD, Article 6 of the annex of Commission Decision 2005/293, requires MS to report to the Commission on results of shredder campaigns that they perform to conclude on output of end-of-life vehicle streams of a shredder. There is however no specification of how often such campaigns should be carried out nor as to whether they should apply to all shredders in a MS or only to a sub-set of these. In consequence, not many MS report on such activities and it is assumed that shredder campaigns are not performed very often and possibly n some MS not at all.

2.1.3.3 Key players and affected population

The most relevant stakeholders affected include the following:

- Illegal treatment facilities may not comply with the environmental standards and with ELV obligations set for ATFs. This can lead to environmental pollution. However, as illegal operators do not comply with various requirements, they have lower operational costs than ATFs, creating an unfair playing field and affecting the economic vitality of ATFs. This is in particular relevant in cases where the illegal operators remove components that can retrieve profits (catalytic converter but also components for reuse) and then dump the vehicle, resulting in ATFs being required to complete the vehicle waste management. A similar case occurs when repair shops (legal and illegal) remove components for reuse without the relevant authorisation and permits, or when vehicle owners engage in such activities.
- As it cannot be ensured that components are removed properly in the above cases, when components are sold for reuse, this can end up having a negative impact on vehicle owners who purchase components from unauthorised entities and have bad a bad experience (i.e., component malfunction after a short period combined with lacking guarantee). Subsequently this can affect the market for reuse (and thus again the ATFs reuse business) when consumers get the impression that reused parts are unreliable.
- Citizens (vehicle owners) may further have unnecessary costs when the repair of a vehicle is performed through replacement of malfunctional components with new ones, as they have not been informed of the alternative of using a reused or remanufactured component.
- ATFs have difficulties to comply with the depollution and removal requirements and to achieve the reuse and recycling targets while remaining profitable. In particular, achieving higher recycling rates or higher qualities of recyclate can depend on the dismantling and separate recycling of some components. When such processes must be applied to fulfil the 3R targets, this can affect the profitability of ATFs.
- The non-removal of certain materials and parts from ELV may affect the quality of recyclates that can be obtained from shredders, meaning a potential loss of materials or material quality as well as possibly affecting the revenues of shredders. For example, the non-removal of copper can affect the quality of steel scrap when not properly removed in

subsequent advanced shredding or PST. The maintenance costs of shredding facilities may increase when large amounts of glass or magnets are left in the vehicle hulk sent to shredding.

- Recyclers could incur a loss in revenues when certain materials are not sufficiently removed from scrap or when the level of PST does not allow sufficient separation of certain fractions. This can be related to lower amounts of scrap made available for recycling processes, but also to higher impurities in available scrap that impact the quality of recyclates and thus also retrievable revenues.
- The presence of hazardous substances as impurities or at higher levels in ELV recyclates may result in downcycling or in some cases even requiring disposal, indirectly meaning a loss of potential secondary material and that more primary materials will need to be extracted for use in new vehicles. The latter is often associated with energy costs and environmental impacts and in some cases also leads to a higher dependency of the EU on exports for supply of material resources.

2.1.3.4 Why should the EU act?

Remedying some of these problems is necessary in some cases to allow fulfilling the objectives of EC policies like the Green Deal, the CEAP and the Sustainable Chemicals Strategy, i.e., reducing the dependency on primary materials and increasing circularity as a means of reducing green-house gas emissions, primary raw material extraction, biodiversity loss and water consumption.

The lack of coherence of the 3R Directive with the ELV in some cases and the shortcoming of the process of 3R Type approval result in vehicles being placed on the market that may not comply with the 3R targets. In particular, the process does not ensure that vehicles are designed to allow reuse of components, neither in terms of their dismantlability, e.g., when their assembly makes the reuse of a component impossible as it cannot dismantled without damage.

Furthermore, in relation to the problems described above, in many cases it is observed that some MS have developed practices that support the waste management more successfully than others. This leads to higher reuse and/or recycling rates in some cases, to recycling of higher quality in others (e.g., glass), while also enabling ATFs to remain profitable in some cases. Not adopting such practices at the EU level will lead to growing differences in the implementation of the ELV among the MS and may also affect the profitability of ATFs over time and lead to an uneven playing field (e.g., MS where backfilling is accounted for as recycling as opposed to those where it is not, MS that require glass removal prior to mechanical treatment where secondary glass also means higher dismantling costs, etc.).

The efforts towards the circular economy objectives in relation to reuse and recycling will increase where the presence of hazardous substances in vehicles has a negative effect on their waste management. Thus, managing and minimizing hazardous substances in vehicles is at the same time a contribution to the objectives set out in the Sustainable Chemicals Strategy for a toxic-free environment as well as for the Circular Economy. It is particularly important to ensure that recycled materials can achieve requirements related to the content of hazardous substances, in line with the Sustainable Chemicals Strategy which “sets out as a principle that the same limit value for hazardous substances should apply for new and recycled materials with derogations in only exceptional and justified cases”. While it is acknowledged that the achievement of this objective depends on the availability of suitable sorting and decontamination processes and whether, with these limitation, safe and fit-for-purpose materials can be produced, it is expected that future EU activities in relation to substances of concern in vehicles may contribute to achieving the above-named objectives.

Taking the current ELVD as a baseline, it is expected that it does not contribute to a further reduction of additional hazardous substances in vehicles. Although this has been reached by restrictions under REACH, legal clarity needs to be established as to the legislation under which the further substance restriction can be expected. Multiple legislations are more burdensome to follow and comply with for stakeholders, in particular for SMEs and also for MS authorities. Besides, multiple legislation can also result in inconsistencies in some cases. In each exemption, ELVD, for example, refers to the continued validity of the exemption to spare parts, whereas the availability of spare parts is addressed differently in REACH[83]).

Generally speaking, for a long time, the EU has been the legislative body addressing hazardous substances/substances of concerns. In consequence, regulation of hazardous substances in vehicles is perceived a continuous task for the EU, especially against the background of ongoing EU activities on other chemical legislations.

2.1.4 Which objective should be achieved?

The European Commission (2019) Green Deal generally refers to industry's still being "too 'linear', and dependent on a throughput of new materials extracted, traded and processed into goods, and finally disposed of as waste or emissions". Promoting more circular business models by linking design issues to end-of-life treatment, considering rules on mandatory recycled content for certain materials of components, and improving recycling efficiency were mentioned as a focus for the revision of the ELVD in the Circular Economy Action Plan (European Commission 2020a). Various EU policies make clear that in order to solve the problems detailed above, it is essential to **Improve circularity in the design, production and end-of-life treatment of vehicles.** This is seen as the primary objective in common to the above problems, which can be broken down into secondary objectives in relation to the various life-cycle stages of a vehicle.

The design stage of a vehicle determines not just its functionality but also the materials and components from which it is composed and how they are assembled in relation to each other. Vehicle design has a significant effect not just on the use phase, but also on the end-of-life of the vehicle, determining to a large extent what components and materials will be readily dismantlable to allow their reuse and/or their recycling. Currently it is considered that the design of vehicles does not sufficiently support their waste management at EoL, resulting in the rate of reuse and high-quality recycling not reaching their full potential: OEMS apply assembly techniques that make it harder to dismantle components and materials for reuse and recycling. In some cases, this impression may be tied to insufficient data made available on the composition, localisation, and dismantling method of components. In others it is due to increased application of materials that hinder dismantling (and thus also reuse and recycling) like glues and sealants or materials that are non-recyclable or for which the existing recycling practices do not enable high quality recycling without the dismantling of certain components.

Vehicle design will also affect the amounts of recycled content that can be integrated into a vehicle as material specifications related to composition, grade of purity and performance requirements will often determine whether certain secondary materials can be applied instead of primary ones. This in turn affects the market demand for recycled materials and may determine to what degree waste management operators are willing to invest to ensure a supply of secondary materials in larger quantities or of higher materials grades and quality. In this respect, the Green Deal specifies the need to develop legal requirements to boost the

[83] In restrictions, spare parts should be addressed when relevant, since the restriction report addresses articles that were placed on the market before entry into force and spare parts produced after that. For both, derogations can be considered.

market of secondary raw materials with mandatory recycled content in the vehicle sector (European Commission 2019). This is particularly relevant in cases where there is a market failure that affects the relations of supply and demand of secondary materials, e.g., due to fluctuation cost of primary ones. The first sub-objective thus relates to the design phase of a vehicle and is aimed to "**Improve design and production of vehicles to support reuse and recycling**".

The ELVD is identified to contribute too little to the elimination and/or reduction of hazardous substances in vehicles. Furthermore, the regulation of hazardous substances in vehicles is a patchwork of different legislations, mainly including chemical legislation. In cases where the use of hazardous substances in vehicles cannot be avoided, ELVD (nor other legislation like the provision for notification to SCIP under the Waste Framework Directive) does not ensure that recyclers have enough information on hazardous substances to allow depollution when this can lead to an increase in recycling amounts and/or qualities. A second sub-objective is thus to "**Ensure elimination of hazardous substances in vehicles**", which is also related to the design of vehicles. As such, it contributes to minimising the impact of end-of life vehicles on the environment. The elimination of hazardous substances in vehicles is treated as a sub-objective under the main objective 2, since a reduction of hazardous substances allows increasing circularity, e.g., in relation to the recycled content, in relation to the prevention of (hazardous) wastes or with regard to increasing the quality of recycled material.

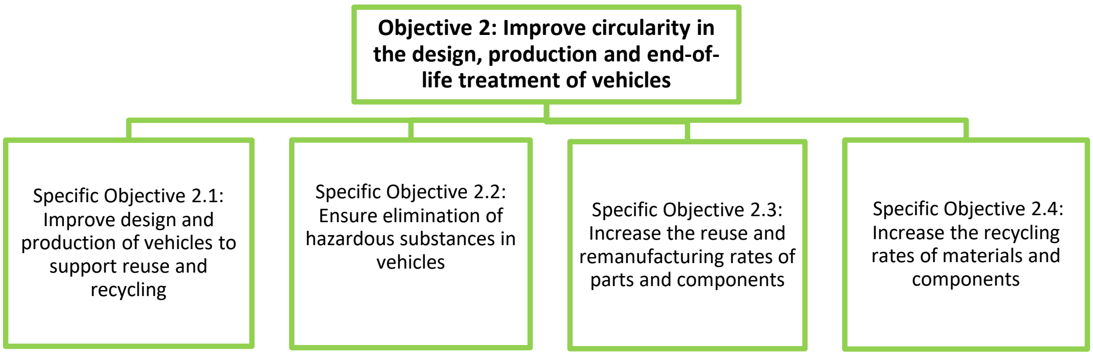
Before a vehicle is placed on the market, it needs to be ensured that its composition, but also the assembly of its parts will facilitate the reuse and recycling of the vehicle at reasonable cost, respectively cost to be covered by the producers. This process is performed as a compliance check through the 3R Directive. The 3R Directive currently does not effectively ensure that the design of vehicles ensures that reuse of components is possible. Though it considers the vehicle composition to decide of the 3R targets can be complied with, it does not take into account material losses, thus considering a distorted picture of the recyclability and recoverability of vehicles. In some cases, the use of certain materials in the vehicle may further raise conflict between the use phase and the EoL phase, in terms of certain materials having a high contribution to weight, and subsequently emissions, despite a high recyclability and vice versa. The process of 3R type approval which ensures the compliance of the vehicle with the targets on reuse, recycling and recovery must thus be able to strike a balance between costs and benefits of certain materials throughout the life cycle of the vehicle when conflicting interest may affect material choice. However, currently despite considering whether a material is recyclable or not, there is no method to ensure that prioritisation of the waste phase will not have adverse impact in the use phase.

At the end-of-life stage, the economic competitiveness of reuse, repair and high-quality recycling of vehicles needs to be increased. Currently, there is unfair competition between ATFs and repair and treatment operators not authorised to dismantle components for reuse. Vehicle owners are also not sufficiently aware of the possibility of using reused components, meaning that the demand is too low to support more dismantling for reuse. It is also important to ensure that there is certainty as to the legal status of reuse or remanufactured components to eliminate possible obstacles to reuse. In turn, an increase in the rate of reuse will mean that less primary materials will be needed to manufacture new replacement components for repair, contributing to the circularity of vehicles. To support circularity related to reused parts, the third sib-objective is thus to "**Increase the reuse and remanufacturing rates of parts and components**".

Looking at the recycling of vehicles, though some materials are recycled at high quantities, current treatment practices often compromise the quality of scrap and thus limit the applicability of secondary materials in vehicle applications. In other cases, common treatment sometimes leads to difficulties in the separation of material fractions after shredder operations and thus limits the amounts of secondary material that can be generated and thus the market for such materials and their competitiveness with primary ones. The 3R targets of the ELVD and in particular their monitoring does not incentivize high quality recycling and further affect the circularity of vehicles. Thus, the fourth objective is to improve the recycling rates of materials and components contained in cars.

The primary and secondary objectives are summarised in the following figure.

Figure 2-20 Objective No2 and related specific objectives



2.1.5 What are the measures to achieve the objective?

The following sections details a number of measures devised to increase the circularity of vehicles. Different measures have been developed for each of the above objectives and feed into the primary objective of circularity. To support some of these measures, it is also necessary to develop the way that the EPR obligation is implemented for vehicles. These are specified in 2.3.5 but are referenced where relevant.

An overview of the measures proposed, and the related specific objective follows.

Figure 2-21 Measures addressing Objective 2: Improve circularity in the design, production and end-of-life treatment of vehicles and its 4 specific objectives

Source Own illustration

2.1.5.1 Measures to achieve specific objective 2.1: Improve design and production of vehicles to support reuse and recycling

2.1.5.1.1 2.1.a) OEM voluntary pledges campaign to increase circularity

To motivate OEMs to increase circularity, the European Commission shall establish a platform for holding campaigns where OEMs shall be invited to voluntarily commit to improving the circularity of vehicles through changes in design and production. For this purpose, the European Commission will target different areas where the circularity of vehicles can be addressed and improved through design changes. In cooperation with the automotive sector (producers, waste management), sector targets will be set for each of these areas, also referring to a timeline for achieving the target. Subsequently, for each such area a campaign will be launched inviting individual OEMs and their suppliers to commit to voluntary actions that will contribute to achieving the mutual target.

This measure is proposed to be initiated at the EU for two reasons. First, development of similar initiatives has been possible up till now at national level, however even if this is the case, the contribution to circularity has not been sufficient. Furthermore, the OEMs are active at European (and actually at global) level. Activity on a European basis will ensure that any achievements apply to vehicles placed on the market in all MS.

At the initial phase, it is recommended to perform a survey for collecting information on the current state of play. Individual operators (OEMS, suppliers, waste operators) will be asked to participate by submitting confidential data. This data will be aggregated to establish the current status of various circular practices ad to set targets for a mid-term timeline (e.g. five years).

On this basis, campaigns will be held on the platform, inviting OEMs and suppliers to commit (i.e., to pledge) to achieving a certain share of the mutual target within the five-year timeframe.

The following areas are to be targeted in this manner:

(i) <u>Increase the rate of materials used in new vehicles, which are easy to re-use and recycle</u>: In this respect, materials are to be targeted that increase the durability of parts (i.e., increasing potential for reuse) and/or that can be recycled at high efficiency and with no or minimum loss in quality (i.e., no downcycling) with the current capacities of the ELV waste management value chain. The ELV waste operators shall be consulted for this purpose in the identification of relevant materials and in the consideration of targets together with representatives of the automotive manufacturing sector that can be achieved in the mid-term.

(ii) <u>Apply composite or materials for which no recycling/re-use is currently possible only when justified from a life cycle perspective</u>: Materials which have a negative impact on the achievability of the ELV recycling targets shall be identified in cooperation with the automotive producers and the respective waste management sector. For such materials, the sector shall pledge to investigate impacts along the life cycle, use such materials only where use benefits set-off EoL costs and to provide funding for developing recycling capacities within a mid-term timeframe.

(iii) <u>Increase the rate of recycled materials used in new vehicles</u>: Together with the automotive manufacturing sector the current amounts of recycled materials used in the vehicle sector shall be established for e.g., steel, aluminium, copper, REE magnets, plastic (specific polymers), glass, rubber. For each of these materials, targets (sector amounts) for the mid-term shall be considered and set for increasing the amount of recycled content in vehicles.

(iv) Develop remanufacturing as part of their production process: OEMs and their suppliers shall be asked to report on the current level of use of remanufactured parts in the production of new vehicles and of "as good as new" spare parts. A target shall be set to increase the use of remanufactured parts, identifying specific components where the potential for remanufacturing is high and mainly depends on the level of demand. OEMs and their suppliers will commit to apply a larger share of remanufactured parts instead of new parts for repair but also in the assembly of new vehicles.

At the end of the five years, economic operators that have made a pledge will be asked to report on its implementation. On this basis it shall be elicited to what degree the set targets were achieved. If this practice results in a significant achievement of the set targets, new campaigns shall be considered and performed on a routine basis. In areas where the campaigns do not lead to significant results, the EC shall take action to introduce the obligatory measures, in the legislation in which appropriate, i.e., under the ELVD, the 3RD or both.

Expected outcome: though stakeholders could be expected to participate in the pledge campaigns, there is a risk that only some OEMs would actually make pledges that are beyond what they are already doing (frontrunners and potentially a few additional OEMs). In that sense, there is a risk that this measure would not reach all OEMs, nor the majority, leading only partial improvements in circularity. A further risk is that unless the EC (and possibly other actors of the sector like waste operators) promote such campaigns on a routine basis (e.g., every few years) that the impact shall only occur in the first years and afterwards subside, again leading to only partial improvements. Furthermore, the measure provides insufficient confidence that key specific objectives will be achieved, this is particularly the case for item ii and iii due to the complex nature of economic impacts.

2.1.5.1.2 2.1.b) EC non-binding guidelines on how to improve circularity in vehicles

The Commission will develop and publish a document with recommendations on best practices for improving the circularity of vehicles. Due to the relevance of circularity to environmental performance, it is proposed to develop a document of Best Environmental Management Practices (BEMP) with focus on establishing circularity in the automotive sector. The document shall be developed based on consultation with frontrunners in the sector as to their circularity practices. It shall be developed in a similar format to EU Eco-Management and Audit Scheme (EMAS) BEMP documents, explaining the relevant actions, their expected achievements, expected relation of costs and benefits of the action, potential cross-media affects to be avoided, benchmarks, etc. The document shall be adopted as a non-binding guideline for improving circular design and production of vehicles and shall be updated from time to time according to technical and scientific progress. The document should focus on:

- Design practices that support dismantling (through shortened dismantling time, increased dismantlability with common ATF tools, avoidance of damage to component removed or its surroundings),
- Design practices that support high quality recycling (through the use or avoidance of certain materials or the mass of materials used in parts that are commonly removed prior to shredding),
- Environmental management practices that encourage exchange of information between designers and dismantling facilities.

A few existing studies prepared by JRC[84] could provide a starting point for such guidelines.

Expected outcome: Similar guidance documents like EMAS exist for other sectors, however it is not clear to what degree they are actually applied and thus also not to what degree they lead to benefits. The understanding that the development of such guidelines could be a lengthy process, requiring involvement of various stakeholders also means that any impacts to derive will incur somewhat in delay. Though this measure could support more communication between manufacturing and waste management sectors, considered a benefit, the range of its actual impacts remains unclear, and it is therefore assumed to be less effective than other proposed measures.

2.1.5.1.3 2.1.c) Obligation for OEMs to develop and implement a circularity strategy for increasing the circularity of vehicles

As explained in section 2.1.2.1.3, Article 6(3) of the 3R Directive currently requires manufacturers to "recommend a strategy to ensure dismantling, reuse of component parts, recycling and recovery of materials […]". The consultants understand "to ensure dismantling, reuse of component parts, recycling and recovery of materials" to mean that on the one side there needs to be a strategy for vehicles to be designed in a way that supports the dismantling of certain components and on the other side, also a strategy for developing methods for dismantling that ensures that reuse and recycling can take place at the ATF in an economically feasible way. However, in practice, even if strategies refer to design for dismantling, they do not include detailed information.

Article 6(5) clarifies that competent bodies acting in the name of Type approval authorities and issuing a Certificate of compliance for a manufacturer, need to "[…] describe the strategy recommended by the manufacturer […]". Annex I(8) of the 3R Directive further requires that Type approval authorities checking the 3R calculation in a type approval submission "shall ensure that the data presentation form referred to in point 2 [the completed Annex A to standard ISO 22628: 2002] is coherent with the recommended strategy annexed to the certificate of compliance referred to in Article 6(1) of this Directive." Though the latter article seems to clarify that the strategy needs to apply at least in part at vehicle level, according to stakeholders (Stellantis 2022; VW/Porsche 2022) strategies developed by OEMs in this respect are quite general. OEMs explain that the information provided in such strategies on the dismantling of vehicle components at EoL is different from dismantling information provided to IDIS and quite general in nature. However, the information provided to IDIS only concerns components addressed under Annex I (3 & 4) of the ELVD and in consequence dismantling of other materials and components is not always economically feasible and thus not necessarily performed. This affects the level of circularity of vehicles. To increase the circularity of vehicles further, it is thus proposed to require OEMs to develop a more detailed circularity strategy. This is proposed to replace the current 3R Directive Article 6(3) provision to improve compliance. Alternatively, it could be included as a separate strategy in either of the two legislations.

Taking consideration of the general objective of vehicle circularity and of other measures proposed in this study, the strategy addressed in this measure should include both elements regarding the OEMs strategy for increasing the circularity of its vehicle fleet in the mid- to long-term (5-10 years) and details on actions planned in the short term in specific vehicle

[84] JRC Report (2020): Sustainable use of Materials through Automotive Remanufacturing to boost resource efficiency in the road Transport system (SMART); JRC /2917) report: Best Environmental Management Practice for the Car Manufacturing Sector

types to be submitted for type approval over the next two years. In this way, the strategy would both set commitments for future development of vehicle models by the OEM, while also already showing the first steps of implementation in vehicles to be type approved in the short term. This is of relevance as in some cases, strategic development can no longer take place at the level an already type approved vehicle, as changes to its assembly and composition would require the type approval to be revised. This is for example the case for any commitments to increase the use of recycled content. The OEM can commit to increase the level over a period of time, but once a vehicle is type approved, the level is assumed to remain constant in any vehicles put on the market covered by the specific type approval. In some cases, however strategic development would require ensuring or at least promote that certain things take place at EoL. For example, if non-recyclables are to be used in large amounts in a vehicle type proposed for type approval, the OEM should have a strategy in place to promote that at EoL of the respective vehicles, recycling capacities will have developed to ensure that the 3R targets can be met. In such cases, detail at vehicle level is relevant as to the use of such materials, however proposing steps that promote the development of recycling capacities is to be addressed at general fleet level, also as some materials may be used in multiple vehicle types. The following thus outlines an OEM circularity strategy referring to minimum information requirements at both the level of the vehicle fleet and at the level of single vehicle types.

A provision shall be included in the future legislation on 3R Type approval, requiring OEMs to develop and implement a strategy for increasing the circularity of their vehicles. The strategy is to be submitted every two years to the 3R Type approval authority/ies in the MS in which the OEM performs the type approval of its vehicle types and to the competent body nominated by the MS to perform the preliminary assessment of the manufacturer, its extension of validity or renewal. Insofar, the strategy shall be checked by the competent body bi-annually as part of the preliminary assessment and the revision of the subsequently issued certificate of compliance. Additionally, the 3R Type approval authority shall ensure that the information submitted for the type approval of a vehicle type is in line with both the general strategy and with specific strategy detailed for that specific vehicle type in the strategy.

The strategy proposed here will need to be developed generally for the vehicle fleet of the OEM and specifically for all vehicle types approved in the two years prior to its submission, in relation to minimum information requirements specified in annex to the type approval legislation. The annex could be updated from time to time, should the need arise to adapt the requirements in scope and/or in ambition. It shall be obligatory to submit the first strategy within 2 years of the entry into force of the legislation and to update it every 2 years.

The provision shall refer to an Annex, detailing minimum information requirements to be addressed in the strategy. The Commission shall initiate a revision of the information requirement annex in any case that provisions, in the ELVD and/or in the 3R Directive, affecting vehicle design are changed in a way that would require an update of the valid information requirements in scope and or ambition level In the updating of their strategies, OEMs will need to consider any amendments included in the Annex up to 12 months prior to publication of the strategy as to the minimum information requirements. The following requirements are proposed to be included in the first information requirement annex:

Elements to be addressed in the OEM “Strategy for increasing the circularity of vehicles” (at vehicle fleet level as a general strategy:

- General considerations on the composition of vehicles for increasing the share of recyclable materials. As a minimum OEMs shall explain the criteria and methods that they apply to consider whether to use materials with low recyclability (or unestablished recycling). This shall include explanation of methods applied to compare environmental impacts related to such material in the various vehicle life cycle phases (e.g., life cycle or carbon footprint balance validation methods). Strategies shall also be detailed application of which ensures that components composed of such materials can be separated from the waste fraction at EoL to avoid contamination of other fractions, i.e., dismantling consideration for components or available treatment technologies that ensure separation and sorting of such materials from shredded fractions.

- General considerations on the composition of vehicles for increasing the share of recycled content used in vehicles. As a minimum, in the first strategy document, OEMs shall report on the total amount of recyclables used in the construction of their vehicles, how this is allocated between various materials and example components where such materials have been introduced. In addition, OEMs shall set a target for the next 5 years as to the increase in use of recycled materials that is planned in their vehicle fleet. Values referred to shall reflect an average for the vehicles to be placed on the market by an OEM in the next 5 years and not the "best in class" in this respect in their product portfolio,
- Considerations on the assembly and dismantling of vehicles that support the removal of vehicle components and materials and facilitate reuse and/or high-quality recycling. As a minimum, OEMs shall report on changes that they have introduced in their vehicle design in the last 3 years to promote dismantling of material components with a high potential for reuse and or for improved recycling (quality or quantity) when removed prior to mechanical treatment processes. This should include as minimum detail on components for which dismantling obligations exist (see related measure in section 2.1.5.4.2) or for which ATFs have reporting obligations on reuse (see related measure in section 2.1.5.3.6). OEMs shall also be required to report on how they ensure that such information reaches ATFs and what feedback mechanisms they have introduced to allow input of such stakeholders to flow back into the considerations of their vehicle design.

Furthermore, elements to be addressed in the first version of the OEM "Strategy for increasing the circularity of vehicles" shall include planned actions at the level of vehicle types to be approved in the following two years in relation to the following aspects:

- General considerations on the composition of vehicles for increasing the share of recyclable materials: OEMS shall be required to declare for which models to be type approved in the next 2 years, more than 10 kg of materials will be used for which recycling capacities do not exist at the time of type approval. In addition, OEMs shall be required to detail how they intend to promote the recycling of such materials within 7 years of market entry of the respective type approved vehicles.
- General considerations on the composition of vehicles for increasing the share of recycled content used in vehicles: For each vehicle type planned to be type approved in the next two years, OEMS shall detail the minimum rate of recycled content used in the vehicle type in general and the specific rate of recycled content used for any material for which obligatory recycled content targets have been introduced under the ELV legislation.
- Considerations on the assembly and dismantling of vehicles that support the removal of vehicle components and materials and facilitate reuse and/or high-quality recycling: As a minimum, OEMs shall detail practices applied in vehicle types to be approved in the next two years to support the economically feasible dismantling of components for which dismantling obligations exist (see related measure in section 2.1.5.4.2) or for which ATFs have reporting obligations on reuse (see related measure in section 2.1.5.3.6).

<u>Expected outcome</u>: It is assumed that this measure could lead to benefits over time, as on one side it shall become more apparent what practices OEMs apply to improve circularity and shall drive OEMs to improve performance over time and on the other side it should improve the understanding of type approval authorities of the relation between material composition and component assembly and the role that these two aspects play in achieving the 3R targets. The minimum information requirements shall allow ensuring that aspects are addressed for which provisions have been introduced, like recycled content targets or provisions to ensure

recyclability of non-recyclables. In these cases, the strategy shall serve as a type of declaration of conformity. In other cases, reporting on minimum level and existing practices and strategies shall allow a better understanding of OEM efforts towards circularity applied on a voluntary basis. In other words, though the strategy would be obligatory, it has a high level of flexibility for implementation in terms of definition of information requirements and subsequently how OEMs prioritise certain aspects over others (or certain materials). This could lead to a more efficient implementation for OEMs in terms of the proportion between investment in actual improvements of vehicles and benefits in circularity that this results in.

2.1.5.1.4 2.1.d) Provisions for improving the relation between the 3R Type approval process and ELV waste management performance.

Declarations on fulfilment of the reuse, recycling, and recovery (3R) targets submitted by vehicle manufacturers and checked by approval authorities (through the technical services/competent bodies) as part of the 3R Type Approval process do not always reflect the achievable rates of the 3Rs at end-of-life. To address shortcomings and to further facilitate waste management in achieving the targets, changes are to be introduced in the process. These shall address how to take into consideration limitations in the predictability of treatment for certain materials at end-of-life with the objective that results of the 3R calculation performed as part of the 3R type approval process are closer to the actual level of reuse, recycling and recovery that is achievable at the vehicle's EoL. Additionally, information requirements shall be introduced into the 3R Type approval application[85] for data needed for developing fee modulation as part of EPR schemes and for data that must be made accessible to waste management operators (see data accessibility obligations under measure 2.1.i in section 0) to facilitate waste management.

The following requirements are to be introduced into the 3R Type approval (regardless of whether it remains an individual legislation or whether it is merged into the future legislation for ELVs). Requirements are to be introduced in a way that will allow possible updates from time to time to align with technical progress (e.g., in an annex or through a delegated act):

- In the calculation of the potential reusability and recyclability of materials:
  - The recyclability rate (R_{cyc}) calculation is to be revised, introducing additional elements to those required under the ISO Standard 22628 EN, as it is not clear if the EC could initiate and successfully change the ISO standard[86]. The following is to be required of the calculation: To be considered recyclable, a component part or material shall be linked to a proven recycling technology:
    - For materials for which recycling capacities of ELV fractions are established (Technology Readiness Level of 8 and above) at the time of the Type Approval submission, the material will be considered 100% recyclable except in the following cases:

[85] Alternatively, and as far as not feasible to introduce it under the 3R type approval, such monitoring might also be established under EPR Regime.

[86] ISO Standard 22628 EN is an international standard. It is also applied, e.g., for the international type approval process which could adopt EC 3R Type approval changes but may also remain unchanged. Should it the ISO standard not be revisable to accommodate changes to the 3R Type approval, the calculation method could be kept, adding to the level of detail that needs to be included in the calculation for example through an annex. This is understood to still be in line with the general calculation method given in the ISO standard.

- The recyclability of tyres is to be calculated as 50% of the tyre weight to reflect material losses during use and the actual level of recycling currently achievable.
- Values could be specified in the future for additional materials where there is evidence that process inefficiencies result in an actual recycling efficiency which is significantly below 100%.

- Where recycling capacities are not yet established for ELV fractions:
  - 0% will be considered, where recycling technologies are at a TRL < 4;
  - 50% will be considered where recycling technologies are at a TRL of 4-5; and
  - 80% will be considered where recycling technologies are at a TRL of 6-7.
- In the specification of reusability and recyclability of materials and components removed at the dismantling stage (m_D), the calculation will include a break down into components and materials that can be dismantled to be reused, remanufactured and/or recycled:
  - Components that can potentially be reused or remanufactured: as a minimum all components specified under ELVD Annex I (4) and/or in the list of components for which dismantling method and time must be provided to the EPR scheme (see details under Section 0 and Section 0) are to be listed, specifying for each: the weight, the composition, the dismantling method (fastening technology + proven dismantling technology[87]) and the dismantling time
  - Components that can be dismantled and recycled separately to achieve higher recycling qualities or quantities: as a minimum all components and materials specified under Annex I (4) will be included in this list, specifying for each: the weight, the composition, the material composition, the proven dismantling technology (see footnote 87) and the dismantling time.
- In the case that the calculation shows that the RRR targets cannot be achieved, the type approval will be declined, unless life cycle data (carbon footprint data) submitted as part of the 3R Type approval application shows that the use of materials with a TRL below 8 contributes to a decrease in impacts in the use-phase that sets-off environmental losses of these materials in the waste phase. This is further detailed under measure 2.1.e under Section 2.1.5.1.5)

- The 3R Type Approval shall cover all stages of multi-stage vehicles type approval (e.g., N1, trucks, caravan):
  - The OEM shall be responsible for the 3R Type Approval of the base vehicle and any further components that are part of the vehicle that the OEM intends to put on the market.
  - Any economic operator that intends to put an altered base vehicle (that has been 3R type approved by an OEM) on the market, will be obliged to submit a 3R Type Approval for all alterations of the vehicle (components and parts integrated and or attached to the vehicle and any changes made in the base vehicle). 3R Type approval of all stages of the vehicle to be put on the market shall be a condition to the type approval of a vehicle based on Regulation 2018/858/EU.

To support the enforcement of the 3R Type approval, and in particular the technical know-how of 3R Type approval authorities, the Commission will have dismantling and shredding tests performed for at least 5 vehicle types approved in that year (1 vehicle of each type).

[87] ISO Standard 22628 EN specifies criteria for the consideration whether a component is to be considered as “reusable” and/or “recyclable”. These include among others the fastening technology and the proven dismantling method for reusable components and the proven dismantling technology for recyclable parts. It is thus assumed that for such aspects, where lists of proven technologies are not mutual, that a common understanding of these exists and could be used as a basis for updating.

Two alternatives are envisioned here in terms of how such tests could be performed and in relation to what stage of type approval.

- Alternative 1:
    - Every year, five vehicle types newly placed on the market will be selected to be dismantled and shredded. A single vehicle of each type will be submitted to this exercise. This could be performed by the Joint Research Centre or through an external contractor.
    - The test will document the dismantling of each vehicle and analyse the information to estimate the achievability of the 3R targets at EoL. For this purpose, the party shall apply methods specified in the type approval submission for the dismantling of components. Tools specified in such information shall only be applied if they are tools commonly used by ATFs. The party performing the test will document the parts dismantled (time of dismantling, tools used to support the task, composition of part). On this basis, the party will then estimate the probable route of treatment of each component dismantled.
    - To estimate the route of treatment for the remaining vehicle, it will then be sent to a shredding facility that will be required to provide data as to the route of treatment of resulting fractions (for each material, the amounts sent to recycling, material losses, and amounts of resulting recyclables, amounts sent to energy recovery or other recovery, and amounts landfilled).
    - On the basis of all collected data, and comparison with the type approval data, the party will estimate the accuracy of the submission. This will be performed also in relation to different scenarios of the waste management in the MS in which the vehicle is being dismantled – i.e. low/moderate/high share of dismantling combined with different levels of shredding and PST).
    - A report documenting the annual results of dismantling tests will be shared with 3R Type Approval authorities to support their knowhow. It shall include references to each of the vehicle cases and where possible recommendations as to how to critically review the 3R type approval submission or proposals for its further improvement. In cases where the results will show that the Type Approval was wrongly approved, the certificate will be withdrawn.
- Alternative 2 for dismantling and shredding tests:
    - As part of the type approval of a vehicle type, OEMs shall be required to have a dismantling and shredding test performed for 1 vehicle per each vehicle type to be approved. Results of the test shall be submitted to the type approval authority together with the type approval application. The test is to be performed by an independent ATF (which does not have other contractual relations with the OEM and which services vehicles of multiple types and brands) and is to be supervised and documented by a type approval service provider.
    - The performing ATF will dismantle the vehicle based on methods prescribed for dismantling of components and materials specified by the OEM in the type approval application and shall record the time of dismantling needed for each component. Where methods are not specified, common practice dismantling methods shall be applied, specifying times for any additional components and materials for depollution or removal obligations exist under ELVD Annex I(3 & 4). For components that have been dismantled, the ATF shall consider the revenue that it could expect to retrieve e.g., from components sold for reuse or from parts sent to separate recycling and shall specify components for which it considers that the dismantling method prescribed I snot economically feasible.
    - To estimate the route of treatment for the remaining vehicle, it will then be sent to a shredding facility that will be required to provide data as to the route of treatment of resulting fractions (for each material, the amounts sent to recycling, material losses,

and amounts of resulting recyclables, amounts sent to energy recovery or other recovery, and amounts landfilled). Should the dismantling and shredding test data show that the dismantling of a certain component is not economically feasible, such data shall be passed to the EPR scheme to feed into future fee modulation.

It is probable that at the time of type approval, that OEMS have only produced prototype versions of the vehicle as mass production will have not yet started. This results in some advantages and disadvantages for each of the alternatives proposed above. Alternative A has the advantage that the dismantling test is performed on a vehicle that is already produced in series production and could thus be more accurate in terms of results. However, if through this test, it shall be discovered that the vehicle actually does not comply with the 3R Type approval, the type approval would have to be withdrawn and all vehicles placed on the market recalled, at high costs. Alternative B performs the test prior to the type approval. Should limitations to the type approval be identified, it would not be approved, prior to the vehicle reaching mass production, saving respective costs. Nonetheless, at this stage, a prototype of a vehicle may be less representative of the actual vehicle, with the consequence that the type approval may still result in vehicles placed on the market that are not optimal in terms of dismantling and fulfilment of the 3R targets. Nonetheless, this option would support the provision of test based dismantling times of specific components to be considered in EPR fee modulation, which may be more representative than times that the OEM would provide independently.

Expected outcomes: The **method proposed for revising the calculation** of the 3Rs in the respective Type Approval process is expected to allow better control of the actual recyclability of vehicles, particularly considering the increasing trend towards use of light-weight materials. The combination of a lower recycling value in the calculation of materials for which recycling is not established with the option of providing LCA data to justify the use of such materials when it hampers waste management is assumed to provide more flexibility for the development of innovative materials. In parallel it is to ensure that vehicles that make use of such materials without an actual reduction of emissions or fuel/electricity consumption during the use phase are denied market access. Though the new calculation differs from the current one, the main additional burden for OEMs is expected in relation to the provision of more detailed data on components and, in cases where it applies, life cycle data. However, the provision of dismantling methods and times for components is assumed to allow a better integration of the reuse objective, without requiring OEMs to forecast which parts will be reused in practice. This will increase the availability of information on dismantling of components with a reuse and/or recycling potential and could support such practices in the future. Provision of life cycle data will turn the process of compliance checking for such materials into a black and white decision and is considered to ensure that the use of non-recyclable materials in large quantities will be limited to cases where this reduces the total negative environmental impacts of a vehicle despite higher impacts at EoL. In this sense, the measure is expected to facilitate ELV waste management and may also increase the use of recyclable materials in vehicles.

The main concern of this measure is that any changes to the 3R Type Approval process may affect the coherence with the international UN ECE Regulation 133 and transboundary movements of vehicles between the EU and other countries. This could require a withdraw from this Regulation and have consequences for vehicles that were formally considered to comply with the EU legislation on 3R Type Approval though approved elsewhere. Extending the scope of the 3R Type Approval beyond the base-vehicle stage to multi-stage vehicles is expected to create a significant burden for economic operators that are involved with the manufacture of multi-stage vehicles and who have up till now only been involved in the general Type Approval process. Such operators include many SMEs which may be affected more heavily. In parallel, it is not clear how many multi-stage vehicles are put on the market in large series, i.e., market volumes that would not be excluded anyway from the 3R Type Approval due to Article 3(c)[88] of Directive 2005/64/EC on the 3R Type approval. The combination of these aspects could mean that impacts for various actors and for the environment could differ for various vehicle categories.

It is hard to anticipate whether the obligatory dismantling and shredding tests will actually lead to an increase in the knowhow of the type-approval authorities and facilitate the identification of vehicles that will not comply with the 3R targets and for which a type approval may not be justified. As only 5 model vehicles will be dismantled per year, it could be that any improvements to the type approval process and to the vehicles that make it to market will be very gradual in development, making for a more modest contribution to increased circularity.

2.1.5.1.5 2.1.e) Option for OEMs to submit life cycle data as part of the 3R type approval process to justify the use of materials where recycling is not yet established

Article 7 of Regulation 2019/631/EU[89] on CO2 emission performance standards for new vehicles requires the Commission to evaluate the possibility of developing a common methodology for the assessment and the consistent data reporting of the full life-cycle CO2 emissions of certain vehicles placed on the Union market at latest by 2023. The Commission is considering the development of such proposals; however, this is expected to mainly focus on vehicle CO_2 emissions. In a study performed in this context, reference to the EoL mainly refers to battery related aspects.

In parallel, it is however observed that certain materials that are hard to recycle are applied in vehicles to generate environmental benefits during the use phase, however it is not always clear if such benefits indeed justify the impacts on the EoL of vehicles.

The intention of this measure is to enable the use of life cycle data as evidence in the 3R Type approval process to justify the use of non-recyclable materials at the time a vehicle is POM. Such data could support a future 3R Type Approval where the use of certain materials hinders waste management but also results in a significant reduction in environmental impact during the use phase which compensates for not achieving the recycling targets at EoL. To ensure that life cycle data for different vehicles is comparable, a standardised method for the calculation and compilation of such information would need to be developed. This could be developed as Product Environmental Footprint (PEF) rules for vehicles that would need to be applied for preparing self-declarations for submission at the type-approval stage or as a guidance document. The development of an LCA method that may be pursued under Regulation 2019/631/EU could also include elements addressing non-recyclable materials at EoL, to make sure that when the method is followed, resulting data can be used in all cases of EU legislation that requires provision of life cycle data. The focus is expected to be on comparisons between costs and benefits related to the use of a specific material in the use phase and EoL phase (though manufacturing should not be excluded). Though currently it would be sufficient for a comparison to be performed based on a total carbon footprint (CO_2 equivalents), in the future, as the market advances towards a larger share of renewables in

[88] Initially based on Directive 70/156/EEC, vehicles produced in small series is considered to apply in cases where less than 500 (M1, N1, O1 and O2 vehicles) or 250 vehicles (other types of motor vehicles and trailers except mobile cranes for which 20 vehicles applies) are to be put in the market in a MS an can thus be exempted from the Type Approval process.

[89] Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles. This aspect is also addressed for trucks under Regulation 2019/1242.

the energy mix, it will become more relevant to focus on energy consumption as the weight of emissions decreases as will the consumption of fuel.

It is assumed that at least two years would be needed to develop PEF rules or a guidance for vehicles and possibly longer. OEMs would be consulted with as part of the development process and are understood to be in the position of contributing to this process, seeing as many OEMs already use life-cycle-analysis to model the environmental performance of new vehicles. This shall also allow time for training type approval authorities so that in the case of submission of such data, the way that it is reviewed by authorities is harmonised across all MS.

After the publication of the PEF rules or guidance, a transition period shall be provided, after which 3R type approval (and POM) of vehicles that are expected not to fulfil the 3R targets (3R Type Approval calculation) shall be conditioned with the submission of life cycle data that shows that such materials provide significant environmental benefits that outweigh their environmental costs.

Type approval authorities will need to critically review the life cycle data as part of the 3R Type Approval process and to consider if it can be considered as sufficient justification for an approval. This should allow consideration of how vehicles placed on the market using non-recyclable material may affect the achievement of targets when they become ELVs and are brought for treatment to an ATF. Vehicles could either be denied market access (Type Approval) when the life cycle data does not support the finding that environmental benefits of the material outweigh its environmental costs. An alternative could also be to require OEMs to take-back such fractions and ensure their reuse or recycling as a condition to Type Approval.

<u>Expected outcome</u>: A condition to the implementation of this measure is the development of a method for preforming comparisons of life cycle data in cases where there are non-recyclables that hinder achievement of the reuse and recycling targets. In this sense, any impacts that are to incur will only be expected after a transition period goes by that allows the development of such a methodology. It shall probably also be necessary to train Type Approval authorities so that they know how to review such data critically, which would be essential for the measure to have an effect. Though it could be said that requiring OEMs to provide life cycle data in such cases could add to the burden of the type approval process, it can be understood that many OEMs already perform LCAs of their vehicles as a whole or of specific components for internal use. In this sense, it is assumed that developing such ongoing efforts for use as part of the 3R Type Approval should be feasible. Furthermore, as the measure is suggested as an option for proving the benefits of using non-recyclable materials in cases that could otherwise result in the 3R Type Approval being denied, it is assumed that OEMs would only make use of this option when they are convinced that the use of the material is indeed justified due to benefits it provides during use.

2.1.5.1.6 2.1.f) Obligatory reporting requirements on the use of materials that affect dismantling and recyclability to facilitate identification of incompatible practices

The presence of certain materials in shredded fractions can hinder the recycling of certain materials, limit the quality of recycled ones, or hinder the achievement of the 3R targets. The way that a part of a material is assembled in a component or in the vehicle also affects the potential for repair, reuse, and recycling. Obligations are thus to be included in the Directive to promote the use of materials, components and parts that facilitate repair, re-use, remanufacture and/ or recycling and to discourage the use of those that hinder such operations. It is observed that the use of a specific material and/or fastening technique in the assembly of one component may be beneficial (or at least not harmful) but that it can hinder reuse and recycling in other cases. Thus, rather than prohibiting the use of certain components, materials or techniques, the focus would be on developing a feedback mechanism that ensures that information on how certain design elements affect EoL is communicated and integrated into the design process. To this end, feedback is to be facilitated both between different departments of an OEM (designers of the model and its components and those dealing with type approval or performing internal dismantling tests) and between OEMs and waste management operators.

OEMs would be required to report every few years on:

- materials and fastening or assembly techniques that have been included in vehicle designs,
- the feedback mechanisms applied to raise awareness of waste management operators as to the need to apply certain methods or to use certain tools to achieve suitable dismantling of components for reuse or for separate (pre-shredder) recycling (e.g., training, provision for data as to material composition, method of dismantling etc. in IDIS or in similar platforms.
- the feedback mechanisms (internal and external) established to learn about the experience with such parts during the EoL phase (e.g., dismantling tests performed internally when a model is introduced to market or in relation with type approval as well as actual experience with vehicles at EoL),
- a summary of the input that has been collected through such feedback mechanisms in the reporting period and how these have been applied in decisions about vehicle design and use of certain materials or fastening and assembly technique. This should also include conclusions as to materials and assembly/fastening techniques that will no longer be used or that will only be applied when certain conditions apply.

Expected outcome: This measure is expected to facilitate more feedback between the design and EoL stage of vehicles with a view to allowing quicker identification of methods that hinder reuse and recycling and those that do not. Though it can be assumed that some OEMs may be more advanced in such practices (at least internally or at regional level), input from waste management stakeholders suggests that for the most part, there is still insufficient exchange with waste operators. This refers both to cases where the latter conclude that certain materials or techniques hinder waste management but also cases where OEMs make efforts towards dismantling to which waste operators remain largely unaware. The first stages of implementation require rather to establish a feedback mechanism that allows information flows in both directions and that ensures that information is used to improve design (or to improve EoL activities). Establishing such a system may not lead to benefits in the short term but is rather expected to allow progressive improvements, first mainly in communication but later on leading to design changes and improved reuse and recycling. Routine monitoring could also allow development of guidance on best practices in the future or practices that should be avoided.

2.1.5.1.7 2.1.f) Obligatory reporting requirements on the use of materials that affect dismantling and recyclability to facilitate identification of incompatible practices

The presence of certain materials in shredded fractions can hinder the recycling of certain materials, limit the quality of recycled ones, or hinder the achievement of the 3R targets. The way that a part of a material is assembled in a component or in the vehicle also affects the potential for repair, reuse, and recycling. Obligations are thus to be included in the Directive to promote the use of materials, components and parts that facilitate repair, re-use, remanufacture and/ or recycling and to discourage the use of those that hinder such operations. It is observed that the use of a specific material and/or fastening technique in the assembly of one component may be beneficial (or at least not harmful) but that it can hinder reuse and recycling in other cases. Thus, rather than prohibiting the use of certain components, materials or techniques, the focus would be on developing a feedback mechanism that ensures that information on how certain design elements affect EoL is communicated and integrated into the design process. To this end, feedback is to be facilitated both between different departments of an OEM (designers of the model and its components and those dealing with type approval or performing internal dismantling tests) and between OEMs and waste management operators.

OEMs would be required to report every few years on:

- materials and fastening or assembly techniques that have been included in vehicle designs,
- the feedback mechanisms applied to raise awareness of waste management operators as to the need to apply certain methods or to use certain tools to achieve suitable dismantling of components for reuse or for separate (pre-shredder) recycling (e.g., training, provision for data as to material composition, method of dismantling etc. in IDIS or in similar platforms.
- the feedback mechanisms (internal and external) established to learn about the experience with such parts during the EoL phase (e.g., dismantling tests performed internally when a model is introduced to market or in relation with type approval as well as actual experience with vehicles at EoL),
- a summary of the input that has been collected through such feedback mechanisms in the reporting period and how these have been applied in decisions about vehicle design and use of certain materials or fastening and assembly technique. This should also include conclusions as to materials and assembly/fastening techniques that will no longer be used or that will only be applied when certain conditions apply.

Expected outcome: This measure is expected to facilitate more feedback between the design and EoL stage of vehicles with a view to allowing quicker identification of methods that hinder reuse and recycling and those that do not. Though it can be assumed that some OEMs may be more advanced in such practices (at least internally or at regional level), input from waste management stakeholders suggests that for the most part, there is still insufficient exchange with waste operators. This refers both to cases where the latter conclude that certain materials or techniques hinder waste management but also cases where OEMs make efforts towards dismantling to which waste operators remain largely unaware. The first stages of implementation require rather to establish a feedback mechanism that allows information flows in both directions and that ensures that information is used to improve design (or to improve EoL activities). Establishing such a system may not lead to benefits in the short term but is rather expected to allow progressive improvements, first mainly in communication but later on leading to design changes and improved reuse and recycling. Routine monitoring could also allow development of guidance on best practices in the future or practices that should be avoided.

2.1.5.1.8 2.1.g) Establishment of mandatory recycled content targets for materials used in cars

Provisions are to be included in the future legislation of 3R for specific materials used in vehicles requiring that a minimum share of the material used is of secondary sources. Requirements shall be specified per material as a recycled content target to be reached within a given timeframe and could also refer additional parameters to be complied with such as the origin of secondary materials (e.g., pre-consumer vs. post-consumer; ELVs vs. other end-of-life product streams).

Mandatory recycled content targets under consideration include:

- targets for plastic (scenarios developed by JRC (Maury et al. 2022) and considered in the analysis performed in this study:
    - Mandatory targets for OEMs to declare on plastic recycled content in vehicles POM,
    - Mandatory targets of plastic recycled content contained in vehicles POM:
        - Achieving 25% recycled content by 2030 and 30% by 2035…
        - Achieving 30% recycled content by 2030 and 35% by 2035…
- target for neodymium magnets and possibly other CRMs : here a limiting factor is the time needed for collection and recycling to establish a reliable supply as secondary materials for use in vehicles. A target could be considered in the long term (e.g., within 10 years) and will probably need to start low and increase gradually. Targets could address a certain element (e.g., neodymium) of NdFeB magnets or the use of recycled magnets. This may also depend on how recycling practices will develop. This is being looked into by a further JRC study to be completed at the beginning of 2023.
- In addition, targets for CRMs gallium, magnesium, tantalum may still be explored in future studies.
- A target for glass could be considered in the future, if the effect of other measures designed to promote high quality recycling of glass is insufficient (e.g., excluding backfilling form recycling, obligations for ATFs to dismantle glass prior to shredding operations, recycling target for glass). Furthermore, though a recycled content target might affect the quality of glass recycling, its investigations would probably require more data to conclude on technical feasibility than is currently available. In this respect, a review clause could be included in this provision, requiring an investigation on the recycling of glass and the use of recycled glass in the manufacture of new vehicles. Should this investigation show that there is room to further support the demand of recycled glass, a target could be added in the future.
- A similar situation is apparent for tyres. High quality recycling is currently understood to be the exception rather than the norm, whereas it is expected that the recycling of rubber form tyres will develop significantly in the coming years. Here too, an investigation would require more data to conclude on technical feasibility than is currently available. The option should be reconsidered in the future.

2.1.5.1.9 2.1.h) Obligatory due diligence for materials used in vehicles

The manufacture of vehicles and vehicle components makes use of numerous materials of both primary and secondary nature. Some of these are sourced from countries (outside the EU) where the local governing conditions and/or the level of performance of mining and processing facilities may not ensure the provision of human rights, the health of workers and/or of nearby residents, or the prevention of adverse impacts on the environment. Where the manufacture of vehicles has a high dependency on material sourcing from such countries, this can contribute to adverse impacts on society and on human health and the environmental. To prevent such impacts, vehicle manufacturers could be required to perform due diligence when sourcing materials to produce vehicles and their components from high- risk countries. This can be related either to primary materials that are sourced from conflict-affected or high-risk areas or to secondary materials sourced from countries that do not ensure a minimum level of environmental performance and/or of minimum social working conditions.

At horizontal level, in relation to the sourcing of minerals from conflict-affected or high-risk areas, Regulation 2017/821/EU lays down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from such areas. The sourcing of e.g., tin, tungsten, tantalum, niobium and gold minerals and metals for vehicle manufacture would be addressed through this Regulation, making an ELV obligation redundant.

In some cases, there may be other materials used in vehicles sourced from countries that do not ensure that the sourcing and processing of such materials is environmentally and socially sound. For such cases, due diligence obligations could be included in the Directive, similar to those currently proposed for the new regulatory framework for batteries. This would include a provision, laying down obligations for OEMs to perform due diligence on the supply of certain materials (primary and secondary), and to declare on the risk of occurrence of adverse impacts and on strategies for their mitigation. Declarations on such actions, including third party verification would need to be made available to authorities as part of the type-approval process and for MS inspections. A list of materials (e.g., REE) for which this is to be obligatory would be included in the future legislation for vehicles, also specifying thresholds for each material as to the amount of use contained in a vehicle above which the obligation would comply. The annex would be updated continuously, in relation to the thresholds and if necessary, also as to the materials specified therein.

There is also a need to consider the requirements set out in the Corporate Sustainability Due Diligence Directive. The CSDD is a horizontal legislation that focusses more generally on the *behaviour* of companies and addresses the entire value chain for all goods and services. It will implement the due diligence requirements of the proposed Batteries regulation by introducing a *value chain* due diligence related to raw materials (and goods and services) that are *not* covered in the Batteries Regulation. Both build on the OECD due diligence guidance, making implementation coherent.

Expected outcome: It is currently not clear which materials could be addressed through a due diligence obligation to be included in the future ELV legislation. Materials addressed under other legislation (or in focus of future sectoral legislation such as the Batteries Regulation) are not used in large amounts in vehicles.

In parallel, the European Commission has published a tender[90] to review the functioning of Regulation 2017/821/EU, which towards 2026 could both lead to adaptations in future due diligence requirements as well as in the materials for which such requirements are necessary.

2.1.5.1.10 2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars

The availability of information or lack thereof plays a large role in the decisions of ATFs as to the waste management of vehicles. Easy access to data on the location of certain materials and substances or as to how certain components can be dismantled efficiently so that the component can be reused, often tip the decision if to remove certain parts or to send them with the rest of the vehicles for shredding and PST. Two alternatives are under consideration as to how to ensure the accessibility of data to waste management operators.

[90] Call for tenders TRADE/2022/OP/0001 “Study to review the functioning and effectiveness of Regulation (EU) 2017/821 (due diligence obligations for importers of tin, tantalum, tungsten and gold from conflict-affected and high-risk areas”

- Alternative 1: As has been the approach of the current ELVD, the future legislation for ELVs or the future 3R legislation will specify for which types of information it is obligatory for OEMS to provide **data and will include elements as to the harmonisation of the format** in which data is to be provided. This will leave open to OEMs to decide how the information is to be provided to waste operators (e.g., elaboration of IDIS, access upon request to systems that currently use other stakeholders (IMDS, RMI) or development and access to new systems). Information to be made accessible to EPRs shall be submitted as part of the 3R Type approval process or to the EPR directly.
- Alternative 2: All relevant information shall be submitted by OEMs and their suppliers to a **digital product passport** for vehicles and made accessible to relevant actors (e.g., 3R Type approval authorities, EPR schemes, ATFs). Here the format is predetermined leaving less room for OEMs to decide what method of data provision is the most appropriate to comply with requirements while limiting the burden thereof.

Since vehicles have a relatively long lifecycle, providing information retroactively for cars already on the market, will be important to ensure that provisions related to e.g., dismantling, lead to benefits in the low and mid-term. It is not clear if such requirements could be included for older vehicles (for example the 3R directive only applies to new vehicles) but this should be investigated. The ELVD currently includes Article 8(4)[91], which is understood to require manufacturers to provide ATFs with information to support reuse, regardless of a vehicle being new or not. It is thus to be seen if such requirements could be included in the future legislation of ELVs, for example as part of EPR obligations.

In both cases, the type of information to be made accessible and any minimal format requirements on its provision will affect both the cost of the preparation and submission of data for OEMs and its usability by ATFs, subsequently determining the range of impacts that increased data availability will have for the ELV waste sector. The following types of information shall be considered for inclusion in any provisions on the obligatory provision of data:

- dismantling time and dismantling method of components with potential for reuse and/or remanufacturing (delegated act defining the scope), shall be provided free of cost and in a harmonised way (see section 2.1.5.3.6 for preliminary list),
- dismantling time and dismantling method of components with for which there are depollution obligations (Annex I (4)) shall be provided free of cost and in a harmonised way
- dismantling time and dismantling method of components which are obligatory to dismantle (e.g., current Annex to the ELVD, possibly to be amended e.g., by a delegated act) for promoting reuse and/or recycling shall be provided free of cost and in a harmonised way. Components shall be referred to (see section 2.1.5.3.62.1.5.4.2 for preliminary lists) that have a high potential for reuse but also a higher value when recycled separately, including:
  - components that contain a minimum mass of certain materials for which removal prior to shredder enables higher quality recycling (e.g., aluminium, copper, glass),
  - components for which separate treatment of sorted fractions will allow targeting materials that it is not economically feasible to target in PST (e.g., electric and electronic components and printed circuit boards, tyres),

[91] 4. ELVD, Art. 8(4): "Without prejudice to commercial and industrial confidentiality, Member States shall take the necessary measures to ensure that manufacturers of components used in vehicles make available to authorised treatment facilities, as far as it is requested by these facilities, appropriate information concerning dismantling, storage and testing of components which can be reused".

    - components containing materials that cannot be recycled at the time placed on the market (e.g., carbon enforced plastics, composites) – could be facilitated through a reference to TRL < 9.
- digital keys, also referred to as "Smart Access Control solution" and information as to the dismantling method for components using digital keys shall be provided through a reasonable procedure, at a reasonable price and in a harmonised way.
- information on the substance content of any component shall be made accessible free of cost and in a harmonised way, for any substance or material that was suspected or identified as a hazardous substance or that was on the EU list of critical raw materials at the time of the type approval of the vehicle.

The future legislation for ELVs shall include a provision specifying for what types of data it is obligatory for OEMs to provide information and specifying any additional obligations in terms of the systems used to provide data and minimum requirements as to the format in which data is to be provided.

It is possible that for some types of data, the ratio of costs and benefits of various actors may be uncertain in the analysis to be performed in this impact assessment and also that this ratio may change in the future in light of developments in the design and waste management of vehicles. There should therefore be an option to update the list of data to be provided. In some cases, the provision may also refer to voluntary provision of certain data types, requiring the Commission to revisit the decision within a certain period, to reconsider whether an obligatory provision would increase environmental benefits or lead to more efficient waste management (e.g., reducing the height of necessary EPR compensations).

Expected outcome: Much of the information referred to above is already collected by OEMs for their own use or for provision to car dealers and/or ATFs. In some cases, information is provided for a fee, in others it is provided freely to certain actors or not at all. The main difficulty in the current situation is related to certain data not always being accessible to ATFs which could facilitate an increase in reuse or recycling were the data available. In some cases, this is a result of a lack of harmonisation or of certain actors not making use of platforms already available. In any case the measure will target an increase in the effectiveness of the existing mechanisms. Though this is expected to result in costs for OEMs and benefits for actors that would have access to data, the starting point is not at zero but rather at a point where OEMs already collect and compile data (at a cost), considering how to manage its availability.

2.1.5.2 Measures to achieve specific objective 2.2: Ensure elimination of hazardous substances in vehicles

2.1.5.2.1 2.2.a): Restriction of substances in vehicles

This measure deals with defining the means to generate specific limitations/restrictions on substances used in vehicles. The expected mechanism should be able to deal with the existing restrictions of the four heavy metals as well as with the exemption mechanism. At the same time, it should cover the restriction of additional substances.

The objective of this measure is to provide legal certainty about the currently restricted substances and their exemption, and the procedure for future substance restrictions and the exemptions mechanism.

Furthermore, it should allow to restrict further substances in vehicles. This is relevant against the background that there is a general increase in the use of plastics, for example, due to its advantages for vehicles in terms of weight reduction. However, the use of plastics also raises concern as to the presence of hazardous chemical additives in such materials and with regard to the question as to how far this can pose technical difficulties for their recovery. Concerns on additives also apply to other materials such as rubber or textiles, though possibly used in lower amounts in these materials. This suggests that there may be a need to regulate the presence of additional hazardous substances that are used in vehicles, aside from the four heavy metals currently prohibited, e.g., certain flame retardants, plasticisers or surface-active agents such as PFAS.

Three variants of this measure can be distinguished, these shall be treated as policy options. Thus, the detailed description of the measures can be found in the description of the policy options in chapter 3.1.4.8.2. For this measure, three alternative policy options are:

POLICY OPTION 1A – RESTRICTIONS AND EXEMPTIONS UNDER REACH

POLICY OPTION 1B – RESTRICTIONS AND EXEMPTIONS UNDER REVIEWED ELVD

POLICY OPTION 1C – HYBRID APPROACH

2.1.5.2.2 2.2.b: Improved communication on hazardous substances in the automotive value chain

This measure addresses the communication needs at the end of life of vehicles on the hazardous substances to allow improved reuse and recycling by sorting (out). An improvement in the communication on hazardous substances in the automotive value chain would also contribute to the elimination of hazardous substances in material fractions generated by the ELV waste management sector. There are information systems in place covering the details on material composition, however, the missing element is the availability of the information at waste treatment facilities on the one hand side, and the information for dismantling on the other side. Thus, there is a need for additional dismantling information for recyclers in addition to the current information provided by SCIP or GADSL in IMDS.

This proposed measure is to introduce an obligation – to be added to the ELVD – that the information on the content of substances with hazardous classifications or substances under assessment for classification needs to be documented along the value chain. Should a need for depollution arise, the information on the content of hazardous substances would need to be made available to treatment facilities in a way that the information is linked to

- single parts/components,
- the location of the parts/components in the vehicle combined with dismantling information and
- to safe use instructions for dismantling and recycling processes.

This communication would enable the dismantling prior to shredder, combined with subsequent decisions on whether to sort out components or materials, from the material flow, for disposal due to their content of hazardous substances (as is the case for parts containing the POP decaBDE) or to sort out such components or materials to allow their diversion to specific treatment that allows controlling the content of hazardous substances (e.g., separating aluminium wrought and cast alloys) or eliminating it from the general material stream.

The improved communication could be envisaged according to three possible information schemes:

- Via the SCIP database as a centralised European Database: The SCIP database was recently established to collect information from companies on the contents of Substances of very High Concern of the REACH Candidate list in articles supplied to the EU market. These notification requirements under the SCIP database for SVHC comprise a current obligation and can be considered as the baseline.

- In order to serve as a measure on improved communication, the SCIP database would need further development and adaptations.

- Via an industry-driven system, e.g., based on GADSL/IMDS: The Global Automotive Declarable Substance List (GADSL) was developed to facilitate communication and exchange of information regarding the use of certain substances in automotive products throughout the supply chain. The list only covers substances that are expected to be present in a material or part that remains in a vehicle at the point of sale. The GADSL specifies not only substances that are prohibited, but also substances that are under assessment and could potentially be regulated in the future. In this sense, the GADSL covers substances beyond those, for which the use is to be notified to the SCIP database.
- In order to serve as a measure on improved communication, the GADSL/IMDS would also need further development and adaptations.

- Via a Digital Product Passport (DPP), which is most likely based on a decentralised IT architecture, as defined in the Proposal for a Regulation establishing a framework for setting Ecodesign requirements for Sustainable Products[92] (ESPR). The information requirement on substances of concern[93] is depicted in the text box below. The information might be made available via different manners.[94] Due to the complex composition of vehicles, a DPP or an access to the information via the VIN number on a website or an application seems to be the most appropriate form of communication. However, a concrete development is still underway and so far not in place.

Proposal for a Regulation establishing a framework for setting Ecodesign requirements for Sustainable Products (ESPR):

Article 7 Information requirements

[…]

5. The information requirements referred to in paragraph 1 shall enable the tracking of all substances of concern throughout the life cycle of products, unless such tracking is already enabled by another delegated act adopted pursuant to Article 4 covering the products concerned, and shall include at least the following:

(a) the name of the substances of concern present in the product;

(b) the location of the substances of concern within the product;

(c) the concentration, maximum concentration or concentration range of the substances of concern, at the level of the product, its main components, or spare parts;

(d) relevant instructions for the safe use of the product;

(e) information relevant for disassembly.

92 COM(2022) 142 final https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products_en

93 The recent Proposal for a Regulation establishing a framework for setting ecodesign requirements for sustainable products introduces an additional criterion for substances of concern if a substance "negatively affects the re-use and recycling of materials in the product in which it is present." (COM(2022) 142 final)

94 The following are mentioned in Article 7: (a) on the product itself; (b) on the product's packaging; (c) in the product passport referred to in Article 8; (d) on a label referred to in Article 14; (e) in a user manual; (f) on a free access website or application.

2.1.5.3 Measures to achieve specific objective 2.3: Increase the re-use and remanufacturing rates of parts and components contained in cars

The ELV Directive contains general provisions which prioritise reuse and recycling over recovery and disposal. Such objectives are in line with the circular economy model that aims to maximise the reduction of waste and reuse of materials. However, the evaluation results95 raised the need to better align the ELV Directive with the objectives of the European Green Deal and the Circular Economy Action Plan. In this respect, the ELV Directive does not sufficiently address waste prevention routes such as reuse, including eco-design of cars to facilitate re-use, repair and remanufacturing. The potential to increase re-use is not realised.

The following described measures thus aim to facilitate re-use and remanufacturing.

2.1.5.3.1 2.3.a) Clarify definition of re-use in the ELV Directive vs re-use and preparing for re-use in the Waste Framework Directive

Under Article 2(6) of the ELV Directive '**reuse**' means any operation by which components of end-of life vehicles are used for the same purpose for which they were conceived.

The Waste Framework Directive[96] (Article 3(13)) adopts a different approach:

> '***re-use***' *means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.*

Therefore, the WFD includes a definition for "Preparing for re-use" (see below) which is also included in the waste hierarchy (Article 4 of the WFD). According to Article 3(16) of WFD:

> '***preparing for re-use***' *means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing.*

This term does not appear in the ELV Directive. Components of a vehicle that has reached the waste phase (became an ELV) can be used for reuse. There is a lack of clear definition on the status of these components as if they shall be considered as waste or not. If yes, the definition of "reuse" according to ELVD is not aligned with the WFD, thus the components that have reached the waste phase can be used for reuse, whereas in the WFD this is enabled through their "preparing for reuse". Components that are considered as waste, their shipment for re-use or remanufacturing is more challenging (e.g., higher transport costs, higher administrative burden).

Additionally, the "reuse" definition in the ELVD as well as in the WFD clearly define that component meant for reuse shall be used again for the same purpose for which they were conceived. This excludes remanufacturing in some manner (please refer to the following section 2.1.5.3.2).

In practice, vehicle components can be removed for re-use from the vehicle:

[95] Commission staff working document evaluation of Directive (EC) 2000/53 of 18 September 2000 on end-of-life vehicles, SWD(2021), European Commission, 2021

[96] Consolidated text: Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (02008L0098 — EN — 05.07.2018 — 003.002)

- During the use phase:
  - Parts are removed either in a garage or by a private person and are directly installed in another vehicle. In this case they do not reach the waste stage. Assuming that the used parts are used for the same purpose for which they were designed.
  - In other cases, a broken component is removed from a vehicle that is in use and this product is shipped by a garage to an operator (remanufacturer) that tests and pre-processes the component as necessary[97] so that it can be sold as a used or remanufactured component (for description of the remanufacturing process see 2.1.5.3.1). It is assumed that at least in most cases these components will be re-used for the same purpose for which they were initially designed (e.g., an engine is reused as an engine, though maybe in a different model).
  - In the case of faulty parts that are tested and pre-processed, some parts could also be used for other purposes than those for which they were designed. This is the case of EV batteries, where it is not clear of "second use" as an energy storage system would be in line with the WFD definitions. Should there be similar situation for other parts, the situation may need to be clarified.
- During the end-of-life stage: parts are removed at an ATF from an ELV, meaning that they reached the waste stage. These ELV components are collected in the ATF's scrap yard and can be sold to private persons, to an economic operator (repair shop) for reuse or for remanufacturing (see Section 2.1.5.3.2).

In the frame of ongoing impact assessment of WFD, the adjustment of the definitions on "reuse" and "preparing for reuse" as well as introduction of "remanufacturing" in this legal document are under consideration. Thus, it is to consider align all these definitions in both legal acts. Nevertheless, aligned existing and new definitions require clear definition, so that components for reuse and remanufacturing:

- do not reach the waste stage;
- do not necessarily need to be used for the same purpose for which they were initially designed (after remanufacturing).

Thus, components removed from the ELVs would be classified as waste by introducing a provision specifying that "the ELV components (products and core) shipped for re-use and remanufacturing shall not be considered as waste to avoid obstacles with their national and trans-national shipments". Moreover, these components might be used for other purpose for which they were conceived.

Additionally, it is suggested to assess the possibility to introduce a special customs code for re-used and/or remanufactured goods, so as to remove trade barriers and improve global movement of remanufactured and directly reused vehicle components.

Expected outcome: Clarity on the status of removed components from the vehicle will facilitate their transport for reuse and remanufacturing by limiting administrative burdens of their shipment (also trans-national). It is expected that more components will be reused or remanufactured as well as their service life being extended.

2.1.5.3.2 2.3.b) Introduce a definition of remanufacturing and specific provisions to support remanufacturing

Remanufacturing is a manufacturing process which typically involves:

[97] This process is called remanufacturing in a number of studies and technical documents. So far, a definition of such processes does not exist in the EU legislation. More under the following measure.

- dismantling of a product,
- cleaning, restoring and replacing its components as necessary,
- testing the individual parts and the whole product.

The product obtained after remanufacturing is expected to have at least the same performance as the original performance specification (like-new) or better. Additionally, the remanufactured product usually comes with a warranty.

There exist numerous **definitions of remanufacturing**, inter alia, widely recognised, is a definition provided by the British Standards Institution's BS 8887-2:2009 Terming and Definitions, as part of the 'MADE' series of standards (Design for Manufacture, Assembly, Disassembly and End-of-life processing). The BS 8887-2 definition states that remanufacturing is the process of:

> *Returning a product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product.*

This definition is accompanied with further notes:

> *Note 1. From a customer viewpoint, the remanufactured product can be considered to be the same as the new product.*
>
> *Note 2. Remanufacturing may not use repaired or reconditioned parts.*
>
> *Note 3. With respect to remanufacture:*
>
> *- manufacturing effort involves dismantling the product, the restoration and replacement of components and testing of the individual parts and whole product to ensure that it is within its original design specifications;*
>
> *- performance after remanufacturing is expected to be at least to the original performance specification; and*
>
> *- any subsequent warranty is generally at least equal to that of new product.*

The remanufacturing process is applied in many industrial sectors, inter alia, automotive parts such as car engines and components. Both terminology and practice in this area may differ slightly between products and sectors. It has been observed that the lack of a definition may result in barriers to international trade, as products and core[98] are sometimes considered as waste, rather than potentially high value input into a (re-) manufacturing process[99].

In 2016, six leading associations[100] that are part of the automotive production sector reached a common understanding as to basic definitions associated with their industry. The associations have converged on the following definitions[101]:

[98] A used part intended to become a remanufactured product

[99] Remanufacturing Market Study, A report by the partners of European Remanufacturing Network (ERN), November 2015

[100] The European Association of Automotive Suppliers (CLEPA), Motor & Equipment Remanufacturers Association (MERA), Automotive Parts Remanufacturers Association (APRA), Automotive Parts Remanufacturers National Association (ANRAP), European Organisation for the Engine Remanufacture (FIRM) and Remanufacture Committee of China Association of Automobile Manufactures (CPRA)

[101] Remanufacturing Associations Agree on International Industry Definition, International agreement an important milestone in further development of a growing industry, Frankfurt, September 2016

***Remanufacturing process**: Remanufacturing is a standardized industrial process[102] by which cores are returned to same-as-new, or better, condition and performance. The process is in line with specific technical specifications, including engineering, quality and testing standards. The process yields fully warranted products.*

***Core**: A core is a previously sold, worn or non-functional product or part, intended for the remanufacturing process. During reverse logistics, a core is protected, handled and identified for remanufacturing to avoid damage and to preserve its value. A core is not waste or scrap and is not intended to be reused before remanufacturing.*

In addition, European associations had previously agreed to the following definition applicable in Europe:

***Remanufactured part**: A remanufactured part fulfils a function which is at least equivalent compared to the original part. It is restored from an existing part (CORE), using standardized industrial processes in line with specific technical specifications. A remanufactured part is given the same warranty as a new part, and it clearly identifies the part as a remanufactured part and states the remanufacturer.*

Currently, a new ISO "Technical product documentation — Design for manufacturing, assembling, disassembling and end-of-life processing — Part 2: Vocabulary"[103] is under development. It is planned that remanufacturing definitions will also be addressed in this document.

The above clarifies that there are different options for the definition of remanufacturing and also processes underway to harmonise the definitions used by various actors. To support the practice of remanufacturing. The Commission should introduce a definition into the legal regulations. Ideally, this definition should be in the line with ISO standards and definitions converged by the automotive sector. As a minimum, the definition should refer to the general process steps that remanufacturing can include and to minimum warranty needing to be identical to that of a new part.

At present, components removed from ELV could be classified as waste, adding to the administrative burden of the remanufacturing process: The legal ambiguity over remanufacturing varies among different jurisdictions particularly around shipment of products and cores considering them as waste, rather than as potentially high value inputs into a (re-)manufacturing process. The transport of waste is significantly costlier and more restrictive (or in some cases even prohibited). Changes are necessary in EU regulation to **recognize the differences between cores and waste**, thus: *the ELV components (products and core) shipped for remanufacturing[104] shall not be considered as waste to avoid obstacles with their trans-national shipments*.

The future legislation of ELVDs is to introduce **provisions to facilitate the dismantling**, appropriate sorting at the source, packaging, labelling (for reuse and remanufacturing) and transport of used components intended for this practice. For this purpose:

- Article 8 is to be amended, requiring OEMs to provide ATFs with information on how to remove components with a high reuse and remanufacturing value from the vehicle without damage to the component. Article 6 will be amended to oblige ATFs to ensure the

[102] An industrial process is an established process, which is fully documented, and capable to fulfil the requirements established by the remanufacturer.

[103] ISO/DIS 8887-2 Technical product documentation — Design for manufacturing, assembling, disassembling and end-of-life processing — Part 2: Vocabulary

[104] Intended to become a remanufacture product

appropriate packaging, labelling and transport of any components targeted for remanufacturing processes,

- A list of components with high potential for re-use and remanufacturing is to be introduced into Annex I (or an alternative legal communication) and referred to in any obligations related to provision of data on the dismantling of parts (more about this under 2.1.5.3.6).

These provisions shall be aligned if needed with requirements for the classification of components according to new definitions in ELVD and WFD and with respective requirements of the Shipment Regulation.

The amended ELVD shall also allow **monitoring the type and share of used or remanufactured components**. This obligation will be introduced into Article 9 and into respective legal documents (on the reporting methodology) requiring MS to report on the extent of reuse and remanufacturing in their Member State. This is to be facilitated through the general requirements for ATFs to report on components dismantled and sent for reuse as parts or to remanufacturers. The provision is to be combined with the reporting on 'direct re-use' and 'overall re-use' of vehicles' components (more about this under 2.1.5.3.6).

Specific provisions shall support **use of reused and remanufactured components** either in the repair of vehicles instead of newly manufactured parts or in the construction of new (or remanufactured) vehicles. There are further issues with use of remanufactured parts:

1. that the terms and definitions of remanufactured parts should be included in the 3R Type-approval Directive if it remains an independent Directive, and

2. that a new category of vehicle – 'remanufactured'[105] in addition to 'new' and 'used' – may need to be considered together with their definitions.

However, as shared by a car manufacturer representative, the current legal **definition of a new product** does not allow inclusion of remanufactured parts. This means that legally, at present a new vehicle may not contain remanufactured elements; the entire vehicle must be made from new components, though these can use recycled materials. This legal issue is not specific to vehicles. This legal limitation restricts the sale of remanufactured vehicle parts to the repairs market.

On the other hand, from a technical perspective, remanufactured vehicle parts are certified as equivalent in functionality and reliability/safety/etc. to new parts and could therefore be acceptable for use in new vehicles.

The other challenge is that there is a limited feedstock of remanufactured parts because of the long vehicle lifetime meaning that the current ELVs do not offer many parts for remanufacture.

For electric vehicles (EVs), the motor and batteries often have longer lifetimes than the vehicle itself, while the technology of other components and materials is still evolving. However, for EVs, even though the motors may be recovered (since 2013), they cannot easily be installed in new vehicles because of developments in weight, size and power. EV batteries from Renault are already in their third generation and upgrading an older vehicle with newer

[105] The consultants are not aware of references to "remanufactured vehicles". This concept exists for EEE, such as refurbished electric devices (e.g., mobile phones, computers) but also medical devices and electron microscopes that, like vehicles, are complex devices with long design phases. Though one could say that a used vehicle repaired with remanufactured parts could be considered to adhere to this concept, in the refurbishment of medical devices, equipment would be considered as such when not just remanufactured parts have been used to repair faulty ones, but when the responsible economic operator has checked the vehicle for functionality and ensured that any repairs or updating of software has been carried out to ensure that it is "as good as new" in terms of functionality and thus also in terms of warranty. This concept is thus considered to be different from a standard used vehicle and to have additional advantages for the consumer.

technology (e.g., a newer battery) raises type-approval issues and requires other parts to be exchanged.

In the latter issue, the proposed new category 'remanufactured vehicle' would have a different pricing scheme from the other categories. And then another issue would arise with how to handle vehicles that are primarily new except for a remanufactured engine, i.e., only one or few remanufactured parts.

The demand for a 'remanufactured' category could be investigated and then the legal and technical issues would need to be discussed and resolved. Overall, the issue of how to more broadly use and encourage remanufactured vehicle parts is seen as stemming from restrictive legal definitions. Since in some countries it might not be allowed to use spare parts in the construction of new vehicles, the provision shall consider that fact.

The other burden in use of remanufactured/used components to repair damaged vehicles (barely new one) is **warranty** issue. For some Member State, the role of vehicle warranties that is given by the OEM or by the economic operator that places the new vehicles on the market is not fully document. Based on the feedback from stakeholder during the workshop, the warranty might be declined or shortened once damaged vehicle is fixed with used/remanufactured component.

Expected outcome: Introducing correct definition will promote remanufacturing and help distinguish it from practices that do not achieve a minimum quality. Moreover, as already listed in the expected outcome for measure 2.2.a about clarifying the definition of re-use etc., clarity on the status of removed components from the vehicle will facilitate their transport for reuse and remanufacturing by limiting administrative burdens of their shipment (also trans-national). It is expected that more components will be reused or remanufactured as well as their service life being extended. A possible limitation of use of remanufactured components may occur in the case of their application in broken newly manufactured vehicles and in construction of new vehicles since this issue is not legally clarified and for some OEMs is not considered as an option (due to definition of new vehicle). However, as described above, whether it would be possible to have an entire car from remanufactured parts is rather unclear. Additionally, some components of ELVs cannot easily be installed in new vehicle. These technical burdens possibly significantly influence the option to use remanufactured/used components in new vehicles.

2.1.5.3.3 2.3.c) Voluntary activities of OEMs and their suppliers to promote the application of reused and remanufactured components

EU product classification, which would distinguish between remanufactured, used and newly manufactured components could help increase the awareness of consumers to the applicability of such components and subsequently will potentially increase the demand for partly or fully reused or remanufactured components. The vehicle production sector should be encouraged to develop a clear classification of such components into the groups, based on the identity of the manufacturer (e.g., OEM, third party), process specifications (e.g., new manufacture, cleaning, testing, repairs) and the quality specification (e.g., warranty). The classification could be used on marketed components through the labelling of products, also distinguishing between components manufactured by authorised operators and those marketed by illegal facilities. Such a scheme could distinguish between:

- newly manufactured OEM components,
- newly manufactured supplier (not OEM) components,
- remanufactured components,

- reused components processed by an ATF.

Expected outcome: Clear differentiation between various levels of reuse should assist consumers in purchase decisions for replacement parts and in the long run could also promote the application of used parts in new vehicles (i.e., or in remanufactured vehicles). The possible limitation of use of remanufactured components might occur in case of newly manufactured vehicles since in some of the Member States it might not be allowed to use such components in the construction of new vehicles. However, labelling of components of ATFs etc. could help tackle the problem of illegal sales.

2.1.5.3.4 2.3.d) Voluntary activities of Member States to promote circularity

To support circularity, the future legislation of ELVs shall refer to activities that MS are encouraged to embark on as a means (Good Participatory Practices) of supporting the circularity of vehicles, including the following:

- Introduce incentives or financial benefits (e.g., reduction of VAT rate on labour costs for employees or reduction of taxes) for products that contain remanufactured products or for remanufacturing operations,
- Introduce criteria into green public procurement guidelines that promote the use of reused and remanufactured components, for example:
- In relation to vehicle services: criteria that favour insurance policies of vehicles that commit to the use of reused/remanufactured parts when available,
- In relation to the purchase of vehicles: criteria that favour of vehicles assembled with a minimum share of remanufactured parts (i.e., remanufactured vehicles).

Expected outcome: Good Participatory Practice may have an added benefit of raising employee awareness to reuse and remanufacturing practices. However, implementation of Good Participatory Practice rules is an individual decision of MS.

2.1.5.3.5 2.3.e) Establish provisions to support the market of used spare parts

Though various components have a high potential for re-use and remanufacture, ATFs (as also repair shops and garages) will only dismantle and prepare for reuse components for which they observe there to be a sufficient market demand. In some cases, the demand is related to the quality of a component (e.g., there is low demand for components that have very few malfunctions as they do not need to be repaired and for components that have many malfunctions as the ATF cannot guarantee minimum warranty). But for most components, demand could be increased by ensuring that consumers are aware of the option of reused and remanufactured components as alternatives to new ones and as to their related advantages (reduced costs).

The goal of this measure is to increase the market demand for used and remanufactured components. This is possible when:

- The price of used components is significantly lower than that of newly manufactured components.
- The price of used components, which is linked to a market demand, can cover the costs of dismantling and any operations performed to enable reuse/remanufacturing.
- There is easy access for the consumers to the used and remanufactured components (i.e., through repair shops and garages).

- The situation of components being offered on the market by unauthorised dismantlers can be eliminated (these are often offered at lower prices as the economic operators perform illegal dismantling and have lower operation costs than those of ATFs).

As part of its Circular Economy legislation[106], France established an obligation to increase the demand for reused/remanufactured components in 2018: car repair shops must make an offer to repair a vehicle with used components in parallel to the offer to repair it with new components.

There are also a few examples of insurance companies, which voluntarily opted for a proactive policy for a sustainable management of ELVs[95]. This includes, for example, the establishment of partnerships between an insurance company in France and a network of qualified ATF and repair companies, to increase application of reused/remanufactured components. For this purpose, the insurance company has been requesting every partner to systematically dismantle economically irretrievable vehicles older thar 8 years and vehicles technically irretrievable (i.e., classified by the insurance company as a "total loss" after an accident). Dismantled used components from these vehicles can then be proposed by the company to its insurance policy holders to repair their vehicles in cases that the repair is performed under an insurance policy. The procedure assumes that the partners dismantle mainly economically valuable components. Since the majority of irretrievable vehicles are vehicles after collision accidents, the insurance company mainly deals with components such as bodywork, doors, and optical elements. Since 2012, the insurance company managed to increase the application of used components systematically every year, so that the initial target to repair 10 % of the 300 000 insured vehicles with re-used components by 2022 was already achieved in 2020. Aside from the environmental benefits of this practice, it has additional economic and social advantages, as it allows offering lower insurance policy costs to vehicle owners that agree to repair their cars with used spare parts (in cases of insured repairs).

Currently, there are no legal restrictions on the online sales of used components. Lack of such restrictions promotes illegal facilities, since the used components from non-legal operators can be offered for sale at lower prices than the those offered by authorised facilities[107]. The goal with this measure is to promote legally operating treatment operations. For this purpose, in some countries, the authorities will need to set up partnerships with online sales websites to ensure that used components sold through the webpage are only sourced from licensed ATFs[108].

The possible provisions to be added to the future legislation of ELVs to support the market of used components are:

- To increase the **demand for used components** on the market:
  - *Introduce an obligation in the future legislation of ELVs that car repair shops must provide customers with an offer to repair a vehicle with used/remanufactured components alongside offers to repair the vehicle with new components.*
  - *Introduce an obligation for insurance companies to offer car owners discounted policies if they agree that repairs are performed with reused/remanufactured parts when these are available*
- To effectively **ban the online sales** of used components by illegally operating facilities (as also by private individuals):

[106] Arrêté du 8 octobre 2018 relatif à l'information du consommateur sur les prix et les conditions de vente des pièces issues de l'économie circulaire dans le cadre des prestations d'entretien ou de réparation des véhicules automobiles

[107] ATFs must comply with the ELV minimum standards which increases the operating costs of such facilities.

[108] Example between the UK authorities and eBay: Environment Agency joins forces with eBay to stop illegal vehicle breakers

- *Enable traceability of the origin of reused components offered for sale by introducing an obligation for retailers (including online sales) to provide the vehicle identification number (VIN) together with the components details at the point of (online) sale.*
- *Introducing an obligation to provide the registration number of the dismantler together with the components details at the point of (online) sale.*

Expected outcome: The market for reused components is dynamic – increasing demand is assumed to provide more flexibility to ATFs to decide on components to be dismantled as opposed to measures for increasing supply which could result in a high burden for storage without significant impact on the actual reuse/remanufacturing of components. Measures for insurance companies may only be implementable through national legislation. Strengthening the market demand for reused components will increase the profitability of dismantling relevant components. Provisions on online sales will reduce sales of used components from illegally operating facilities, increasing profitability of legally operating ones.

2.1.5.3.6 2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing

Currently, the ELV Directive addresses reuse and recycling under a combined target. The share of reuse reported by the Member States varies between zero and more than 30 %, possibly caused by different reporting methodologies.

In the OPC as well as during the targeted consultations, the opinions of stakeholders on the implementation of a separate reuse target were divided. A significant number of stakeholders did not support a separate target but rather indicated the following measures as a means of contributing to the reuse of vehicle parts:

- Obligations for repair shops to offer customers used components as an alternative to new ones.
- Obligations for ATFs to remove certain components of ELVs before shredding to help increase reuse.
- Obligations for car manufacturers to enable (e.g., the ATFs) unlocking components so that they can be reused and dismantled.
- Obligation for car manufacturers to provide the dismantling centres (ATFs) information about which components can be used as identical parts in other models of the manufacturer or even other brands.

Among stakeholders that supported the idea of implementation of separate reuse tartes, the majority of them was for introducing these targets for specific vehicle components such as the combustion engine and car headlights instead of implementation of a separate reuse target by weight of the reused components compared to the weight of the vehicle.

A common stakeholders' opinion is that the reuse of specific components is market driven. Additionally, imposing mandatory dismantling of about 20 years old vehicle components where there is no market for reuse would not be economically viable. A requirement to remove components for reuse from ELV might increase only operation costs for the ATFs (time-intensive removal and storage of removed parts) and have no additional benefits if there is no demand for these components. As manufacturers would have to pay for this expenditure, the price for dismantling at end-of-life would in the end be shifted to consumers through the sales price of new vehicles, as well as it would impact the positive value of ELVs (EuRIC (2022c)).

Various actors claim that the removed components could be counted towards recycling instead of for a reuse target (for more information please refer to measure point that refers to 2.1.5.4.2).

Considering the above opinions, there are two possible options that could be implemented together or separately (preferably together) to improve share of ELVs components for reuse/remanufacturing/preparing for reuse by setting out:

Adding an annex to the future legislation of ELVs with a **list of components** that are relevant for reuse and remanufacturing. This list will be referenced in the type approval for the obligatory provision of information by OEMs on the dismantling time and method (see 2.1.5.1.4). This list shall be revised and updated from time to time. Obligatory reuse targets could be set for these parts in the future if the rate of reuse remains low, i.e., we do not propose a target for specific components at this point, under the assumption that the measure for increasing the market will suffice but include the option for adding such targets in the future if in the reporting (see below) it is observed that the level of reuse is lower than it could be expected to be. We would like to confirm that this is in line with the EC options. Possible condition for the removal of components for reuse might be also the age of the vehicles, e.g., 15 years.

A yearly reporting obligation of a list of removed spare parts together with a declaration as to the shares (total number per part and respective shares of operation) of these parts which were prepared for re-use/sold for reuse or remanufacture/ recycled in that year. All removed components should be detailed and not only those listed in the annex referred to under point 1. Obtained information will allow a better understanding of the potential for reuse and how it is influenced by measures that affect market demand. It will also help in the future in the revision of the list of removed spare parts for reuse as well as to set out the targets (point 1). Introduction of the yearly reporting list for removed parts will also require revision of Commission Decision (please refer to point 0).

The following preliminary list of components is to be considered for this purpose:

- Engines (combustion and electric)
- Rear and front lights
- Bumpers
- Tyres
- Gear box
- Alternator
- Exterior mirrors
- Doors
- Fenders
- Clutch
- Brake callipers

Expected outcome: Harmonising monitoring will allow understanding the actual volume of reuse in different MS and will enable the comparability of monitoring data. Additionally, combination of both sub-measures assumed to result in a more significant impact. However, separate reporting on components sold for reuse/remanufacturing could create a relevant burden for ATFs if it cannot be linked to list of sales, thus it requires developing of an effective reporting list.

2.1.5.4 Measures to achieve specific objective 2.4: Increase the recycling rates of materials and components contained in cars

Despite general provisions to require recycling, the ELV Directive does not sufficiently address this waste management route, including through the eco-design of cars to facilitate recycling. The potential to increase recycling and ensure a level playing field for high quality recycling is not realised. The following section thus details measures under consideration to increase the rate of recycling of vehicle materials and more importantly to promote their high-quality recycling.

2.1.5.4.1 2.4.a) Align definition of 'recycling' with the WFD

The ELVD defines recycling as the reprocessing in a production process of the waste materials for the original purpose or for other purposes but excluding energy recovery. Energy recovery means the use of combustible waste as a means of generating energy through direct incineration with or without other waste but with recovery of the heat.

In this sense, the ELVD definition for recycling excludes energy recovery but does not exclude backfilling, as is the case under the Waste framework Directive (WFD). This results in some MS including shredder heavy fraction (SHF) used for backfilling[109] operations in the accounting to show compliance with the ELVD reuse and recycling target. This statistical inclusion as recycled material is not in line with the Waste framework Directive (WFD) definition of recycling and results in an unfair comparison on the achieved targets in the various MS. It also means that there is an untapped recycling potential in the MS that report backfilling in this context.

In the OPC most stakeholders (56%) agreed that the ELV definition for recycling should be aligned to that of the WFD as this would support a higher level of material recovery. Aside from the automotive producers that were mainly neutral, the majority in all stakeholder categories supported an alignment. Only 3% disagreed with this statement, however there was also a large share of stakeholders that were neutral (40 individuals) or that did not have an opinion (31 individuals) making for a total of 40% together with those that did not specify an answer (13 individuals).

Towards this end, it is essential to align the ELVD with the WFD definition for 'recycling'. The WFD definition for recycling should replace the current one. The WFD definition reads (Article 3(17)):

> *'recycling' means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;*

This would also mean that any future decisions to take place under the WFD as to which technologies count towards recycling would automatically apply also under ELV.

It is important to note that some shredder output fractions are used for road surfacing in landfills or for filling underground mines. Some countries consider these operations as recycling, as this shredder output fraction replaces a new / non-waste material.

<u>Expected outcome</u>: Increase of coherence with WFD. To allow MS to be able to prove compliance with future recycling targets, in some cases (e.g., where backfilling is applied or other treatment methods that result in downcycling) they may need to promote the implementation (in some cases also development) of other treatment methods that would be classified as recycling. Depending on how the alignment of the definition 'recycling' with WFD is performed (only backfilling or also other downcycling treatments) it will either have a

[109] Article 3(17a) of the amended WFD (Directive 2018/851) defines backfilling as "any recovery operation where suitable non-hazardous waste is used for purposes of reclamation in excavated areas or for engineering purposes in landscaping. Waste used for backfilling must substitute non-waste materials, be suitable for the aforementioned purposes, and be limited to the amount strictly necessary to achieve those purposes

marginal affect (exclusion of backfilling) or will potentially lead to higher quality recycling (exclusion of all downcycling treatments). In MS in which downcycling has been accounted for as complying with the targets, this is likely to require investments in the development of alternative treatment routes.

2.1.5.4.2 2.4.b) Making it mandatory to remove certain parts/components before shredding to encourage their Reuse and recycling

The typical treatment of ELVs, after their collection, usually includes the following steps:

- de-pollution of relevant components and materials (referred to in Annex I (3)) from ELVs in an ATF:
  - final treatment (final treatment) of depolluted fractions by dedicated recyclers,
- dismantling of relevant components (Annex I (4)) from ELVs in an ATF;
  - preparation for reuse of relevant components, sometimes including remanufacturing,
  - recycling of removed and sorted fractions by dedicated recyclers,
- shredding of depolluted ELVs in a shredder facility (not always ELV dedicated)
  - resulting outputs (after shredding) are either disposed of or treated in post-shredder technology (PST) facilities.

The removal of parts from ELVs prior to shredding is a precondition for increasing their rate of reuse. It also supports higher quality recycling in some cases, e.g., where it is not feasible to recycle a certain fraction after shredding (e.g., neodymium magnets) or where such recycling is limited in the quality of secondary raw material that it can achieve due to a high level of impurities (e.g., aluminium). The ELV Directive sets out minimum technical requirements for treatment of ELVs to promote reuse and recycling (Article 6(1) and (3) and Annex I(4)) that are not sufficiently precise and thus have limited effect on reuse[95] and on the quality of recycling operations. To begin with Annex 1(4) requires the removal of components to "promote recycling". Though this can indirectly support reuse in some cases, reuse is not specified as the objective. Furthermore, currently provisions do not mention at which stage of the treatment the removal of certain components (e.g., catalysts and glass) should take place (meaning that shredding can be used to remove them from other fractions), thus limiting the possible output fractions. The conditions set for other specified materials and parts, e.g., metal components, tyres and large plastic components, enable shredding as long as the material can be "effectively recycled", however without setting criteria so that downcycling is not prohibited. Additionally, the list of parts/materials to be removed before shredding is rather limited. Stakeholders have mentioned additional parts for which removal prior to shredding enables reuse or higher quality recycling such as electric and electronic components, engines, and others. In these cases, the decision to remove is rather motivated by economic considerations (market prices for materials, available dismantling equipment and labour costs) as well as legal differences between MS. Elaborating the existing provisions, to include additional components and clarifying when removal is to be performed prior to shredding would increase the potential for reuse[110] and for high-quality recycling.

In the OPC the vast majority (67%) of stakeholders agreed that the ELV Directive should require the removal of certain parts from ELVs prior to shredding to promote their high-quality recycling.

[110] Some dismantled components can be readily reused, while others require remanufacturing to be performed to enable reuse.

Nevertheless, during the stakeholder workshop, some stakeholders stated that dismantling is not always required for high-quality recycling. It was raised that post shredder treatment can also achieve high recycling levels. This depends on the facility and technology applied, since the PST are not established evenly across the EU and though there may be technologies that can achieve high recycling levels, this will only deliver results where such technologies are indeed applied.

Resulting from the research and feedback from stakeholders, this measure would only be relevant for some components and materials. To give few examples:

For glass some studies show that dismantling and separate recycling could lead an increase in circularity due to an improvement in the quality of recycled material and supposedly respective environmental impacts. Dismantling and separate recycling however have been said to not be economically viable, mainly due to the transport costs. However, there are countries that do this (required by law in the past, supported with financial compensations, etc.) and thus it is assumed that the environmental benefits set off the economic costs (i.e., the practice is not far from economic viability).

In some cases, components, for example those mainly composed of steel, can be dismantled prior to the shredder, but an initial analysis (presented at workshop) of specific components suggests that this does not lead to a significant benefit in terms of the share recycled (environmental gains), whereas the dismantling and transport will at times make sense (e.g., at times of high market price for primary steel) and at times will not due to market fluctuations. In other words the proportionality of the measure for steel will be volatile as is the market. FEAD (2022) confirms that "separate recycling of steel components (prior to shredder) would have a small impact on the quality of steel" that is recycled.

For aluminium, obligatory dismantling will make sense for some components (depending on size, dismantling effort and effect on quality of recyclate) but not for all. This is for example the case today for wheels (in the past cast alloys were used but nowadays for weight reduction more technical cast as also wrought alloys are used): they are dismantled from ELV and sent directly to recycling and their value is comparable to the value of primary aluminium (European Aluminium 2022). When it comes to aluminium components, according to (European Aluminium 2022), it is already common and best practice to dismantle wheels and engines before shredding and to recycle them separately. Obligations to dismantle the following components would support high-quality recycling: bumpers, engines, heat exchangers, wheels, mono-material aluminium components separated into cast and wrought alloy with a weight above 10 kg.

In this regard, to ensure that certain parts are removed prior to shredding, provisions in the future legislation for ELV should be revised so that it is clear for which components removal is to take place prior to shredding. Furthermore, the list of components for which this is already obligatory should be extended. The following preliminary list of components is to be considered for this purpose:

- Windshield, rear and side windows composed of glass
- Engines,
- Main wiring harness (copper) and other large mono-material copper components,
- Electric and electronic components above a certain size (some copper and precious metals),
- Mono-material aluminium components with a weight above 10 kg, requiring the separate collection and treatment of cast and wrought aluminium, e.g. bumpers, engine block, wheels, heat exchangers,
- NdFeB magnets when the engine is not prepared for reuse/remanufacturing (still to be reviewed).

- Materials benefiting from a derogation from compliance with the ELVD and 3R Type approval Directive provisions on the reuse, recycling and recovery targets, in cases where the material cannot be recycled at EoL.

For components already specified in annex I (4), revisions are to be considered to ensure that removal is performed prior to shredding and where relevant to specify separate treatment, for example: as big plastic parts (e.g., bumpers, dashboard), tyres, glass (e.g. front and back windshield), catalytic converter system, batteries, airbags…

It may also become necessary to add in the future components that might have a negative effect on the residues of shredder/PST fractions.

Removal of parts from ELVs prior to shredding is not just a precondition for high-quality recycling but can also contribute to increasing the reuse rate. It should thus also be possible to revise the list of parts/materials to be removed before shredding from time to time, particularly should the market situation (demand for components for re-use) suggest that the removal of additional specific parts should be promoted (please refer also to point 2.1.5.3.6 in regard to the list of components that are relevant for reuse and remanufacturing). In parts removed for reuse, they will be checked by the ATF to decide whether they can be prepared for reuse (depending on condition and market demand) or whether it is more beneficial to send them to separate treatment (e.g., the value of steel scrap sold to a recycler can be higher at times than the value per kg of ELV scrap sold to a shredder). As an example, an engine removed prior to shredding will be checked to decide if it is fit for reuse. In cases of low market demand or bad condition, it may be sent for recycling instead of reuse. According to one of the stakeholders, dismantling of such engines – despite additional costs – would be economically viable, since the revenue for the ATF is often higher when the engine is sold directly to the smelter than when it is sold to the shredder facility.

Nonetheless, the provision to remove some components/materials prior to shredding may increase the operating costs for ATFs, where the revenues generated from these activities are not offset by their costs. This should be addressed as part of an EPR scheme to support the treatment of ELVs and the prevention of waste (see proposed measures under section 0).

Expected outcome: Prioritising dismantling of components with a high potential for increasing quality and/or quantity of recyclates will increase availability of secondary materials and probably also their use in the manufacture of new vehicles. Additionally, measures will contribute to reuse where components have potential for both reuse and recycling. Increased dismantling and sales of separate fractions will increase complexity of ATF logistics and could affect their profitability.

2.1.5.4.3 2.4.c) Set material-specific recycling targets for a selection of materials

Many different materials are used in cars, but their treatment at end-of-life differs. Steel, aluminium and copper are recovered to a large extent, but other materials are not. As certain materials, such as plastic and glass, account for only a small portion of the vehicle weight, they are often discarded and/or only recovered after shredding, leading to a reduced quality of the recovered material. Rare earth elements (REEs) are used for permanent magnets, platinum group metals (PGMs) for catalytic converters and printed circuit boards, gallium for lighting equipment and integrated circuits, magnesium and niobium for metal alloys, and natural rubber for production of tyres. Electric and electronic (EE) systems in vehicles also contain e.g., precious metals, gallium, tantalum, and REE.

Since at present the ELVD sets out an annual common (for all materials) recycling target based on the average weight of the vehicle, not all the materials used in vehicles are subject to the same high standard of recycling. While high-quality recycling can often be technically feasible and environmentally beneficial (e.g., of glass, selected plastics, electronic components), it is not performed in cases with low or lacking profitability. In some cases, this is due to the low efficiency of the technologies applied for recycling (also lack of advanced shredding and post shredding technologies) but in others it can also be connected to lacking pre-treatment (dismantling and sorting) of ELV components prior to shredding, to allow higher quality input materials for specific recycling processes.

The main goal of the proposed measures is to promote an increase in the quality of resulting recycled materials together with the increase of the amount of recycled material as opposed to forms of treatment of a lower hierarchy like energy recovery, backfilling or disposal. Additionally, the material-specific recycling target should also consider the materials and components dismantled from the ELV before shredding for reuse, remanufacturing, and recycling.

An effective way to ensure high-quality recycling, is to introduce a provision in the future legislation of ELVs that would allow considering only **recycled waste for the reporting on the recycling target**. In other words, recycling targets would be accounted for on the recyclates level, i.e., considering the mass recovered after recycling operations.

A similar approach was applied in the Packaging and packaging waste Directive, where only "the weight of packaging waste recycled shall be calculated as the weight of packaging that has become waste which, having undergone all necessary checking, sorting and other preliminary operations to remove waste materials that are not targeted by the subsequent reprocessing and to ensure high-quality recycling, enters the recycling operation whereby waste materials are actually reprocessed into products, materials or substances". It has also been applied to the WFD.

The definitions of "calculation point" and "measurement point" relevant for reporting of data on waste have been recently introduced through delegated acts, for instance in the amended Commission Decision of 22 March 2005 (Article 2)[111]:

> *(d) 'calculation point' means the point where packaging waste materials enter the recycling operation whereby waste is reprocessed into products, materials or substances that are not waste, or the point where waste materials cease to be waste as a result of a preparatory operation before being reprocessed;*
>
> *(e) 'measurement point' means the point where the mass of waste materials is measured with a view to determining the amount of waste at the calculation point.*

It is proposed to introduce similar definitions into the future legislation of ELVs (or in a revision of Commission Decision 2005/293/EC).

It would also be needed to specify the calculation points in this document that are applicable to certain ELV waste materials (e.g., glass, plastic). Doing so will require further analysis before their publication in, e.g., an Annex to the legislation or delegated act. Therefore, the introduction of the calculation point approach might need to be performed stepwise. Together

[111] Commission Decision of 22 March 2005 establishing the formats relating to the database system pursuant to Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste (2005/270/EC)

with the definitions of the calculation and measurement points, the possibility of application of 'average loss rates'[112] shall be introduced in the ELVD.

Additionally, to avoid down-cycling, it shall be required to set up a **provision defining the quality of obtained recycled material**, which is of high importance especially for glass (among the selected materials for which it is recommended to define material-specific recycling targets). In this regard, the recycled glass shall be of a quality that can be applied to produce glass products. In contrast, the definition of output of the recycling process for the plastics is still unclear since plastics can be chemically recycled (further detailed below).

Setting up the provision that recycling targets apply at the recyclates level, will subsequently most probably result in a decrease of the current total rate of re-use and recycling as well as re-use and recovery targets. Together with the material specific targets, these targets should also consider the efficiency of the recycling operation.

A new calculation methodology requires in-depth recognition of the outcomes from shredder and post-shredder facilities, which are sent further on to the recycler. As addressed under the measures in section 2.1.5.4.4, there is a need for standardizing the **shredder and post-shredder technology** and to obtain in-depth information on their capacities and input/output flows. Together with the introduction of the term 'calculation point' into the legislation, it will be required to assess the share of ELVs (broken down into selected materials) in the obtained recyclates but also in the residues of shredder/PST facilities that enter recyclers. This would probably have a high level of administrative burden (e.g., how to allocate parts or materials from ELVs). One possibility is to introduce a calculation approach on how to allocate the input materials that enter shredder/PST facilities to their outputs, to assess the weight of materials sent to recycling operations. Where it is not possible to assess the recycling losses, the 'average loss rates' shall be applied.

At present, **new recycling technologies** are under development and their recycling feasibility is still not clear. For instance, current studies indicate several ELV waste fractions as potential candidates for chemical recycling, e.g., polyurethanes (PUR) mostly used in car seats and granulates from tyres. It is of high importance for the Commission to study the technical and economic feasibility of chemical recycling in the context of ELV waste materials, however these technologies must still evolve further to allow considering what outputs they will result in and how this could be accounted for in the fulfilment of the ELV targets. The further development of this recycling technology and its successful applicability for shredder/PST outcomes could contribute towards the increase of the share of recycled materials, towards their energy recovery or disposal (in case it will not be banned).

New calculation rules will also require **adjustment of the existing reporting scheme** since recycling operators will be obliged to monitor and report on recycled materials. This will possibly require additional effort and time to implement.

Insofar the specification of this measure relies to some degree on the other measures to be implemented and how they may contribute to high-quality recycling for the various materials used in vehicles. This includes the measures: alignment of the 'recycling' definition (measure 2.3.a), setting up mandatory removal prior to shredding/PST (measure 2.3.b), regulation of shredder/ post-shredder facilities (measure 2.3.d) as well as common recovery/recycling targets and ban disposal (measure 2.3.e).

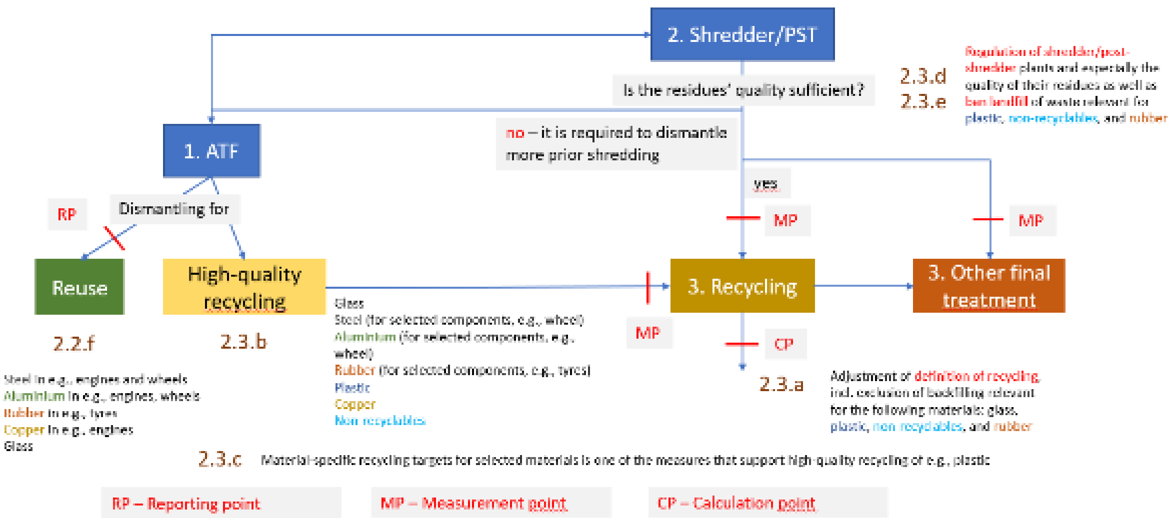
Resulting from the research and feedback from the stakeholders, there is a need to conclude what is the best approach (which measure or which combination of

[112] Delegated act of 31.08.2021 supplementing Directive 2008/98/EC of the European Parliament and of the Council with regard to rules for the calculation and verification of the weight of materials or substances which are removed after a sorting operation and which are not subsequently recycled, based on average loss rates for sorted waste.

measures) for each considered material. The following figure illustrates processes and conditions in the treatment of ELV in relation to the various measures and how they could relate to the monitoring of compliance with recycling targets and the calculation/measurement point. The diagram makes a first specification of which measures are considered to be relevant for which of the selected materials. It also includes possible calculation and measurement points for either recyclates or fractions to be recycled as well as a possible reporting point for components to be reused.

As already mentioned in the previous section (2.1.5.4.2), for some materials dismantling and separate recycling could be expected to have a significant contribution to improving the quality of their recyclates and a recycling target could be seen as an alternative measure that is less prescriptive as to how improvements are reached. Where recycling is already relatively efficient, like steel, a recycling target could increase the share of recycled material. However, it is not clear if the relation of costs and benefit would be proportional. Material-specific recycling targets could be of benefit for aluminium. However, splitting the targets for wrought and cast aluminium shall not be introduced, since monitoring of these targets will not be possible, i.e., the separation of cast and wrought aluminium after shredding is not performed in practice and it is not possible with the currently available analytic instruments to determine the % of wrought or cast aluminium in mixed fractions. The same is true for plastics (either in general or for specific polymers), textiles and rubber. However, setting up the targets for these materials might require further studies on the feasibility of chemical recycling for these materials as well as technological developments. Nevertheless, in this case, it may be possible to introduce the specific targets stepwise, so that in the second step after a few years the targets would be revised considering the new technological standards. In other words, different materials would be affected differently by the introduction of a recycling target, and even where this is not implemented, reporting on achieved amounts will need to apply a suitable method for ensuring that it reflects the actual treatment of vehicles and its circularity.

Figure 2-22 Objective 2: Processes and conditions in the treatment of ELV in relation to proposed measures



Source: own illustration

Looking at the figure above, setting targets in relation to the calculation point could promote reuse and recycling at higher quality. Introduction of calculation/measurement points for materials not under the specific targets, could also improve comparability of reported data among EU-countries and thus can be seen as an alternative sub-measure to setting a target together with the monitoring method. The intended calculation point for materials for reporting on actual recycling should refer to the recyclates obtained after recycling (losses are excluded). However, it would also be possible to apply 'average loss rates' in case where no data on recyclates is available. For instance, for glass the measurement point would require subtracting the average loss rate (ALR) from the amount reported for dismantling.

At present material specific targets are under consideration as follows:

- Glass – 70% recycling of a quality acceptable for container glass or equivalent,
- Plastic – 30% as of 2030 based on the introduction of the calculation point principle, or 40% is the current reporting scheme is retained.

Expected outcome: Material-specific targets could promote high-quality recycling. However, their feasibility needs to be verified with for each material separately, considering also other measures that could be more efficient in achieving similar results. The calculation/measurement point when applied on its own shall increase comparability of reported data, also generating data that could be used in the future to see where recycling targets should be considered for additional materials.

2.1.5.4.4 2.4.d) Regulate shredder/post shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process

After depollution and dismantling, mechanical treatment of ELVs takes place in shredders of metal waste. The input materials are crushed into smaller material components. Afterwards, the obtained smaller pieces are separated into metallic and non-metallic fractions. Typical process steps in a shredder are: 1. delivery, reception, and acceptance, 2. pre-sorting and pre-treatment, 3. pre-sorting, shredder technology, 4. post-shredder processes, and 5. end-of-pipe abatement techniques (Pinasseau et al. 2018).

The main output of the process is quality steel scrap (with high density, high degree of purity and predominantly homogenous size) which can be used directly in metal works to produce steel. The other obtained fractions are shredded non-ferrous fractions (containing other metallic products) and Auto Shredder Residues (ASR) containing the subfractions Shredder Light Fraction (SLR) and Shredder Heavy Fraction (SHF). These fractions can be further treated to recover as much material as possible and to minimise the amount of waste sent for disposal.

The possible further treatment of mixed non-ferrous output may be separation, for example by eddy current separations, metal-sensing or by dense media separation.

The ASR fractions can be further treated in post-shredder technology (PST) plants. Such further treatments of the mixed non-ferrous fraction and the ASR fraction can take place in integrated plants or separate (centralised) plants.

As demonstrated in several studies untreated SLF contains several percent of residual metals, representing up to 7.8 %, respectively 6.3 % (Sander et al. 2020) or according to studies performed more than a decade ago even 11 % (Duwe and Goldmann 2012).

Regarding the SLF a joint presentation of Ökopol and Umweltbundesamt (Germany) concluded (Sander et al. 2017):

"Typical disposal routes for the shredder light fraction are energy recovery or incineration, backfilling, the use as landfill construction materials, or landfilling. In the case of these disposal routes, functional recycling of the recyclable materials is mostly not carried out. Therefore, a limitation of the contained recyclables, in particular of the metals, seems appropriate."

A possible maximum metal content for shredder residues, which are destined for backfilling/ landfill construction, energy recovery/ incineration or final disposal/landfill sites, should be ambitious in order to recover as many metals as possible as secondary raw materials, and should orient themselves to the technical possibilities. The removal of metal from the shredder light fraction at least to below 1 % metal content by means of post-shredder separation (Tabel et al. 2011; Sander et al. 2017) is considered to be feasible.

In Switzerland, such an approach is already implemented: According to Article 21 of the Swiss Waste Ordinance[113], metal pieces are to be removed and recycled from the lightest fraction that occurs during the comminution of metal-containing waste (light fraction)."

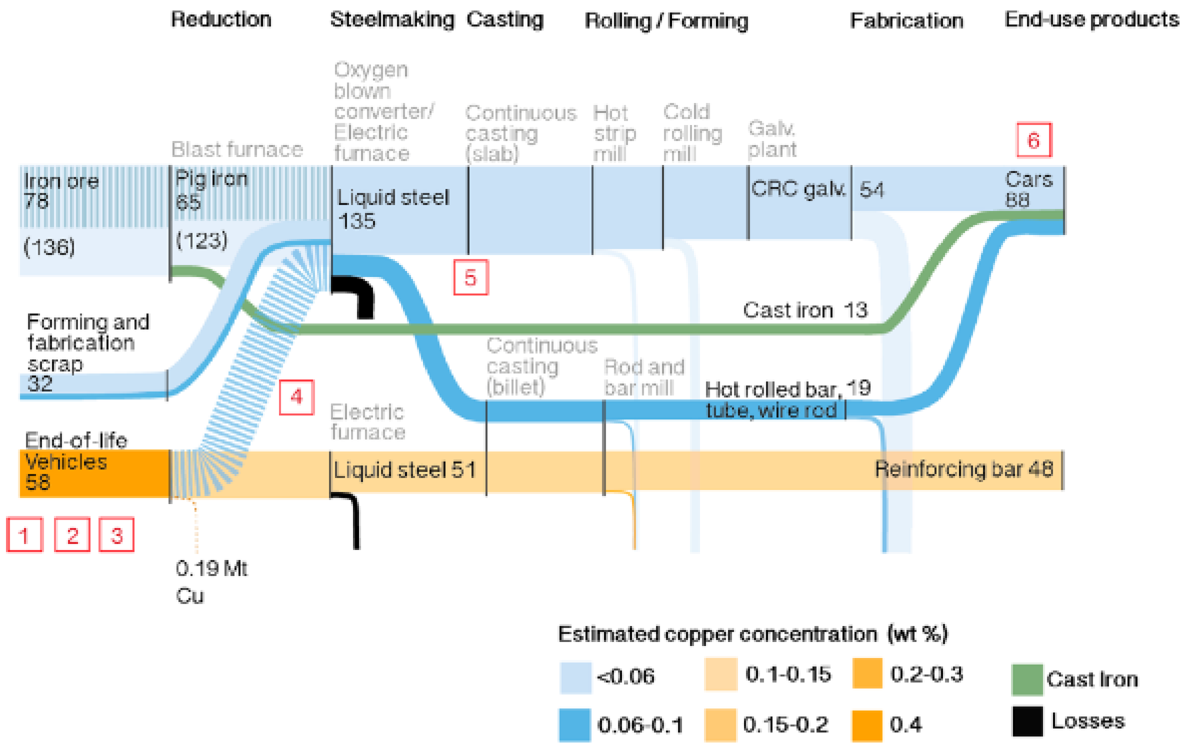
On the other side copper content in steel scrap destined for recycling, is considered an impurity of steel and may affect the portfolio of applications in which secondary steel can be applied (EUROFER 27.10.21). Copper content in shredder/PST deliverables is considered an impurity also for fraction rich in aluminium. Similar to steel, Eurometaux state that the dismantling of components with copper prior to shredding would allow secondary aluminium of higher purity. Impacts of copper removal related to dismantling of EEC and its contribution to purity of the aluminium/steel fraction are mentioned shortly under the impact analysis section for EEC see section 3.1.10.

Thus, this measure aims to set up a threshold on the maximum Cu-contamination on steel scrap, as main outcome from shredder/PST processes, could lead to higher quality secondary steel and aluminium as well as higher quantity of copper for recycling.

As outlined in the chapter 2.1.2.5.1 the Cu-contamination in steel varies and ranges between 0.2 to 0.7 wt %. Galvanized cold rolled coil require less than 0.06 % copper. The bards, tubes and wire rods allow up to 0.1 % copper. These are the main intermediate products in cars. High Cu-contamination requires dilution with virgin material or steel scrap with lower Cu-content. A theoretical closed-loop of ELV steel scrap (Figure 2-23) was analysed by (Daehn et al. 2017a) "using ELV scrap for the production of new vehicles would reduce the amount of iron ore required from 136 to 78 Mt, accounting for 32 Mt of fabrication scrap generated in car manufacturing." However, the closed-loop in automotive could be possible only when the Cu-contamination in steel scrap would decrease significantly (at the global scale this would require removing of 0.19 Mt of copper, assumed based on 2008 data).

[113] VVEA: Verordnung über die Vermeidung und die Entsorgung von Abfällen (Abfallverordnung, VVEA) vom 4. December 2015. Switzerland.

Figure 2-23 Steel mass flows (in Mt) corresponding to the production of cars and the recycling of end-of-life vehicles traced through the 2008 global steel system, both current practice and a theoretical closed-loop.



Legend: In the closed loop, indicated by dashed flows, ELVs are not used for reinforcing bar production. The red numbers represent technical interventions along the supply chain to achieve a closed loop: (1) more disassembly, (2) better shredding, (3) better sorting, (4) chemical extraction, (5) increase tolerance, and (6) reduce copper content.

Source: (Daehn et al. 2017a)

According to (Daehn et al. 2017b) about 80 % of the original copper can be removed in magnetic separation. However, alternative practices exist. For instance, Sicon claims to reduce the output of their improved shredding[114] to 0.1 % of copper concentration. The following figure (Figure 2-24) illustrate effectiveness (copper concentration achievable) to qualitative energy/cost for various technologies to separate copper. It also shows the scale of development of introduced technologies. Some of them are applicable copper separation routes from the steel melt not applicable by the shredder operation. Other, like high density shredding, O_2/Cl_2 gas are technics for copper separation from solid scrap, however not all might be possible to be applied by shredder facility (this statement would require further analysis). The most common separation methods and the methods that are in practice under certain conditions are not necessary the most efficient ones and can be actually also quite costly (quite high qualitative energy/cost). Methods that show higher efficiency (lower copper concentrations achievable) that seem to be not too costly need still scale-up development[115]. Thus, it would be recommended to introduce the limit on copper contamination in steel scrap (excluding homogenous steel that contains alloyed copper) stepwise and with transition time.

[114] High density shredding, which produces 40-50 mm pieces more regular in shape than the about 100 mm pieces from today's low density shredding.

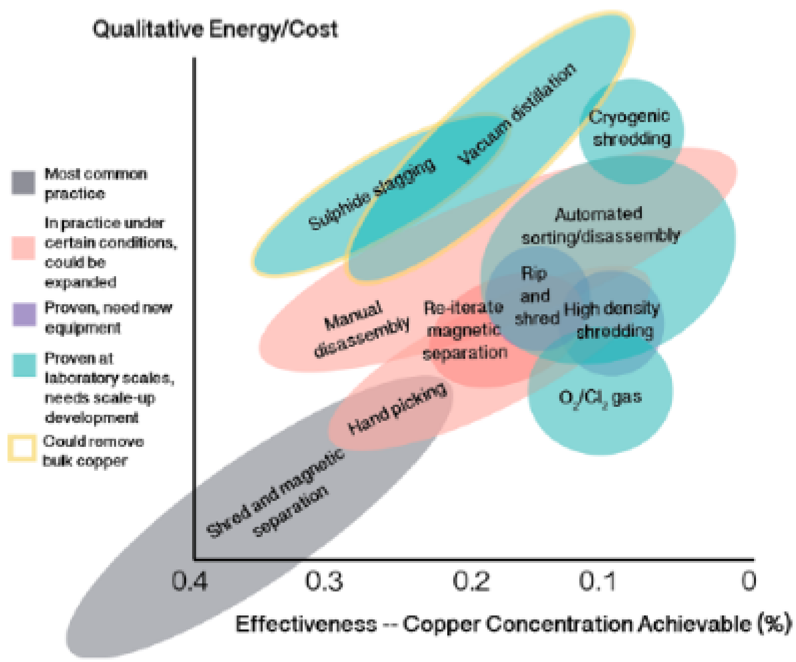
[115] Detail description of existing Cu-removal methos are in (Daehn 2019).

According to the European Steel Scrap Specification[116] that defines aimed analytical content of E40 steel scrap (output from the shredder), the aimed Cu-content is 0.25 %[117]. Additionally, sorting trials performed by ArcelorMittal with X-ray sorting machine (QXR TITECH) prove that it is possible to obtain Fe fraction with Cu-contamination lower than 0.25 % (obtained 0.209 %) from the shredded scrap with original Cu-contamination in a level of 0.655 %.

Thus, it seems technically achievable to set up a first threshold for average copper content of 0.25 %, which after several year could decrease, while in the meantime technology could develop. Nevertheless, it is possible to obtain the level of 0.25 % also due to improved dismantling. IRSID-USINOR & CTRA Study and presentation from ArcelorMittal[118] show that improved sorting dismantling of parts that contain copper prior to shredding significantly influence Cu-content after shredding of the dismantled ELV (see further details in the description of scenario 3 “Mandatory dismantling” under impact analysis of steel, section 3.1.5.2.4).

Additionally, an introduction of such provision would require also development of monitoring methods of the concentration of tramp elements in solid scrap since there are no nominal limits for this concentration (Daehn et al. 2017a). Institute of scrap recycling industries (ISRI) classifications do not classify the max. level of Cu in ferrous scrap[119].

Figure 2-24 Comparison by copper concentration achievable and estimated relative energy and cost of the discussed copper separation interventions.



Source: (Daehn et al. 2017a)

[116] http://ehrhardt-recycling.de/wp-content/uploads/2017/05/Stahlschrott-Sortenliste-Englisch.pdf

[117] The values retained for the analytical contents are those which have been experienced in real terms in the various countries of the European Union and are achieved by scrap yards working normally with standard methods and standard equipment.

[118] Russo, Philippe, Bollen, Jan, presentation on “Scrap for Decarbonized Steels” from ArcelorMittal, IARC – July 5th 2022

[119] http://www.scrap2.org/specs/20/

Under "non-normal operating conditions" smoke, dust and possibly dioxins may be released, e.g., by deflagration and or fire. Such conditions can be caused by fuel residues or Li-ion batteries left in end-of-life vehicles. The number of deflagrations varies from one shredder site to another.

For poorly managed shredders, 50 deflagrations per year are reported. An efficiently managed shredder is able to reduce the number of deflagrations to one per year (Pinasseau et al. 2018). The BREF Document for Waste Treatment (2018) defines detailed rules for the operation of shredders to minimise emissions under standard conditions and to minimise deflagrations and fire.

Currently, the ELV Directive defines minimum technical requirements for treatment operations for depollution of ELVs (Article 6(3) and Annex I (3)) as well as for treatment and for storage, which refer to dismantling processes performed by ATFs (Annex I (1) and (2)), nonetheless no such requirements for shredder processes (incl. post-shredder plant) exist in the current Directive.

Measure:

In this regard, the ELV Directive should introduce mandates for the EC to establish (e.g. by means of e.g. delegated act):

- 1) minimum operation requirements for shredder plants (regards implementation of the BREF standard, monitoring of explosions and dust emissions and application of measures to control input streams with the aim to minimise explosions to not more than once per year),
- 2) if 3 deflagrations per year are exceeded, the operating licence must be suspended until an optimised operating plan, including input quality control, is submitted to the licensing authorities.
- 3) minimum requirements for shredder/PST plants (regards technical concept and output qualities e.g., limiting the metal content of untreated SLF envisaged for disposal to 1% metal content).
- 4) national reporting obligations on:
    - national capacities of PST and
    - information on input/output flows, including information on the final use and indication of how much of the input materials comes from Auto Shredder Residues (ASR) in cases where plants treat multiple waste streams.

Additionally, the profitability/economic viability of the operation of PST is hampered by the volatility of market conditions for the output streams. It is, however, necessary to ensure removal of substances such as PVC or plastics containing flame retardants such as decaBDE. In cases where PST are not economically viable, the operators of the PST plants shall have two options how to deal with the output materials:

- to sell them to recyclers, or
- to request the EPR Scheme to take care of the output materials. Here two further options are under consideration, where the operator of the PST could offer the EPR scheme to take care:
    - only of selected output streams or
    - of all output streams.

Such requirements are to be linked to the measures described under section 0.

<u>Expected outcome</u>: Sub-measure should reduce losses of residual metals while ensuring a minimum level of performance of PST operations. Fractions that reach PST plants may differ in quality due to the techniques applied by shredders and may affect the effectiveness of this measure.

2.1.5.4.5 2.4.e) Increase (?) current re-use and recycling targets and/or ban disposal or landfilling of waste from ELVs

Originally it was contemplated to increase the common reuse and recycling target to 90% by 2025 and to 95% by 2030. However, for the purpose of the assessment, it is proposed to keep the targets unchanged, due to the fact that a higher recycling quote might not be in line with the main goal of ensuring higher-quality recycled materials. The provision indicated in section 2.1.5.4.3 proposing an approach in which recycling targets refer to the recyclates level (calculation point) could make achieving the current re-use and recycling targets more challenging for MS once the new calculation rules are applied. Thus, to ensure high-quality recycled material, it is proposed not to increase the common targets at this time. Final conclusions as to recommended targets should be based on the outcome of the impact assessment.

Additionally, it is proposed to introduce a ban on landfilling.

Ban of disposal or landfilling

The profitability/economic viability of the operation of PST is hampered by the volatility of market conditions for the output streams. It is, however, necessary to ensure removal of substances such as PVC or plastics containing flame retardants such as decaBDE.

According to the POP-Regulation (Annex V), POPs containing components must be separated.

Diverse studies report concentrations of PBDE[120] (as addressed by the POP Regulation) beyond 1000 mg/kg for several components of ELVs.

Due to the lack of information on components containing POPs in specific vehicles dismantling of components containing high concentrations of PBDE is not feasible. Even if information would be available, it is unrealistic to dismantle all these small components where POP might be included.

Today, the majority of materials (e.g., from textile, wiring harness) containing PBDE are directed to the Shredder Light Fraction (SLF), and when Post Shredder Treatment (PST) is applied, to the granulate with a specific weight > 1.3 g/cm3 (or > 1.2 g/cm3 different from plant to plant) which includes the PVC fraction as well. DecaBDE occurs at least occasionally in the SLF with concentrations beyond 1000 mg/kg.

According to POP Regulation (Annex V Part 1), disposal on landfills is not mentioned as a permitted option for disposal or recovery.

Article 7(4) of the POP regulation offers conditions for derogation. As mentioned above, SLF (if not further treated e.g., in PST) and PST granulate with a specific weight > 1.3 (or 1.2) g/cm^3 are occasionally at risk not to comply with the conditions for derogations.

Shredder fractions containing PBDE are not treated in compliance with the POPs Regulation, possibly leading to the landfilling of such fractions and accumulation of POPs in the environment.

[120] Including decaBDE

To ensure a consistent implementation of this aspect, it makes sense to introduce a ban on the disposal of ELV post shredder fractions to landfills and a ban on material recycling of these fractions for

a) the entire SLF, if not sent for further treatment to PST, and

b) the output fractions of PST with a specific weight of > 1.3 g/cm^3.

A ban of landfilling and material recycling of these fractions will have different effects:

If landfilling and material recycling is not allowed, the SLF (respectively the PST fraction mentioned) will be directed to waste incineration (D10) or energy recovery operations (R1) or to chemical recycling. Considering the high caloric value of these fractions such treatment is energy efficient and all these treatment options are higher in the Waste Treatment hierarchy.

However, there remains the risk that, if higher costs occur for the waste management of the fractions which are banned from landfilling and material recycling, that operators of shredders / PST plants seek to minimise these fractions and direct the POPs to other (non-regulated) fractions. If landfilling (and backfilling) will be banned for all wastes generated from the treatment of ELVs this effect can be avoided and make the separate recovery target obsolete (i.e., the distinction between landfilling and recovered fractions will no longer be needed).

It will simplify the operation of the shredders as they do not need to prove that POPs concentrations in the output fraction are below the “upper level” displayed in Annex IV of the POPs Regulation.

On a common disposal ban of untreated shredder residues or of treated shredder residues or of PST residues, which contain hazardous substances, OVAM (2022) think a transition period of 3 years is necessary.

Indicative outlook of impacts

A revised recycling definition (excluding backfilling) and a ban of landfilling / material recycling for the mentioned fractions will have relevant effects on the disposal routes e.g., a study[121] on the state of the art of treatment of hazardous substances in plastics and their impact on disposal provides first insights on the current disposal routes for Auto Shredder Residue (ASR) in Germany:

- “Shredder heavy fraction (SHF):
  - plastic content of SHF: 3.6-21.8% (1,550-9,400 t);
  - recycling: 100% (43,000 t);
- Shredder light fraction (SLF):
  - plastic share of SLF: 28-50% (27,660-49,400 t);
  - material recycling (mainly as mineral-rich fraction in mining backfill and landfill construction, in small parts mechanical recycling): 54% (15,000-26,660 t);
- Energy recovery (waste incineration / RDF): 38 % (10,500-18,70 t) (10.500-18.770 t);
- Landfilling: 8 % (2,200-3,950 t)”.

Expected outcome: Shredder fractions containing PBDE are not treated in compliance with the POPs Regulation, possibly leading to the landfilling of such fractions and accumulation of POPs in the environment. The ban removes ambiguity as to routes of disposal that comply with the POPs Regulation and will lead to treatment of POP containing fractions at a higher hierarchy (energy recovery rather than disposal).

[121] Polcher et.al (2020): Sachstand über die Schadstoffe in Kunststoffen und ihre Auswirkungen auf die Entsorgung; Publisher: BMU Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Germany).

by Umweltbundesamt UBA Texte 15/2020

2.1.5.4.6 2.4.f) Revision of Commission Decision 2005/293/EC on the circularity aspects

The reporting, performed according to Commission Decision 2005/293/EC laying down detailed rules for the monitoring of the reuse/recovery and reuse/recycling targets, does not provide sufficient evidence on the recycling rates achieved.

This is due in particular to the fact that the Commission Decision provides for different (non-comparable) options for calculating the recycling rate, that Member States do not interpret some terms of the Directive in a uniform way and that the current reporting requirements do not require information on the PST capacities available in each Member State.

Considering these aspects, the Commission Decisions should be revised as follows:

- Introduce a common methodology (in contrast to the current situation where different methodologies can be applied) for the calculation of the reuse and recycling targets, making the results comparable across the EU.
- Revision of the existing common methodology on how to perform a shredder campaign, by reflecting on the numerous shredder campaigns done in the meantime and also reflecting on the experiences in France, Belgium and the Netherlands to monitor continuously the shredder (and sector) input / output.
- Provision of a definition of Post Shredder Treatment (PST) including minimum quality requirements for certain output streams and reporting on established and used capacities of such PST plants (see details in section 2.1.5.4.4 above).
- Reporting on vehicle fleet and annual registrations and de-registrations is addressed in section 2.2.5.1.9 at page 166.

Most of the above-mentioned aspects are addressed in detail in a proposal for the revision of Commission Decision 2005/293/EC which was discussed with the Member States in 2018. A report is available to the EC with all detailed comments from the Member States[122].

Depending on the new measures proposed for implementation, appropriate monitoring of progress towards other targets with the aim of improving circularity (e.g., recycled content targets, material specific recycling targets and/or requirements for the reporting/measuring/calculation points, reporting on components prepared for reuse and/or remanufacturing rates, monitoring of PST plants) might also be included in the reporting requirements.

Expected outcome: Harmonisation of reporting method will help clarify the possible accounting for certain fractions and could help promote practices that lead to higher quantities and qualities of recycled materials as well as a higher level of harmonisation between MS in the future. Inclusion of monitoring on additional aspects will increase the burden of reporting for waste operators.

2.2 Missing vehicles

This section addresses unreported and/or illegal treatment of ELVs, unreported and/or illegal export of used vehicles or ELVs.

[122] Mehlhart, G.; Hay, D. (2019): Assessment of the comments of the Member States in relation to the draft proposal for the amendment of Commission Decision 2005/293/EC, commissioned by the EC DG Environment as an amendment to contract No 07.0201/2015/723374/ETU/ENV.A.2.

2.2.1 Introduction

Missing vehicles means that we observe difference in the input / output balance for the European vehicle park. We know the number of new vehicles placed on the market very well. Next, we have information on the size of the vehicle park (the stock), the actual registered vehicles. Eurostat provides information on the number of vehicles exported from the EU27 and data (as reported by the Member States to Eurostat) on the ELVs treated in ATFs. Comparing the stock and the input/output, it is obvious that the reported output does **not** reflect the total output in reality. As reported in previous studies the gap is between 3 and 4 million vehicles and the situation has not altered since a decade when the first study for this issue was commissioned by the EC.

The gap might have different reasons:

- Not all exported vehicles are reported
- Not all ELVs treated domestically are reported

Other reasons, including the following, are assessed by previous studies as not likely and not contributing significantly to the gap:

- new registered vehicles are overreported and
- imported used vehicles are overreported
- Vehicles are not registered any more (deregistered) and stored (e.g. by car dealers) but not exported nor scrapped.

Regarding the stock (size of the current EU27 vehicle park) it must be said that there is evidence that the stock is even overreported (too many vehicles are considered as registered e.g. in Poland) and this would even increase the number of missing vehicles.

More details on the findings from previous studies and the environmental, social and economic concerns connected with the high number of missing vehicles are provided in section '2.2.2 Current situation'.

The problem of illegal exports shall be assessed in this chapter as well. Illegal export does not necessarily contribute to the number of missing vehicles. For example, it is observed that a relevant number of vehicles are officially exported even though they are to be considered as waste (end-of-life vehicles) according to the guidance prepared by the correspondents of the Waste Shipment Regulation[123]. According to the findings from the evaluation of the End-of-Life Vehicles Directive, this is not simply a problem of national enforcement, but rather a problem of legislation, as the current conditions are not enforceable in practice.

2.2.2 Current situation

2.2.2.1 Missing vehicles

A number of studies have assessed the issue of ELVs of unknown whereabouts. Each of these studies has had a different focus:

- 'End of life vehicles: Legal aspects, national practices and commissioned recommendations for future successful approach' (Schneider et al. 2010), commissioned by the

[123] Used vehicles exported to Africa: A study on the quality of used export vehicles (2020). Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management. available at: https://www.ilent.nl/binaries/ilt/documenten/rapporten/2020/10/26/rapport--used-vehicles-exported-to-africa/RAPPORT-+Used+vehicles+exported+to+Africa.pdf.

European Parliament; 'End of life vehicles: Legal aspects, national practices and commissioned recommendations for future successful approach' (Schneider et al. 2010), commissioned by the European Parliament;

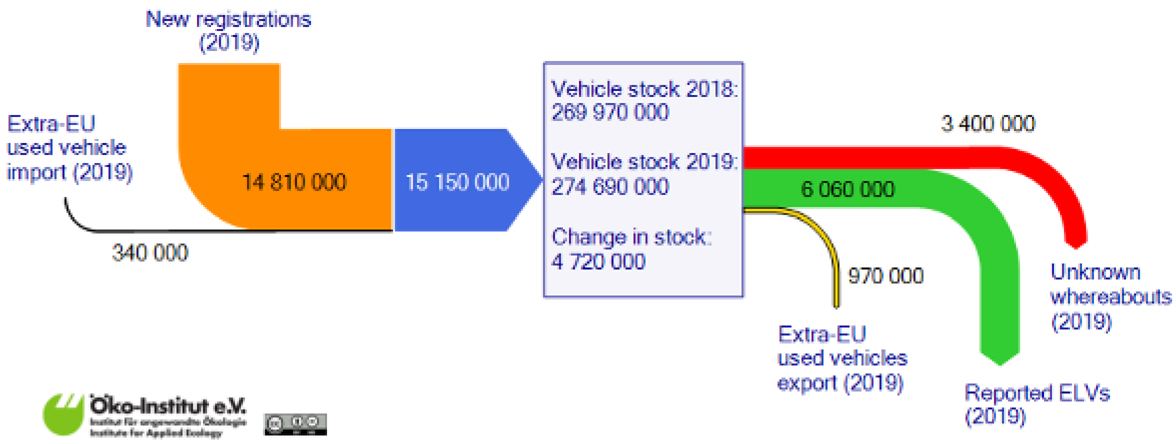
- 'European second-hand car market analysis', (Mehlhart et al. 2011), commissioned by the European Commission (DG CLIMA);
- 'Compliance promotion initiative to assess the implementation of Directive 2000/53/EU on end-of-life vehicles with emphasis on the end of life vehicles of unknown whereabouts' (Mehlhart et al. 2017), commissioned by the European Commission (DG ENV).
- 'Supporting the Evaluation of the Directive 2000/53/EC on end-of-life vehicles' (Williams et. al 2020), commissioned by the European Commission (DG ENV).

All these studies identified shortcomings in the registration and de-registration procedures in several countries, making it difficult to identify the correct number of ELVs generated in each Member State.

In the context of the Compliance promotion initiative (Mehlhart et al. 2017), a comprehensive stakeholder involvement was included and a discussion of potential measures to overcome the problem of missing vehicles.

In line with the methodology applied for DG Environment in previous studies mentioned above, we have updated the detailed input-output flows for 2019 and calculated it for EU-27 instead for EU-28. As displayed in Figure 2-25, 10.43 million vehicles exited the stock of registered vehicles in EU-27 (sum of the red, green and yellow arrows to the right of the figure), thereof 6.06 million ELVs were treated within the EU, 0.97 million were exported to non-EU countries and the whereabouts of 3.4 million vehicles is unknown.

Figure 2-25 Unknown whereabouts of vehicles (N1 + N1) in the EU -27 in 2019, excluding Bulgaria, Cyprus and Malta



Concept: Oeko-Institut
Sources: Eurostat: reported ELVs, extra-EU import and export, vehicle stock and new registrations only for BG, CY, MT; ACEA: vehicle stock and new registrations (excl. BG, CY, MT)

The table below displays estimates of how many vehicles are of unknown whereabouts each year in the EU. It is apparent that the situation has not substantially altered from 2008 to 2017.

Table 2-7 Results of the calculations for unknown whereabouts of vehicles for EU-28 excl. BG, CY, MT (2008- 2014) and EU27 excl. BG, CY, MT (2015-2019)

	Unknown whereabouts in million vehicles	ELVs treated (Eurostat)	Share of unknown whereabouts of total
2008	4.1	6.3	39%
2009	3.4	9.0	27%
2010	3.4	7.4	32%
2011	3.8	6.8	36%
2012	3.5	6.3	36%
2013	3.7	6.3	37%
2014	4.7	6.2	43%
2015	*	6.1	*
2016	3.2	4.8	40%
2017	3	5.3	36%
2018	2.8	6.1	31%
2019	3.4	6.1	36%

Source: 2008-2014 (EU-28): (Mehlhart et al. 2017)
2016-2019: update for EU27 for this report
2015: break in series

Efforts were made to model the amount of 'missing ELVs' per Member State (Mehlhart et al. 2017). This analysis would potentially be very interesting as it would show if Member State specific approaches on vehicle deregistration and export, such as those pursued e.g. by the Netherlands (online deregistration of ELVs (post CoD), by ATFs and no export without a roadworthiness certificate) were effective. However, the approach was a model calculation, which required multiple assumptions for each Member State (on vehicle stock and age of removal etc.) to be made. The results were not felt to be robust enough to demonstrate the effectiveness of measures such as those established in the Netherlands and Denmark.

From this analysis, it appears that the ELVD does not deliver the expected result of ensuring that all ELVs are treated according to the minimum requirements established by the Directive. To what extent this is an 'administrative issue' only and to what extent hazardous liquids and components are released into the environment is not known. A number of measures to overcome these shortcomings are listed in the study commissioned by the EC in 2016 (Mehlhart et al. 2017).

Article 5(3) of the ELVD does not effectively ensure that the last owner of the end-of-life vehicle has to deliver it to an ATF in exchange for a Certificate of Destruction (CoD). Article 5(3) says: 'Member States shall set up a system according to which the presentation of a certificate of destruction is a condition for deregistration of the end-of life vehicle.' Obviously, this paragraph is understood that a CoD is one option for deregistration and others might apply like export, stolen vehicle or use on private ground. Additionally, several member states also apply a kind of 'indefinite' off-road notification with automatic deregistration after a certain time but without further follow up of change in ownership.

ELVs of unknown whereabouts can occur for a number of different reasons, including export or non-reported treatment as displayed in Table 2-8. For each of the reasons the legal situation and the environmental concerns are assessed in the following table.

Table 2-8 Different reasons for ELVs of unknown whereabouts

Reason for unknown whereabouts ELV	Legal situation	Environmental concern
Non-reported export of used vehicle to non-EU-countries	The export of second-hand vehicles is permitted under European law, but failure to declare is a breach of the obligation to report to the customs authorities.	If the used vehicle is near to EoL, hazardous components might be harming the environment in the near future if not treated according to the minimum requirements applicable in the EU.
Non-reported export of used vehicle to other EU Member State	In some importing countries, import bans apply to used vehicles with different characteristics. Thus, undeclared exports could also violate the regulations of the destination country.	No direct environmental concern as long as treated in registered ATFs and shredders
Export of ELVs to non-OCED countries	Currently there is no obligation in force to report to the vehicle register of origin the re-registration in the country of destination.	Inappropriate treatment of hazardous waste might cause environmental harm. Illegal transfer might cause clean-up cost and compensation to the receiving country by the country of origin
Non-reported export of ELVs to other EU Member State. Treatment in the receiving MS in ATF or non-ATF. (Even if a CoD is issued, it is not forwarded to the country of origin.)	In the context of the car registration procedure there is a request to the register of origin if the car is stolen or other police information is registered. However, this communication is not necessarily introduced in the register of the country of origin.	No concern if the ATF operates according to its permits. The risk of environmental pollution is higher in non-ATFs compared to ATFs
Non-reported treatment in ATFs (While it would be possible, no CoD is issued)	Clear infringement of European law (Waste Shipment Regulation).	No concern if the ATF operates according to its permits
Treatment in not authorised treatment facilities	Legal situation in EU differs by MS. For most MSs the export is not illegal.	The risk of environmental pollution is higher compared to ATFs
Increase of ELVs / de-registered vehicles in stock	Unlikely option as the number of vehicles of unknown whereabouts is simply too high, vehicles would be visible.	

Source: (Williams et. al 2020)

2.2.2.2 Intra-EU trade of used vehicles and ELVs

Trade statistics for intra-EU trade on used vehicles are of limited value as a much of the shipments are not reported according to the reporting thresholds applied for intra EU trade. Thus the statistics often underestimate the trade by 50% and more (Mehlhart et al. 2017).

For the intra EU trade a distinction of ELVs from used vehicles is relevant on the one hand for statistics but also for the correct application of shipment documents carried with the transport according to the Waste Shipment Regulation. The criteria must not necessarily be the same as the criteria for extra EU export (see below), as the treatment requirements within the EU are basically equivalent. However, it remains an enforcement aspect as many transports were observed in the past, where vehicles which cannot be repaired in the country of origin passed the inner European borders without waste shipment documents.

2.2.2.3 Definition of end-of-life status

The current ‘Correspondents Guidelines No 9’ on shipment of waste vehicles to the Waste Shipment Regulation, defines criteria for the differentiation between second-hand vehicles and ELVs. However, the current ‘Correspondents Guidelines No 9’ is not legally binding.

Additionally, the findings of the study supporting the evaluation of the ELV Directive (Williams et. al 2020) shows, that the current Correspondents’ Guidelines No 9 on shipment of waste vehicles is not practical for application by custom authorities and that it needs to be revised (e.g. it needs to harmonise the interpretation of terms such as ‘repair at reasonable costs’). Furthermore, past efforts indicate that customs authorities are not able to assess each used vehicle intended for export since the number of (officially) exported used vehicles of around 1 million is simply too high to perform the inspection for each of these cars. Available staffing capacity is far from sufficient to conduct such inspections, and Customs argues that there are numerous other priorities for enforcement by Customs officers.

Some Member States have established national implementations and enforcements so that there are a number of best practices for preventing illegal export of ELVs as used vehicles.

As of 1 January 2020, following the amendment of the wording of Article 103(1) of the Italian Road Traffic Act, the new procedure for deregistration following permanent export abroad came into force. The cancellation of the vehicle for definitive export abroad must be carried out before the actual export. Following the recent amendment to Article 103 of the Highway Code introduced by Law no. 120 of 11/9/2020 (in force since 15/9/2020), it is no longer required that the vehicle has been inspected, with a positive outcome, at least 6 months before the date of the request for cancellation. The new provisions stipulate that, at the date of the cancellation request, the vehicle must have a valid roadworthiness test. [124]

Austria issued a decree in 2015 that for the export of vehicles that are not roadworthy and operationally safe, the exporter need to demonstrate either an expert opinion or a domestic "certificate on the reparability of a vehicle" to prove that it is not an end-of-life vehicle.[125]

Ireland has issued in 2019 the 3rd version of a guidance for exporters and customs authorities and has set out some procedures for the enforcement of Guidance Note 9 of the Waste Shipment Regulation. The exporter must provide either a National Car Test (NCT) certificate or a specific certificate for used vehicles (or used spare parts for vehicles) showing that they are in working order. These documents must be prominently displayed on the outside of the vehicle (or spare part) in question, without the need to unpack any items. If a vehicle's NCT certificate has been expired for more than two years, the vehicle is considered waste.

[124] Home page ACI: https://www.aci.it/i-servizi/normative/codice-della-strada/titolo-iii-dei-veicoli/art-103-obblighi-conseguenti-alla-cessazione-della-circolazione-dei-veicoli-a-motore-e-dei-rimorchi.html, accessed 3 February 2022

[125] Österreich: Erlass zur Altfahrzeugverordnung Stand: April 2015 https://www.wko.at/service/umwelt-energie/Erlass-AltfahrzeugeVO-Stand-April-2015.pdf

Vehicles for which a Certificate of Destruction (CoD) has been issued are automatically classified as waste.[126]

2.2.2.4 Extra-EU export of used vehicles and ELVs

As long as an exported used car or (illegally) exported end-of-life vehicle is reported in the statistics, its fate is no longer unknown.

However, the export of used vehicles might be problematic as:

- ELVs might be falsely declared as used vehicles. The extra-EU export of ELVs to non-OECD countries is illegal[127]. If such export of ELVs is detected, exporting countries might be responsible for (environmental) damages caused and obliged to take back such vehicles at their own cost.
- If not limited at all, the export of (old) used vehicles will cause in the receiving countries a higher volume of (hazardous) waste per use (km driven) compared to the import of new (or younger used) vehicles. Developing countries are not necessarily prepared to handle such waste in an environmental sound manner.
- Import of (old) used vehicles possibly without roadworthiness certificate or with not functioning exhaust treatment (dismantled catalytic converters) delays the effects of more advanced emission standards and health risk for the population in the receiving countries persist for a longer period.
- The importation of (old) used vehicles delays the introduction of advanced road safety equipment in receiving countries, and as a result, unnecessary injuries and fatalities in accidents continue to occur.
- Last but not least, resources recovered through reuse and recycling are lost for the EU.

As recently reported by two studies[128, 129] 80 percent of the investigated exported vehicles were below Euro 4 emission standard and most of the vehicles did not have valid roadworthiness certificates or fail to comply with the emissions standard. For instance, catalysts were dismantled before export. The majority of export vehicles to African countries are older than ten years and the peak is between sixteen and twenty years. The Dutch study concludes: “The desk study shows that the group of vehicles exported to West Africa is quite similar to the group of vehicles dismantled in the Netherlands concerning age, euro emission class, and mileage.” In result these vehicles contribute to critical air pollution and to a decrease in road safety in developing countries. More findings of these studies about the current characteristics of the export of used vehicles are displayed in in Section 6.5.1 “Facts on extra EU Export” in Annex 1.

The same studies investigated in the status of import regulations of countries receiving used vehicles. When looking for the most relevant export markets (of used vehicles) for the EU, Africa and Eastern Europe, the Caucasus, and Central Asia, 5 countries out of 82 have established an import ban for used vehicles. 17 importing countries have defined a minimum level regards the emission standard and 28 importing countries have established age limits for the import of used vehicles.

[126] Dublin City Council / National Office TFS (October 2019) A GUIDE FOR THE SHIPMENT OF USED VEHICLES, USED VEHICLE PARTS AND USED ELECTRICAL AND ELECTRONIC EQUIPMENT: Version 3

[127] According to the Basel Convention and the Waste Shipment Regulation

[128] Baskin, J. et al. (2020), Used vehicles and the Environment. A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation, published by United Nations Environment Programme (UNEP), 10/2020

[129] Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management (2020): Used vehicles exported to Africa: A study on the quality of used export vehicles

After the completion of the above-mentioned studies the Economic Community of West African States (ECOWAS[130]) adopted on 5 September 2020 a Directive[131], limiting the import of used vehicles to those with a minimum Euro 4/IV emission standard. The age limit for importing vehicles into the ECOWAS region is 5 years for light duty vehicles, two-wheel motor vehicles, tricycles and quadricycles and 10 years for heavy-duty vehicles. A period of 10 years is granted to countries that have not yet adopted these age limits to gradually comply. In result 11 additional countries introduced import limitations for the first time and another 4 countries increased the level of limits.

Table 2-9 below displays the number of receiving countries in total and the number of countries which have an import ban, very good, good, or at least any regulation in force for the import of used vehicles. In addition, it displays in the last column to the right the share of vehicles exported to these countries.

The conclusion is that 43 receiving countries in Africa, Eastern Europe, the Caucasus, Central Asia and Middle East have an import ban, very good or good regulations in force and these countries represent 55% of the exported used vehicles from the EU27 in 2020.

Table 2-9 Share of used vehicles exported in 2020 from EU-27 to differently regulated countries

	Countries mentioned as destination	Share of the total number of EU-27 export in 2020
Total export to Africa and Eastern Europe, the Caucasus, Central Asia and Middle East	82	91%
Ban of import of used vehicles	5	0.4%
Good, very good regulated or the import of used vehicles is banned (UNEP 2020)	29	29%
Good, very good regulated or the import of used vehicles is banned (UNEP 2020) + ECOWAS Countries	43	55%
At least any regulation for the import of used vehicles by age or emission class (including ECOWAS Countries)	59	82%

Source: UNEP 2020; Eurostat: COMEXT (download 27.1.2022); for more details see section 6.5.1 "Facts on extra EU Export" in Annex 1.
Very good (UNEP 2020): a used LDV Euro 5 or more emission standard adopted and / or age limit of 3 years or below;
Good (UNEP 2020): a used LDV Euro 4 emission standard adopted and/or age limit of 4 or 5 years.

More details regard the import regulations in the receiving countries are displayed in Section 6.5.1.2 "Regulations for the import in receiving countries and share of used vehicles directed to these countries" in Annex I.

In the context of the stakeholder involvement, the representatives of UNEP and UNECE explained that it is difficult to the receiving countries to enforce the import limitations as it is (most) likely that each imported vehicle will find its market in the receiving countries. Thus, cooperation and support by the exporting countries is required to support import limits.

[130] Members of ECOWAS: BENIN, BURKINA FASO, CABO VERDE, CÔTE D'IVOIRE, The GAMBIA, GHANA, GUINEA, GUINEA BISSAU, LIBERIA, MALI, NIGER, NIGERIA, SENEGAL, SIERRA LEONE, TOGO

[131] Directive C/Dir.2/09/20 relating to the harmonization of the limits of gas and exhaust particle emission for light and heavy vehicles, two wheel vehicles, tricycles and quadricycles within the ECOWAS region.

2.2.3 What is the problem and why is it a problem?

2.2.3.1 Description of the problem

As outlined in the previous chapter on the current situation in section 2.2.2, the whereabouts of around 30 % to 40 % of the M1 and N1 vehicles is not known. They might be exported without reporting to the customs authorities or treated without reporting to the registration authorities or simply dumped. To date it is not possible to assess whether all ELVs are directed to authorised treatment facilities (ATFs) or not. Instead, there are concerns about environmental impacts, losses of potential recyclables if not directed to legal treatment facilities, economic losses for the formal sector, and social impacts for informal sector workers.

In this respect, the problem is not a unique (partial) aspect where it is possible to assess which metrics (e.g. economic losses, negative environmental impacts) are caused by the problem. It is rather a general problem that currently for 30 to 40% of the vehicles it cannot be proven whether the European legislation is applied or not.

Additional environmental and social risks exist for the countries of destination in the event of illegal export from the EU.

2.2.3.2 Description of the problem drivers

The problem is caused by manifold reasons:

- **Market failure/ Regulatory failure:** In many Member States vehicle owners have no benefits and no penalties apply if the vehicle is scrapped without sending a CoD to the registration authorities.
- **Regulatory failure:** Several Member States apply a system of temporary deregistration, often in combination with an automatic deregistration after a certain number of years. In combination with unregistered transfer to the next owner, it is difficult to track vehicle ownership in the registers. [132].
- **Behavioural Biases:** Vehicle owners are not aware that it is important to inform the vehicle register if they export a vehicle.
- **Regulatory failure:** Repair costs differ across Europe. Damaged or old cars are transferred to MS with cheaper repair cost. At the country of destination not all transferred vehicles are repaired, but several are used for spare parts only (=ELV). In result the shipment
  - (used) vehicles become ELVs but are not reported to the vehicle register in the MS of origin (absence of information sharing between EU MS),
  - did not comply with the stipulations of the Waste Shipment Regulation.

[132] For instance in Germany, motor vehicles can be decommissioned by deregistration. Since March 1, 2007, this official act has been called " Außerbetriebsetzung" (decommissioning). In addition to the name, the period has also changed, and is now 7 years. The official seal is removed from the license plates when the vehicle is taken out of service. Only after the 7 years have expired does the operating license expire and the registration certificate part II (formerly: vehicle letter) loses its validity. A full expert opinion (e.g. from TÜV or Dekra) is then required for re-registration. If the vehicle is re-registered within 7 years, proof of a valid roadworthiness inspection is sufficient. The roadworthiness inspection is therefore only due if it was required within the out-of-service period. Further requirements for re-registration: Neither the owner nor the registration district may have changed. As mentioned in "Jahresbericht Altfahrzeuge 2019 (Umweltbundesamt 2021) 9.325.269 vehicles are reported for "Außerbetriebsetzung" (temporary or not temporary) and 3.117.208 thereof are considered as permanently deregistered, the last based on a study for the year 2017. Insofar the figure for the permanently deregistered vehicles is not known from registration/statistics, but derived by studies and assumptions only.

- **Regulatory failure:** as mentioned by EuRIC and some Member States in the context of the Evaluation of the ELV Directive (see Report published in 2020), insurance companies apply auctions for the residual value of individual vehicles but also bulk auctions with a mix of several damaged vehicles. Many of these vehicles are total economic losses or even total technical loss. Most insurers do not verify that such vehicles are delivered exclusively to ATFs and that CoDs are issued for vehicles with economic total losses respectively total technical loss. It might be connected to the principle agent problem. While the issue was regularly highlighted by stakeholders of the ATF sector as a relevant aspect no detailed data on the volume of vehicles dealt with such (bulk) auctions is available.
- **Regulatory failure:** No obligation applies to ATFs to issue a CoD and send it to the registration authorities of the Member State where the ELV was last registered (respectively to a central point of the national register).
- **Market failure/ Regulatory (enforcement) failure:** For legal and illegal garages, not being ATFs, it is economically attractive to make use of spare parts of ELVs and dismantle the ELV for direct shredding without passing an ATF and without issuing a CoD.
- **Regulatory failure:** No obligation exists that used spare parts can be offered to the market only by demonstrating the origin of that part (VIN and CoD).
- **Regulatory failure:** Shredding facilities are not obliged and not willing to check if depolluted, dismantled (and compressed) vehicles are de-registered and if a CoD is issued accordingly. Shredding facilities also accept shear scrap that contains (parts from) end-of-life vehicles without asking where the scrap came from.
- **Market failure/ Regulatory (enforcement) failure:** A demand exists in developing countries for used vehicles from EU and prices paid by the final users of such used vehicles are higher than the prices paid in EU. Inspection capacities and enforcement of environmental requirements are weak in many developing countries. In result the environmental and road safety standard (as defined in the type approval) are not enforced accordingly.
- **Regulatory failure:** For the purpose of cross border trade, distinction of used vehicles and ELVs is defined by a 'Correspondence guidance No 9'. Member States are not obliged to apply this guidance. Customs services in the Member States do not have the capacity (it is unrealistic to have such capacity) to apply the guidance for each vehicle.

2.2.3.3 Key players and affected population

In the following we identify roughly the key players and first assumptions by what and how they are affected. More detailed economic, environmental and social impacts for the listed stakeholders are discussed and displayed in section 3.2.

- Illegal garages might cause environmental pollution and might employ staff informally.
- ATFs compete with illegal garages and illegal exporters – which may be capable to pay higher prices as they do not comply with all legal requirements.
- Citizens, not taking due care what is happening to their vehicle might receive higher prices for their ELV when it is sold to non-ATFs.
- Insurances might get higher residual revenues for vehicles with total economic loss if they do not care who buys a vehicle with total economic loss.
- Due to illegal export and treatment by illegal and legal garages not being ATFs the ATFs have less turnover than expected and ATFs business might be less profitable / not profitable.
- Illegal export limits the turnover of shredders and the generation of recyclable fractions.

- Companies shipping used vehicles to another EU Member State or to third countries, which sometimes derive important revenues from this activity which would be affected by export restrictions.

2.2.3.4 Why should the EU act?

The overarching problem of not being able to demonstrate that 30-40% of ELVs are treated in accordance with ELVD requirements calls into question the success of ELVD. For the future, ATFs and recyclers fear that the informal sector will a fortiori fail to meet the more demanding requirements outlined in the circular economy section, thus jeopardizing the circular economy aspects addressed in the ELVD revision.

At least since 2011, the problem of missing vehicles has been well known to member states, and the issue has been prominently addressed at numerous meetings and conferences. However, the problem has not changed and continues to jeopardise the objective of the ELV Directive that all end-of-life vehicles should be depolluted and dismantled in ATFs in compliance with the minimum requirements of the ELVD.

In the study for the European Commission (Mehlhart et.al 2017), various measures to address the problem were outlined and discussed with stakeholders. In this context, almost all stakeholders were in favour of action at the EU level.

As demonstrated in the past MS fail to address the issue by themselves and regards intra EU-cross border trade (e.g. definition of ELV and cross-country reporting obligation and cooperation Member States cannot solve the problems by themselves.

Last but not least the aspect of exports of ELVs or used vehicles with similar characteristics than ELVs to non-OECD countries is an issue which cannot be addressed at national level but at level of the European Union (as a trade union) only.

2.2.4 Which objective should be achieved?

The objectives are directly converting the problems to a positive perspective as displayed in Table 2-10 below.

Table 2-10 General Problems and related Objectives

Problem in the Member State	• No proof that all ELV generated are treated according to minimum technical and environmental requirements; • Economic losses for the formal sector, and social impacts for informal sector workers; • Concerns that (a part of) recyclables are lost if not directed to legal facilities, including concerns that the informal sector will not comply with more challenging requirements as outlined in the section on circularity
Specific Objective 1	• Evidence available that all ELVs are treated according to minimum technical and environmental requirements; • ELVs are being fed into the formal sector, and the informal sector is being pushed back . This contributes to better treatment in particular if more chanllenging objectives shall be achieved as discribed under the related Circularity chapter.

Problem from intra EU trade

- Difficult distinction between used vehicles and ELVs causing problems in the application of the WShipR and responsibilities of the last owner (e.g. in case of total loss)

Specific Objective 2

- Improved traceability in the shipments of used cars and ELVs to ensure that vehicles are not shipped to another MS for the purpose of dismantling them in breach of the EU legislation
- Clear and practical appilcable defintion of ELV is in force and applied.
- The proximity principle (Art 16 of WFD) for the treatment of ELVs is applied, cross border shipment of ELVs is applied in case of technical need only;

Problem from extra EU trade

- Environmental health and social risks for the countries of destination caused by (old) used vehicles imported;
- Financial risks for the Member States of origin in the event of a complaint by the recipient country (WShipR).

Specific Objective 3

- No (non-depoluted) ELVs are exported to non OECD countries; Rules of the Basel Convention and WShiR applied
- No used vehicles exported which would generate environmental adverse impacts in the receiving countries

Source: Own illustration

2.2.5 What are potential measures to achieve the objective?

In the following we will introduce and explain measures addressing the above-mentioned objectives. Subsequently we will conduct a first initial assessment on effectiveness and feasibility with the result that some of the measures are considered as inevitable, others are discarded or kept at the agenda for later consideration.

2.2.5.1 Potential measures to achieve Specific Objective No 3.1: Ensure that all ELVs are treated in accordance with the requirements of the ELV Directive

2.2.5.1.1 Provide economic incentives for the last owner of an end-of-life vehicle to deliver it to an ATF and report the certificate of destruction (CoD) to the administration

The EU legislation may require Member States to ensure that there are economic incentives for the last owner of an end-of-life vehicle to deliver it to an ATF and receive a CoD in return. Tree alternative options might apply for such incentives:

a) Link the (end of the) payment of insurance[133] schemes to provision of CoD;
b) Link the end of administrative fees to provision of CoD;
c) Member States set up other financial incentives (premium / pay out) for last owners to hand over ELVs to ATFs, possibly as part of EPR scheme.

We distinguish to levels regards this measure:

Level A: Member States shall report on incentives in force to strengthen the effectiveness of the CoD. Level A is considered as a low level of intervention, driving attention to this kind of instruments.

Level B: Member States shall demonstrate that they implemented one of the three options above. If a Member State wishes to choose alternatives to the above two options, it must demonstrate equal or better effectiveness. The reasoning for this option is that detailed regulations for insurances or the details of administrative fees (what level and by when they start and end) and also premium pay out systems are typically considered as objects of subsidiarity. Insofar it is not possible and not meaningful to establish detailed rules which and how such incentives are applied. Instead, the Member States have more choices to implement the most appropriate for their national system, but at least some measures (not explicitly specified) of equal effect to the listed shall be established.

Comment to Option a) and b) other options to terminate an insurance against civil liability in respect of the use of motor vehicles might be Demonstration of an export-sales contract or statement that the vehicle is used exclusively on private property. There is a risk that fraudulent contracts are presented to the insurance companies and the vehicle is instead

[133] DIRECTIVE 2009/103/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 relating to insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability

delivered to an illegal dismantler at a higher profit than if offered to an ATF. Such cases are known for the Netherlands[134] where the assumption is that around 30 000 ELVs[135] are reportedly exported but remain in the Netherlands and are treated in substandard treatment facilities instead. This demonstrates that a mix of measures is required and not one measure alone can address the general issue of missing vehicles.

Comment to Option c)
as demonstrated above the level of such premium is in Norway and Denmark around € 300 and the German study confirmed that the illegal sector has higher benefits compared to ATFs of about 250 € to 300 € per ELV. As long as the premium is too low, it will not have a sufficient effect as demonstrated in Figure 6-20 at page 626.

In 2019 the French ADEME published a comprehensive report on a global overview of incentive schemes aiming to bring ELVs through authorised processing channels[136]. The report describes in detail the systems in Denmark, the Netherlands, in Spain and the Czech Republic.
Reportedly there was a reflection conducted on an implementation of a bonus for the recovery of ELV in legal sector (to compensate for the gap of economic competitiveness with illegal sector). France did **not** establish such bonus due to a lack of consensus on its funding[137]

[134] Janet Kes & Pieter Kuiper (2016): De-registration and monitoring of ELV's in NL; Presentation at the STAKEHOLDER WORKSHOP organised by the EC: ASSESSMENT OF THE IMPLEMENTATION OF DIRECTIVE 2000/53/EU ON END-OF-LIFE VEHICLES (THE ELV DIRECTIVE) WITH EMPHASIS ON THE END-OF-LIFE VEHICLES OF UNKNOWN WHEREABOUTS; Date: 21 November 2016

[135] In average for 2015 – 2019 the Netherlands report 190 000 ELV generated. Following this assumption 30 000 more are treated in the Netherlands (= ca. 15%).

[136] ADEME (Eric LECOINTRE), Deloitte Développement Durable (Alexis LEMEILLET, Radia BENHALLAM, Antoine HENRY, Marie FILLION, Rafael BASCIANO), In Extenso Innovation Croissance (Victoire ESCALON, Beatriz BERTHOUX). 2019. Final report: Global Overview of Incentive Schemes aiming to bring ELVs through Authorised Processing Channels. 119 pages.

[137] Meeting of the expert group on waste on 1 June 2018 Directive 2000/53/EC on end-of-life vehicles (ELV):

2.2.5.1.2 Alignment of the terms of the ELV Directive with the terms of Directive 1999/37/EC on registration documents

"**Registration**" shall be used in compliance with Directive 1999/37/EC, Article 2: "registration" shall mean the administrative authorisation for the entry into service in road traffic of a vehicle, involving the identification of the latter and the issuing to it of a serial number, to be known as the registration number.
Comment: the term is needed in the context of the reporting on the national vehicle park / fleet.

"**Suspension**" shall be used in compliance with Directive 1999/37/EC, Article 2: "suspension" means a limited period of time in which a vehicle is not authorised by a Member State to be used in road traffic following which – provided the reasons for suspension have ceased to apply– it may be authorised to be used again without involving a new process of registration.
Comment: A suspension is initiated by the competent authorities of registration of a Member State for any reason, for instance if a vehicle does not comply with vehicle requirements for use on public roads. The term might be needed for the completeness of reporting on the national vehicle park. It is also mentioned here for completeness (and distinction from the other terms).

"**Cancellation of a registration**" shall be used in compliance with Directive 1999/37/EC, Article 2: "cancellation of a registration" means the cancellation of a Member State's authorisation for a vehicle to be used in road traffic.
Comment: we need this term for the list of conclusive reasons for (permanent) cancellation. In the discussion the term of '(permanent) deregistration' is often used as synonym for the same purpose. However, as the term permanent cancellation of a registration is already established in Directive 1999/37/EC[138] it is meaningful to make use of the existing definition and avoid confusion in the future.

2.2.5.1.3 Introduction of new definition: "temporary deregistration"

"**Temporary deregistration**": based on a request (not ex officio) of the vehicle holder and/or owner a vehicle is temporarily not permitted to be used in road traffic.
Comment: The definition was discussed by DG ENV with DG MOVE and proposed by DG MOVE in 2016/2017. The explanation "not ex officio" expresses that it is not an authority but e.g. the owner/holder of the vehicle which asks for a temporary deregistration. Insofar it is different from the term suspension. The term "temporary deregistration" is mentioned in recital 17 of the current ELVD[139]. However, the term not addressed in any article of the current ELVD nor is the term defined in the current ELVD. "Temporary deregistration" is typically applied by

[138] Directive 1999/37/EC Article 3a(3): 'In the event that the competent authority of a Member State receives notification that a vehicle has been treated as an end-of-life vehicle in accordance with Directive 2000/53/EC of the European Parliament and of the Council (1), the registration of that vehicle shall be cancelled permanently and information to that effect shall be added to the electronic register.'

[139] DIRECTIVE 2000/53/EC, recital (17): 'This Directive does not prevent Member States from granting, where appropriate, temporary deregistrations of vehicles.'

dealers when they keep used vehicles on private grounds before selling them but also can be applied by private person for any reason defined in the national legislation. It is necessary to define the term as it is necessary to define some obligations for the owner / holder of vehicles during the time of temporary deregistration.
In absence of a well-defined term, the term (temporary/ indefinite) off-road notification is often used as synonym for (temporary/ indefinite) deregistration.

2.2.5.1.4 Introduce at EU level a conclusive list of conditions for permanent cancellation of the registration including regulations for how to apply “temporary de-registrations” (and in addition to cars that are deregistered after COD)[140]

Conclusive list of reasons for permanent cancellation of the registration[141]:

a) CoD submitted to national vehicle register,
b) Submission of a police report demonstrating that the vehicle is stolen and missing,
c) Documents demonstrating that the vehicle is exported,
d) Exemptions upon specific request: e.g. a vintage vehicle is stored in a (private) kind of Museum: accompanying documents demonstrate the conditions where and how the vehicle is stored.

Management of temporary deregistration:

i. Prohibition of “automatic” permanent cancellation of the registration after a certain period of temporary deregistration (or (indefinite) off-road notification).
ii. The use on private ground shall not be a reason for permanent cancellation of the registration but it shall fall under temporary deregistration.
iii. Require the owner of a vehicle to report changes in ownership to the registration authority during temporary deregistration. [142]
iv. A monthly administrative fee (at minimum to recover the related administrative effort) is charged for the entire duration of the temporary deregistration.

By legal reasons not all of the above-mentioned aspects might be not regulated by the new ELV Regulation but by other revisions as for instance in the context of the Roadworthiness legislation under DG MOVE supervision.

If so, it might be an option to establish in the new ELV Regulation at least a requirement Alternatively, a requirement could be established for the owner of a vehicle which is “temporarily de-registered” to report changes on the ownership of the vehicle in question to the registration authority. The owner of such vehicles should provide information on the

[140] Elements to be considered:

Criteria for a MS to apply permanent cancellations of registrations - a) Certificates of Destruction (CoD), b) proven export of a vehicle, c) proven theft of a vehicle, d) official declaration from the owner that the vehicle is no longer available for re-registration

[141] The current Directive 2000/53/EC refers constantly to the undefined term “deregistration”. To be consistent with the proposed definitions in the text box here the term “permanent cancellation of the registration” is applied.

[142] The owner of such vehicles should provide information on the details of the new owner, so that this new owner can be clearly identified and recorded in the national register of the country where he is established. The aim of this measure is to avoid that vehicles which are “temporarily de-registered” are transferred to owners who would dismantle or export it illegally.

details of the new owner, so that this new owner can be clearly identified and recorded in the national register of the country where he is established.

The aim of this measure is to avoid that vehicles which are "temporarily de-registered" are transferred to owners who would dismantle or export it illegally. However, if such (separated) clause shall be established in the new ELV Regulation it is necessary to establish at the same time the definition for "temporary deregistration" as described in the chapter before. For the purposes of the Impact Assessment dealt with later in this report, all proposals in this section will be taken into account, regardless of the area of law in which they are implemented.

2.2.5.1.5 Obligations for dismantlers /recyclers to check and report on ELVs / CoDs

Requirement that ATFs issue a CoD for each dismantled vehicle through an electronic notification procedure to the registration authority along with the delivery of the CoD to the last owner (hardcopy or electronic statement).

Obligation for shredders to not accept bulks of vehicle carcasses or shear scrap that apparently comes from end-of-life vehicles without accompanying copy of CoDs. Shredders should be able to assess the VIN number at the delivered bulks (as it is the regulation in the Netherlands).

2.2.5.1.6 Improve the exchange of information between national registration authorities including obligation for MS to provide reasons for de-registration.

a) Member States shall include information in their national register on the reasons for which a vehicle is permanently removed from their register, and make this information accessible to other MS.
   These reasons shall be limited to:
   - Dismantling of a car considered as an ELV at an Authoriz*ed Treatment Facility (ATF), upon presentation of a Certificate of Destruction (CoD);*
   - *export of a vehicle, upon presentation of relevant export document;*
   - *theft of a vehicle, upon presentation of police report;*
   - *Exemptions upon specific request: e.g. a vintage vehicle is stored in a (private) museum*
b) Establishment of an electronic notification procedure between MS when a CoD is issued for a vehicle last registered in another Member State. The MS where the CoD is issued but the vehicle was not registered (respectively not registered the last) is obliged to inform the Member State where the vehicle was last registered. MS shall jointly establish a data exchange, making it possible to submit such information and to search by VIN for a vehicle, when the last owner (respectively country where the vehicle is been registered last), cannot be detected from accompanying (respectively missing) registration documents
c) Set up an obligation for Member States authorities to provide access to their national registers respectively make available to authorities (e.g. registration authorities, customs services, police) in all other Member States to verify information on vehicles registered/de-registered from their register, including the motives of vehicle de-registration.
   This would allow authorities in one Member State to retrieve information pertaining to one vehicle present on its territory and check what its status is in another Member State. This would also increase traceability of vehicles which are moved in large number

between Member States during their use phase and sometimes for the purpose of their dismantling at their end-of-life phase. This is key for the purpose of reducing the number of “missing vehicles”, but also for the functioning of “extended producer responsibility schemes” whereby car manufacturers would assume additional obligations for the dismantling of end-of-life vehicles, including where these ELVs are treated in a MS different from the one where the vehicle was first put on the market. Exchange of information should be made possible through the use of the Vehicle Identification Number (VIN) and provide information on the brands of the vehicles concerned.

The aim of these measures is to increase transparency on the de-registration of vehicles, which is a serious obstacle today to track “missing vehicles”. This information should also be directly accessible by national authorities responsible for the implementation of the EU rules on end-of-life vehicles.

By legal reasons not all of the above-mentioned aspects might be not regulated by the new ELV Regulation but by other revisions as for instance in the context of the Roadworthiness legislation under DG MOVE supervision.

For the purposes of the Impact Assessment dealt with later in this report, all proposals in this section will be taken into account, regardless of the area of law in which they are implemented.

2.2.5.1.7 Include Vehicle Identification Number (VIN) in customs declaration

For extra-EU export: registration of the exported vehicle VIN and obligatory information of the MS of origin (the MS where the vehicle was last registered) on the export. This measure enables spot checks / cross checks between the export files and the vehicle registers e.g. whether the vehicle is already considered waste (CoD issued), mentioned as stolen or regards information on the emission level / age / roadworthiness certificate as far as registration paper are not accompanying the export of the vehicle. Once digitalisation is more advanced and interfaces between the export data and registration data are available the cross check can be done as standard procedure.

2.2.5.1.8 Establish EU vehicle registration database-system

Either extract / link to the national registers or build up a new database, with the aim to generate a data base which can address the complete life phase of each single vehicles, including first registration of new vehicles, import to EU of used vehicles, change in ownership across EU, temporary deregistration (off road notification) including change of ownership during this phase export, extra EU export of used vehicles, permanent cancellation of a registration, proof of depollution and recycling by CoDs. In addition, there are aspects registered such as stolen vehicle, economic total loss of the vehicle, technical total loss of the vehicle and the status of the roadworthiness certificate.

2.2.5.1.9 Improve reporting obligations on the current vehicle market and the ELVs on their territory

The current mandate in the ELV Directive does not explicitly require Member States to report on the vehicle fleet and the details of changes in the vehicle fleet.

The current Commission Decision 2005/293/EC (2005/293/EC 2005) requires the Member States to complete the tables 1-4 and to report in addition on "the current national vehicle market and the end-of-life vehicles on their territory". However, this last aspect is not detailed further in the Commission Decision. Eurostat's guideline[143] tries to specify details on what shall be reported under this aspect; however, Eurostat's guideline is not legally binding and only a minority of Member States have replied according to the proposed approach.

Since reporting on the national vehicle stock and changes in stock is a prerequisite for verifying that all ELVs are transferred to ATFs, such a mandate should be introduced in the Directive/Regulation. The aim is to overcome the current situation where currently for 30-40% of the vehicles it is not possible whether they are treated according to the requirements of the ELVD. Today reporting on the stock is not harmonised and guided by an informal Eurostat document only. To improve the reporting with this regard it is important that the diverse national Ministries necessarily involved in such reporting are encouraged to cooperate. As the current stipulations are not that concrete for instance the Ministries of interior (or transport) often ignore the request of the Ministries of environment to support them in the reporting. When the reporting obligations become more concrete by this measure, the need for national and international cooperation becomes more evident.

The details could be implemented through an Annex (if agreed upon in time) or delegated act (if more time is needed for preparation).

The proposal for the Directive or Regulation is as follows:

Member States report on the national vehicle stock and detailed changes from one year to the next in the total number of vehicles registered, new registrations, imports and exports of used vehicles, temporary de-registrations and permanent de-registrations.

The purpose of this reporting is that a) Member States demonstrate that all ELVs are directed to ATFs and b) to overcome the current situation where it is for a large number of vehicles unknown whether they are exported or treated as ELV (without CoD issued).

The European Commission communicated possible reporting details to Member States in 2018. Some MS mentioned that it might become difficult to collect the data, other questioned whether the current (version 2018) ELVD includes a mandate to make it mandatory to answer such questions. As more and more ELVs are shipped across the EU this shall also be included in the reporting obligations as also discussed with the Member States in 2018. The detailed proposal and comments of the Member States on the proposal can be found in the report "Assessment of the comments of the Member States in relation to the draft proposal for the amendment of Commission Decision 2005/293/EC"[144]. The table below refers in most details to this proposal with a few adjustments in the terminology.

[143] How to report on end-of-life vehicles according to Commission Decision 2005/293/EC, Revision by Eurostat: 17 December 2019

[144] Mehlhart, G.; Hay, D. (2019): Assessment of the comments of the Member States in relation to the draft proposal for the amendment of Commission Decision 2005/293/EC, commissioned by the EC DG Environment as an amendment to contract No 07.0201/2015/723374/ETU/ENV.A.2.

Table 2-11 Data reporting form: Data on the national vehicle market for M1 and N1 vehicles

Reference year (n)	
Certificates of destruction (CoDs) issued for domestic ELVs	
CoDs issued for vehicles, not registered in the reporting country	
Permanent cancellations of registration	
ELVs imported for treatment (excluding transit)	
Total ELVs treated in the reporting country	

	Number per year, during the reference year
(A) New vehicles placed on the national market:	
(1) Registered for the use on public roads for the first time	
(2) not registered (not for the use on public roads)	
(B) Import of used vehicles:	
(1) from other EU Member States and re-registered for the use on public roads	
(2) from non-EU countries and re-registered for the use on public roads	
(3) not re-registered (not for the use on public roads)	Estimation possible

(C) Change in vehicle stock			
	Numbers on the 31 December of the reference year (n)	Numbers on the 31 December of the previous year (n-1)	Change in stock = year (n) – year (n-1)
(1) Stock of vehicles registered for the use on public roads			
(2) Temporarily de-registered vehicles			
(3) Suspended vehicle registrations			
Total = Σ(C)			

	Number per year, during the reference year
(D) Export of used vehicles:	
(1) to other EU Member States and re-registered for the use on public roads	
(2) to non-EU countries and re-registered for the use on public roads	
(3) other exports of used vehicles, not re-registered for the use on public roads or unknown if re-registered in the country of destination	
(E) Domestical ELVs treated, proven by issued CoD:	
(1) domestical ELVs treated domestically	
(2) domestical ELVs exported for treatment	

Accompanying notes to the data reporting form:

For the terms: "registration", "cancellation of a registration", "suspension" pls refer to COUNCIL DIRECTIVE 1999/37/EC of 29 April 1999 on the registration documents for vehicles.

The terms "temporary deregistration" and "Certificate of destruction" is defined in Article [to be completed one the articles are drafted in detail] of the revised ELV legislation.

The term "permanent cancellation of the registration" means that one of the following situations apply: a) CoD issued to national vehicle register, b) proven theft of a vehicle, c) proven export of a vehicle, d) Exemptions upon specific request: e.g. a vintage vehicle is stored in a (private) kind of Museum: accompanying documents demonstrate the conditions where and how the vehicle is stored. The use on private ground shall not be a reason for permanent cancellation of the registration but it shall fall under temporary deregistration.

Data from intra-EU foreign trade statistics are, due to the reporting thresholds, not reliable for reporting on this intra EU export of used vehicles. Instead, data shall be available from the national vehicle registration authority using data exchange based on Article 5(2) of Directive 1999/37/EC.

For the data on export to non-EU countries data from foreign trade statistics shall be used as an additional source to the data provided by the national registration authority.

The submission of the data shall be accompanied by a quality report on methods used for the collection of the data, the data sources and their quality. As far as the quality report does disclose problems with data sources and quality, the report shall outline how the Member State proposes to overcome the identified problems.

2.2.5.1.10 Establish collection target based on the reporting obligations on the national vehicle market

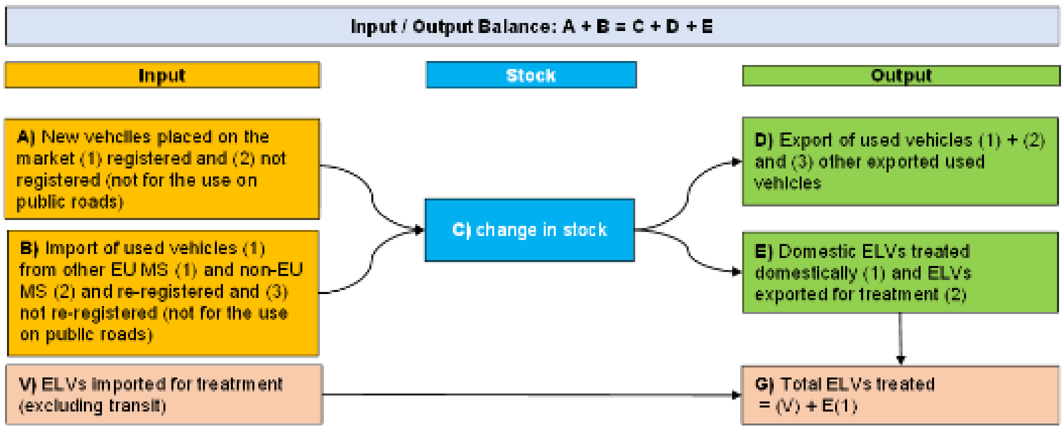
As mentioned during the stakeholder involvement one challenge, hampering proving that all ELVs that are domestically generated are treated according to the EU requirements is the lack of cooperation between the Ministries of Environment, in charge for the enforcement of the ELVD, and the Ministries in charge for the vehicle registration procedures, the last often with the Ministry of interior of Ministry of transport. Establishing a reporting obligation (see measure before) might not enough stimulus to overcome the problems is cooperation. A distinct target, where the collection of the data is inevitable to prove compliance is easier to communicate on pilots and EU infringement procedures too.

Based on the before mentioned definitions for the reporting form the collections rate shall be calculated as follows:

Collection rate = Σ(E) / (Σ(A) + Σ(B) – Σ(C) – Σ(D))
The indices refer to the reporting table before where
Σ (A) = New vehicles placed on the national market
Σ (B) = Import of used vehicles
Σ (C) = Change in vehicle stock
Σ (D) = Export of used vehicles
Σ (E) = Domestical ELVs treated

The Figure 2-26 below displays the relation of the before mentioned categories.

Figure 2-26 Input / Output Balance for the national vehicle market



<u>Level of the collection target:</u> Article 5 (2) of the current ELVD stipulates that "Member States shall also take the necessary measures to ensure that **<u>all</u>** end-of life vehicles are transferred to authorised treatment facilities." This implies, that 100% of the generated ELVs should be collected.

However, there is no explicit monitoring with this regard included in the current ELVD. The challenge for MS to demonstrate achievement of the collection target is related to data on export and import. In particular the data for intra EU trade is by far not complete and MS must establish new procedures to collect data accordingly. Interoperability of the diverse national registers – possibly supported by EUCARIS (see chapter 2.2.5.1.6) would be a strong support to complete the data accordingly. For a target it must be considered that stock effects and enforcement effects might apply, making it challenging or impossible to achieve 100% collection rate when following the calculation rules.

2.2.5.2 Potential measures to achieve Specific Objective No 3.2: Reduce levels of illegal dismantling and illegal export of ELVs

2.2.5.2.1 Exchange on MS best practice (national implementation and enforcement incl. sector inspection campaigns)

Such exchanges were continuously maintained by the European Commission in the framework of working group meetings. Here, Member States presented practices, such as:

- Germany (TAC ELV 2015): Elaboration of proposals to improve data about the whereabouts of end-of-life vehicles
- Germany (WG ELV 2016): German study on vehicles of unknown whereabouts
- Denmark (WG ELV 2016): Improving ELV collection rates in Denmark- a story about a changed marked
- Finland (WG ELV 2016): Finnish Guidance on POPs waste and pre-treatment of ELVs
- Portugal (WG ELV 2016): the EPR system Valorcar
- Germany (EC's Stakeholder meeting 2016-11-21): Flashlight of practice in Germany: REGINA – making use of re-registration information to clarify used vehicle exports
- France (EC's Stakeholder meeting 2016-11-21): Ways to fight against illegal sites and illegal activities of end-of life vehicles
- Netherlands (EC's Stakeholder meeting 2016-11-21): De-registration and monitoring of ELV's in NL
- UK (EC's Stakeholder meeting 2016-11-21): Illegal dismantling
- UK (EC's Stakeholder meeting 2016-11-21): Registration/Deregistration Procedures in UK
- Poland (WG ELV 2017): Legalization of vehicles from crimes
- Germany (WG ELV 2017): ELVES and ELV Recycling in Ireland Discussion about the role of online car marketplaces /online salvage car auctions
- Ireland (WG ELV 2017): ELVES and ELV Recycling in Ireland
- France (WG ELV 2017): ELV Reporting: Which organisation in France?
- Germany (WG ELV 2107): Results of the German ELV shredder trial of 2016
- Germany (Expert Meeting ELV 2021): ELV Treatment: Current cost and revenue situation of German ATFs

However, most of the Member States did not change their approach (e.g. regards inspections) or legislation substantially with the aim to address the aspect of missing vehicles and only few Member States can provide detailed data on the whereabout of all used vehicles and ELVs. One basic problem is that such changes are not exclusively in the domain of the participating representatives of TAC meetings (almost all from Ministry of Environment and/or Environmental agencies), while changing e.g. registration procedures is the task of other Ministries in the Member States.

2.2.5.2.2 Voluntary campaigns on export of ELVs with a focus on the current guidelines on distinction between ELVs and second-hand vehicles (waste shipment correspondents' guidelines No9)

Today for three countries detailed studies on export are known:

- A study commissioned by the German UBA in 2006 titled "Improving precious metal cycles: analysis of export flows of used cars and electrical (electronic) equipment at the Port of Hamburg"[145].
- A study commissioned by the Dublin city council, in charge for this export in Ireland, updated in 2019 the Guide for the shipment of used vehicles, used vehicle parts and used electrical and electronic equipment.
- In 2020, the Dutch authorities[146] published a report on inspection at the harbour in Amsterdam and additional desk research on the characteristics of the exported vehicles.

The costs for these studies are not yet known, but we expect them easily to exceed several 10 000 € each.

Despite these activities no other voluntary inspections respectively reports on such inspections are known to us. Most likely road police in cooperation with customs services from time to time perform spot check inspections of shipments, but no systematic approach with this regard is reported.

As long as such investigations remain voluntary, we do not expect that MS will spend more attention on this aspect, as the inspections capacities are in general limited, and many other aspects need to be addressed by the relevant authorities in charge.

2.2.5.2.3 Effective Deposit Refund Scheme (DRF) for vehicles.

Denmark and Norway have established a premium payment system when the ELV is delivered by the last owner to an ATF. The premium in Norway is NOK 3000. -(approximately € € 288) and is provided to the last owner upon demonstration that a CoD is issued[147]. Vehicle owners pay upon the first registration 2 400 NOK to the government for a deposit.

The premium in Denmark is 2200 DKK (approximately € 286) [148]. The vehicle owners pay 85 DKK (ca. 11 €) per year and per registered vehicle into the DRF Scheme.

Both systems are managed by public authorities. More details on the existing systems can be found in chapter 6.7.3 of Annex I

[145] Verbesserung der Edelmetallkreisläufe: Analyse der Exportströme von gebraucht-Pkw und –Elektro(nik)geräten am Hamburger Hafen. (Buchert et al. 2007)

[146] Used vehicles exported to Africa: A study on the quality of used export vehicles (2020). Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management. available at: https://www.ilent.nl/binaries/ilt/documenten/rapporten/2020/10/26/rapport--used-vehicles-exported-to-africa/RAPPORT-+Used+vehicles+exported+to+Africa.pdf.

[147] Siri Sveinsvoll (2019): The Norwegian ELV System, presentation

[148] Deloitte Consulting (September 2016): Udredning af skrotningsgodtgørelsens incitamentsstruktur (

Preliminary results of a German study indicate that the illegal sector would have in different scenarios higher benefits compared to ATFs of about 250€ to 300€ per ELV[149]. Insofar the three sources demonstrate that almost the same level of premium is necessary to make it attractive to the last owner to provide the ELV to an ATF instead to the illegal sector.

If a premium of €300 for each CoD presented would be paid to the last owner, this would be a very effective way of ensuring that more ELVs are supplied to ATFs rather than to the illegal sector. The funds for paying the premium could be collected when new cars are sold or during the use phase.

The main risk is that implementation is hampered by missing information for other 24 national markets than the three (DK, NO, DE) mentioned above and subsequent discussions about the correct level of a premium. There might be also needs to adjust the premium from time to time with adverse effects as observed in Denmark when the premium was reduced between 2014 and 2017 to 1500 DKK.

A premium charged on the sale of new cars would increase the cost of new cars, as well as used cars, because the prices of old used cars would also include the premium payment as a markup on the market price.

For the assessment the following measure is considered:

Member States are encouraged to apply Deposit Refund Schemes either managed by public authorities or as a part of the EPR obligations. MS shall report on the level of the premium and why it is deemed sufficient / effective.

2.2.5.2.4 European-wide deposit refund scheme for vehicles supervised by a single European body

MS or OEMs are obliged to pay into a European fund a minor amount per year for vehicles registered for the use on public roads (alternative: for each new vehicle placed on the market in the EU). The European fund pays out a fixed amount to the last owner of a vehicle when it becomes an ELV, and a CoD is issued.

Comment The European approach is more just for the Member States which import a high share of used vehicles. All car drivers pay the same fee, and all last owners get the same pay out.

Risk: Fraudulent issuance of CoDs, e.g. for vehicles that are in fact exported to non-EU countries. The approach requires strict rules for registration and deregistration and tough penalties for fraudulent cases.

A (new) European authority must be assigned for this purpose and equipped with staff and equipment.

[149] Regina Kohlmeyer (Umweltbundesamt): ELV Treatment: Current cost and revenue situation of German ATFs; preliminary results presented to the ELV Expert Group Meeting (online) on 28 June 2021.

2.2.5.2.5 Binding criteria for a distinction of used vehicles / ELVs, based on existing waste shipment correspondents' guidelines and looking at examples of practices in some MS (i.e. Austria's legislation according to which a damaged vehicle that is considered a total economic loss is to be considered an ELV)

a) Transformation of the Waste Shipment Correspondents' Guidelines No 9 on waste vehicles into a binding document (such as an annex to the ELV Directive);

b) Explicitly define (e.g. in the context of the definition of end-of-life vehicles) that a vehicle that is considered an economic total loss (in the country of origin) is considered waste. Consequently, vehicles considered to be economic total losses must be offered to ATFs and the Waste Shipment Regulation must be applied to cross-border shipments of such economic total loss vehicles. If intermediary brokers are involved, these brokers must prove to the last owner of a total loss vehicle that the final destination is an ATF. This could also help avoiding that insurance companies sell "economic total loss cars" to unscrupulous operators, as they would be forced to hand over these cars (deemed ELVs) to ATFs, even when the cars are not shipped to another country but sold in the same country.

2.2.5.2.6 Definition of minimum requirements for sector inspections: oblige MS to set up and notify inspection plans + extend the inspection requirements to all economic operators in the sector (not ATFs only, but operators suspected to conduct illegal dismantling as well).

All Member States are required to conduct once a year a campaign to have physical inspections of the sector, meaning a) ATFs, b) repair garages not registered as ATFs and c) known/suspected illegal operators not registered at all. The campaign shall cover at least 10% of all sites/facilities each year. The campaign shall also cover inspections on at least three different days per year on which unannounced used/end-of-life vehicle transports are focused, as far as known along the known land transport routes and harbours with the aim to inspect shipment documents and compliance with the Waste Shipment Directive and the definition of ELVs distinguished from used vehicles.

The Member States shall submit a report on the concept / design of the inspection campaign and the findings/results to the EC. The EC shall prepare a report drawing conclusions from these reports accordingly.

2.2.5.2.7 penalties for operators of illegal dismantling and shredding or for selling an ELV to illegal dismantlers and for dealers (and electronic platform) dealing with dismantled (used) spare parts from non-authorised facilities.

Regards this measure we distinguish to levels:

Level 1
Member States are **encouraged** to establish fines and penalties for

a) The owners in case of breach or regulations/rules how to manage ELVs
b) illegal dismantling and shredding or for selling an ELV to illegal dismantlers.
c) dealers (and electronic platform) dealing with dismantled (used) spare parts from non-authorised facilities.

Level 2
As is the case in other pieces of EU law[150], the future legislation on ELV would foresee that Member States are **required** to establish effective, proportionate and dissuasive penalties corresponding to breaches of the requirements under the ELV legislation, especially for:

a) owners who bring their ELV to non-authorised facilities.
b) illegal dismantling and shredding or for selling an ELV to illegal dismantlers.
c) dealers (and electronic platform) dealing with dismantled (used) spare parts from non-authorised facilities.

For both levels the following reporting obligation shall apply

Member States shall report by 31.12.2025 once on the fines and penalties applied in this context to the EC. The EC will prepare a report on the received information with the aim to share best practices among the Member States.

[150] See for example Article 50 of Regulation 1013/2006 on shipment of waste

2.2.5.3 Potential measures to achieve Specific Objective No 3.3: Establish enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards

2.2.5.3.1 Action at international level to support that roadworthiness (and others) become criteria for export of used vehicles

There are no reasons preventing the EC from acting more proactively in this regard at the UN and UNECE level.

We expect the measure to have low to zero impacts at EU level (exempt some effort for the EU Commission in the respective UN, UNEP, UNECE institutions). However, it is important for the effectiveness in the receiving countries. The aim is to encourage other exporters like United States, UK and Japan to follow the request of Ms. Andersen, Executive Director of UNEP, which said in 2020 “Developed countries must stop exporting vehicles that fail environment and safety inspections and are no longer considered roadworthy in their own countries, while importing countries should introduce stronger quality standards”.

2.2.5.3.2 Promote enforcement actions by MS through EU funding and EU enforcement actions against environmental crime

There are no reasons preventing the EC from supporting implementing measures, e.g. under IMPEL, in particular support for export controls. In the past, several IMPEL activities have addressed the Waste Shipment Regulation[151]; it appears that such activities can be strengthened with focus on ELVs.

2.2.5.3.3 (Extra-EU) Export restrictions for used cars linked to valid roadworthiness certificate; Import rules of receiving countries for age and emission level shall be respected

More and more countries importing used vehicles from the EU are introducing regulations to limit such imports by age and emission standard in order to avoid negative impacts of these imported vehicles on air quality, road safety and pollution from improper disposal. For instance, the Economic Community of West African States (ECOWAS[152]) adopted in September 2020 a Directive to limit the import to those vehicles with a minimum Euro 4/IV emission standard and established an age limit of 5 years for light duty vehicles respectively 10 years for heavy-duty vehicles. Several other receiving countries, but by far not all, have similar restrictions in force.

[151] See: https://www.impel.eu/topics/waste-and-tfs/

[152] Members of ECOWAS: BENIN, BURKINA FASO, CABO VERDE, CÔTE D'IVOIRE, The GAMBIA, GHANA, GUINEA, GUINEA BISSAU, LIBERIA, MALI, NIGER, NIGERIA, SENEGAL, SIERRA LEONE, TOGO

As mentioned by UNEP and UNECE it is difficult to the receiving countries to enforce the import limitations as it is (most) likely that each imported vehicle will find its market in the receiving countries. Thus, cooperation and support by the exporting countries is required to support import limits.

Ms. Andersen, Executive Director of UNEP, said “Developed countries must stop exporting vehicles that fail environment and safety inspections and are no longer considered roadworthy in their own countries, while importing countries should introduce stronger quality standards”

First discussions indicate that setting definitive conditions for export of all used vehicles linked to emissions or age would be at risk to not comply with WTO.

In result the proposed measure is twofold: first implementing a clear criterion for a calid road-worthiness certificate as a condition for the export and secondly drawing attention of the European customs service to the criteria of the importing countries to consider them in the spot checks (risk-based approach).

1. Exporters exporting used vehicles to extra-EU countries must demonstrate that the vehicle to be exported is in possession of a valid roadworthiness certificate.

2. Customs services and other control/inspection authorities of the MS shall, when drawing up their risk-based approach for controlling the export of used vehicles, pay particular attention to the measures adopted by importing countries on the conditions for import of used vehicles, especially limitations based on age or compliance with air emissions like Euro emissions standards.

The effects will be presumably as follows:

Old cars with similar characteristics to ELVs that cannot be repaired in the EU at a reasonable cost will not be exported but scrapped in the EU. This will affect the business model of ATFs in two ways: a) more ELVs will be transferred to ATFs, b) less revenue from the export of used vehicles, which is often also a business of ATFs (e.g. via specialized intermediaries).

The market for (very) cheap vehicles in the receiving countries will decline, cost for mobility will increase. As seen in other counties with import bans/limitations, the fleet will get younger, and the emission level will decline, and road safety will improve.

The market for spare parts from old vehicles in the receiving countries will persist. ATFs will separate more spare parts for export in non-EU countries.

Does it make a difference whether all the three criterial (emission standard / age / valid roadworthiness certificate) apply or if only one applies or a set of two?

Figure 6-11 in Section 6.5.1.3 in Annex I displays findings of a Dutch Study in 2020 on the age and periodic roadworthiness test of exported vehicles from the Netherlands to West Africa (and separately for Morocco) compared to ELVs treated in the Netherlands.

Surprisingly even relatively young, exported vehicles in the categories younger than 10 years have a high share of vehicles without valid roadworthiness certificate or a certificate which expires in less than one month. In total around 15% of the vehicles exported from the Netherlands to West Africa have a valid roadworthiness certificate. Unfortunately, the reasons for this observation are unknown: whether the cars need repair beyond the current value (economic total loss) or by other reasons it is not worth to apply for a renewed roadworthiness certificate, or whether it would be possible to renew the certificate at reasonable cost, at least for the younger vehicles. Considering the last aspect, we assume that at least 30% to 40% of the vehicles (double than displayed in the Dutch report) will have or may get a roadworthiness certificate.

Regards the age we take from the same figure in Annex I that possibly 25 to 50 out of ˜6000 exported vehicles to West Africa are younger than 6 years (representing a share of less than 1%). This is in contrast to the situation in Morocco, where around 75% of the exported vehicles are younger than 6 years. This, of course, reflects Moroccan regulations on the import of used vehicles, which may not be older than 5 years[153].

Concluding on the effects of export limitations (e.g. maximum age for export is 5 years) is not strait forward as we must expect that the exporters will adopt their business to the new rules of export and focus more on younger vehicles. Without considering this adoption effect one would assume that with the implementation of export restrictions less than 1% of the current export would be exported to West Africa. Considering the demand in the receiving countries and the adoption of the import business we might consider for a limitation to 5 years a reduction by 60% to 80% of the exports.

[153] Unfortunately, it is not possible to derive from time series for Morocco's import of used vehicles the impact of the introduction of the 5 years threshold as Morocco supports since a very long period the development of its own vehicle production and support this with regulations / agreements and import taxes. Thus, there is no sudden break detectable in the import data (of Eurostat).

2.3 Extended Producer Responsibility (EPR) and advanced economic incentives

This section addresses the current situation, the problems (if any) and its drivers, why action on EU level might be needed and potential measures under an EPR regime.

Other advanced economic incentives as

- Green Public Procurement, which might include circularity aspects in the future,
- Deposit Refund Schemes (DRF), which might be under EPR regime or under public systems,
- Incentives and penalties in particular to strengthen the relevance of the CoD.

2.3.1 Introduction

While the term EPR is not explicitly mentioned in the current ELVD some provisions oblige the member States to implement basic obligations for the producers. At the same time the WFD established detailed provisions for EPR schemes in Article 8 and 8a for all wastes.

2.3.2 Current Situation

2.3.2.1 ELV Directive

The ELV Directive does not explicitly introduce the term EPR but sets out provisions on the role of producers (e.g., car manufacturers) in respect to the collection of ELVs, as well as on making dismantling information available for each new car, as reflected in the box below:

Main requirements for vehicle producers under the ELV Directive:

Article 2(13):

'Dismantling information' means all information required for the correct and environmentally sound treatment of end-of life vehicles. It shall be made available to authorised treatment facilities by vehicle manufacturers and component producers in the form of manuals or by means of electronic media (e.g. CD-ROM, on-line services).

Article 5(4):

Member States shall take the necessary measures to ensure that the delivery of the vehicle to an authorised treatment facility in accordance with paragraph 3 occurs without any cost for the last holder and/or owner as a result of the vehicle's having no or a negative market value.

Member States shall take the necessary measures to ensure that producers meet all, or a significant part of, the costs of the implementation of this measure and/or take back end-of life vehicles under the same conditions as referred to in the first subparagraph.

Article 8(3):

Member States shall take the necessary measures to ensure that producers provide dismantling information for each type of new vehicle put on the market within six months after the vehicle is put on the market. This information shall identify, as far as it is needed by treatment facilities in order to comply with the provisions of this Directive, the different vehicle components and materials, and the location of all hazardous substances in the vehicles, in particular with a view to the achievement of the objectives laid down in Article 7.

Article 8(4):

Without prejudice to commercial and industrial confidentiality, Member States shall take the necessary measures to ensure that manufacturers of components used in vehicles make available to authorised treatment facilities, as far as it is requested by these facilities, appropriate information concerning dismantling, storage and testing of components which can be reused.

According to the last evaluation report[154] , all Member States without exception have transposed into national law the provision that the delivery of the vehicle to an ATF must occur without any costs for the last holder/owner.

The WFD provides more details regards the implementation of EPR schemes.

2.3.2.2 Waste Framework Directive

In March 2022 the EC submitted a survey on EPR aspects to the Member States. Out of 14 replies 13 states that that they have established an EPR system for ELVs in the MS. 10 out of 14 MS also stated that the EPR system is in compliance with Article 8a[155] of the WFD.

Details of Article 8a of the WFD:

Art 8a(1)

MS shall

d) define the roles and responsibilities of actors involved, incl. producers, PROs, re-use and preparing for re-use operators and waste operators;

e) set waste management targets, at least quantitative targets as laid down in the ELV Directive and set other quantitative targets and/or qualitative objectives that are considered relevant for the EPR scheme;

f) ensure that a reporting system is in place for products placed on the market and data on the collection and treatment of waste resulting from those products specifying, where appropriate, the waste material flows, as well as other data relevant for the purposes of point (b);

g) ensure equal treatment of producers of products.

[154] Commission staff working document (15.3.2021): Evaluation of Directive (EC) 2000/53 of 18 September 2000 on end-of-life vehicles. For details see page 57 ff.

[155] Article 8a is introduced by Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018

Art 8a(2)

MS shall take measures

- to ensure that waste holders are informed about waste prevention measures, centres for re-use and preparing for re-use, take-back and collection systems;
- to create incentives for the waste holders to assume their responsibility to deliver their waste into the separate collection systems in place, notably, where appropriate, through economic incentives or regulations.

Art 8a(3)

MS shall take measures to ensure that producers / PROs

a) has a clearly defined geographical, product and material coverage without limiting those areas to those where the collection and management of waste are the most profitable;

b) provides an appropriate availability of waste collection systems within the areas referred to in point (a);

c) has the necessary financial means or financial and organisational means to meet its EPR obligations;

d) puts in place an adequate self-control mechanism, supported, where relevant, by regular independent audits, to appraise:

i. its financial management, including compliance with the requirements laid down in points (a) and (b) of paragraph 4;

ii. the quality of data collected and reported in accordance with point (c) of paragraph 1 of this Article and with the requirements of Regulation (EC) No 1013/2006;

e) makes publicly available information about the attainment of the waste management targets referred to in point (b) of paragraph 1, and, in the case of collective fulfilment of EPR obligations, also information about:

i. its ownership and membership;

ii. the financial contributions paid by producers of products per unit sold or per tonne of product placed on the market; and

iii. the selection procedure for waste management operators.

Art 8a(4)

MS shall take measures to ensure that the financial contributions paid by the producer to comply with its EPR obligations:

a) cover the following costs for the products that the producer puts on the market in the Member State concerned:

- costs of separate collection of waste and its subsequent transport and treatment, including treatment necessary to meet the Union waste management targets, and costs necessary to meet other targets and objectives as referred to in point (b) of paragraph 1, taking into account the revenues from re-use, from sales of secondary raw material from its products and from unclaimed deposit fees,

- costs of providing adequate information to waste holders in accordance with paragraph 2,
- costs of data gathering and reporting in accordance with point (c) of paragraph 1.

  This point shall **not**[156] apply to extended producer responsibility schemes established pursuant to Directive 2000/53/EC[157], 2006/66/EC[158] or 2012/19/EU[159];

b) in the case of collective fulfilment by PROs, are modulated, […] by taking into account their durability, reparability, re-usability and recyclability and the presence of hazardous substances, …; and

c) do not exceed the costs that are necessary to provide waste management services in a cost-efficient way. Such costs shall be established in a transparent way between the actors concerned.

Derogation to depart from point a) → **anyhow explicitly not applicable for the ELV Directive**

Art 8a(5): Governance and authorised representative

- MS shall establish an adequate monitoring and enforcement framework with a view to ensuring that producers and PROs implement their EPR obligations, including in the case of distance sales, that the financial means are properly used and that all actors involved in the implementation of the EPR schemes report reliable data.
- Where, in the territory of a MS, multiple organisations implement PROs, the MS concerned shall appoint at least one body independent of private interests or entrust a public authority to oversee the implementation of EPR obligations.

Article 14: Costs

1. In accordance with the polluter-pays principle, the costs of waste management, including for the necessary infrastructure and its operation, shall be borne by the original waste producer or by the current or previous waste holders.
2. Without prejudice to Articles 8 and 8a, Member States may decide that the costs of waste management are to be borne partly or wholly by the producer of the product from which the waste came and that the distributors of such product may share these costs.

While Article 8a(4) point a) of the WFD excludes the Producers from the compensation of compliance cost, Article 5(4) of the ELV Directive (the "lex specialis") requires the Member States to "take the necessary measures to ensure that the delivery of the vehicle to an authorised treatment facility […] occurs without any cost for the last holder and/or owner as a result of the vehicle's having no or a negative market value. Member States shall take the

[156] The reasoning is that the detailed provision for (compliance) cost compensation are elaborated in the "lex specialis" as mentioned subsequently. The detailed provisions for the ELV sector are displayed in the previous section ELV Directive.

[157] ELV Directive

[158] Battery Directive

[159] WEEE Directive

necessary measures to ensure that producers meet all, or a significant part of, the costs of the implementation of this measure and/or take back end-of life vehicles under the same conditions as referred to in the first subparagraph."

Despite the intent of WFD Art 8a of placing the waste management costs for Batteries, WEEE and ELV on the producer, for ELV it is insufficiently clear how the compliance costs shall be distributed between the producers and the ATFs.

Producers argue that the costs for depollution and dismantling are covered by revenues from the reuse of components and recycling of materials and producers feel that it is not their responsibility to combat illegal activities. Producers call the system a joint responsibility system of producers and recyclers.

ATFs argue that they are exposed to illegal competitors who do not have to cover all depollution, dismantling and disposal efforts, some of them operate informally at substandard facilities with informally employed staff. Regarding the economic conditions, EGARA, the European Group of Automotive recycling associations has developed a tool on the costs and revenues of ATFs[160], which demonstrates that currently the ATFs are highly dependent on revenues from metal scrap and revenues from separated catalytic converters:

- If these revenues for steel and catalytic converters drop under a certain level, the ATFs are not profitable.
- If the market value of recyclables from the catalytic converters is high, ATFs experience that ELVs arrive without catalytic converters, reducing the revenues for ATFs.
- And if the steel scrap prices are high, the illegal sector competes with ATFs by offering to the last owner higher prices for their ELVs and in result ATFs receive less ELVs during such period

Thus both, low but also high revenues for metal and scrap catalytic converters and depolluted/ dismantled vehicles is not always beneficial to the ATFs and the economic situation is instable.

Many ATFs – in particular the smaller ones - simply survive by performing a combination of activities like repair (garage) activities, export of valuable vehicles, selling spare parts and recyclables that generate revenues.

Other Stakeholders, including Member States, are concerned that the environmental benefits of recycling glass, large plastic parts and copper from the wiring harness and the separation of electronic components is hampered by unprofitable economic conditions and costs to ATFs which are not recovered by the producer.

[160] Results / compilation of a survey of EGARA: delivered to the EC during a (virtual) meeting in February 2021

2.3.2.3 Economic situation of the sector

Two Member States carried out studies on the economic situation of ATFs:

- In 2015, a consortium of Terra SA - Deloitte - BioIS carried out a study for Ademe on the economic evaluation of the ELV treatment chain in France[161]. The study identified a representative sample of 25 ELV centres and 7 approved shredders in metropolitan areas. These sites were surveyed and interviewed regarding their costs. This work revealed a weighted average loss for ATFs of 23.90 € per ELV. However, there was a significant variation in the results, which ranged from -225.20 €/ELV to +109.80 €/ELV for the sample. Approximately 40 % of the ATFs in the sample had a loss on their ELV activities. The result of the ATFs activity is particularly positive for ATFs whose share of ELV turnover is greater than 75 % of the company's total turnover, the result being negative on average for companies whose ELV turnover represents less than 75 % of the company's total turnover. For shredders the cost for the shredding of ELV is difficult to separate as all the shredders in the sample shred other scrap as well. The study reports fewer disparities in the results for the shredders compared to ATFs: the range of economic balance for ELV shredders results in 0.8 €/t ELV as a weighted average (from -29.8 €/t ELV carcasses to +27.2 €/t ELV). The ELV shredder activity is loss making for 3 out of 7 shredders. The operating result for all activities is negative for 2 shredders.
- Germany is carrying out a study on the current cost and revenue situation of German ATFs. Preliminary results were presented during the ELV Expert Group meeting on the 28 June 2021. The presentation concludes that ATFs are not profitable without spare part reclamation. Additional costs would occur for dismantling of glass and plastics which wouldn’t be recovered by revenues for the separated materials. The illegal sector would have in different scenarios higher benefits compared to ATFs of about 250 € to 300 € per ELV[162].

Stakeholders also mention that additional burdens for the ATFs (e.g., the obligation to carry out more intensive dismantling for better quality recycling) will result in a shift to the illegal sector as long as the costs of the additional effort are not recovered e.g., from the producers.

For more details on the economic situation of ATFs and related studies in France and Germany, please refer to section 3.2.5.4

As it became obvious during the stakeholder involvement the economic viability of PST is mainly driven by the national regulations/cost for landfilling. In countries which have restrictions for landfilling (either regards the maximum TOC or a landfill tax), PST is economically viable, in contrast to countries where it is allowed to landfill the shredder residues for 20 € per ton. In the last countries, it is not profitable to invest in PST. For the details on the current restrictions for landfilling please refer to CEWEP[163].

In addition, Member States, which carried out comprehensive compliance inspections in the sector, are concerned about the costs of such inspections and would like compensation for these costs.

[161] ADEME (2015): TERRA SA – DELOITTE – BIOIS - EVALUATION ECONOMIQUE DE LA FILIERE DE TRAITEMENT DES VEHICULES HORS D’USAGE – 2015 – Synthèse. 40 p.

[162] Regina Kohlmeyer (Umweltbundesamt): ELV Treatment: Current cost and revenue situation of German ATFs; preliminary results presented to the ELV Expert Group Meeting (online) on 28 June 2021.

[163] https://www.cewep.eu/wp-content/uploads/2021/10/Landfill-taxes-and-restrictions-overview.pdf, accessed 21 June 2022

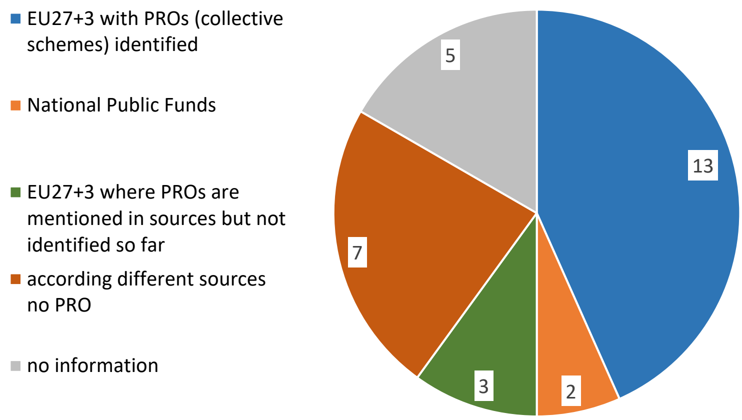
2.3.2.4 Existing Producer Responsibility Organisations

The clauses in the current ELVD do not require explicitly the establishment of "EPR Systems" in the meaning of individual or collective Producer Responsibility Organisations (PRO). Instead 1:1 implementation in the MS is sufficient if the OEMs established contracts with a (sufficient) number of ATFs where these ATFs confirm that they take back all ATFs offered to them "without any cost for the last holder" according to Article 5(4) first subparagraph, and also considering that the delivery of end-of life vehicles is "not fully free of charge if the end-of life vehicle does not contain the essential components of a vehicle, in particular the engine and the coachwork, or contains waste which has been added to the end-of life vehicle." according to Article 5(4) third subparagraph.

Considering the implementation report (published in 2016) [164], all Member States without exception have transposed the provision that the delivery of the vehicle to an ATF has to occur without any costs for the last holder/owner. At least 19 Member States have limited the guarantee of free take-back by the condition that the vehicle contains the essential parts and that no waste has been added. In most cases, the wording of the national legislation is identical or very similar to paragraph 3 of Article 5(4).[164]

To understand the current implementation in the MS better, the EC submitted in March 2022 a questionnaire to the MS on EPR schemes. 14 Member States replied with details accordingly. As displayed in Figure 2-27, PROs are identified for 13 Member States while for other 5 Member States different sources mentioned the existence of PROs, but we were not able to identify them. For 2 of the 5 Member States the existence of national public funds is reported. For 7 Member States it is reported that no PRO is established but the Member States rely solely on individual producer responsibility. For 5 Member States no information is available. As the ELVD is applicable in the EEA countries Iceland, Norway and Lichtenstein too, the following figures refer to EU27+3 EEA countries. More details on the names of the PROs and the sources are displayed in Table 2-12 where UK and Switzerland are displayed in addition for information purposes.

Figure 2-27 Exitance of PROs in EU27+3 EEA countries



Source: see Table 2-12 more below

[164] ARGUS (2016): Implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end-of-life vehicles with unknown whereabouts: Summary report on the implementation of the ELV Directive for the periods 2008-2011 and 2011-2014 ("Lot 2")

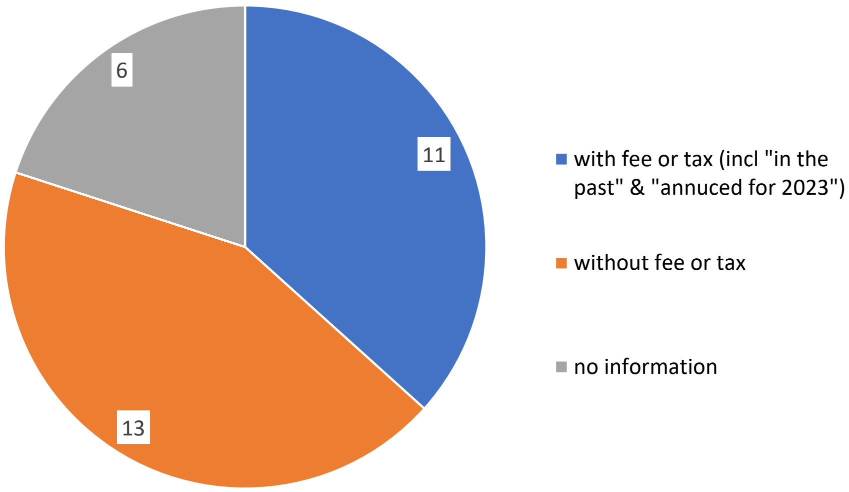
2.3.2.5 Member States where fees or taxes are established for the management of ELVs

The questionnaire submitted in March 2022 to the MS investigated the existence of taxes / fees for the management of ELVs. As displayed in Figure 2-28 below, we identified 11 Member States with fee/ taxes, including those which had a fee / tax in the past and which announced a fee for the future. For 13 Member States no fee applies and for 6 Member States no information is available. For an overview on the kind and level of fees please refer to Table 2-12 below.

In theory a fee modulation could be applied for collective PRO systems. To our knowledge such fee modulation is not applied in any of the EU27+ 3 countries.

More details on the different approaches in the MS and for some MS also the development over time in displayed in Annex I under chapter 6.7 on "Detailed current situation of EPR schemes, PROs and fees / taxes applied in the MS for the management ELVs" at page 620

Figure 2-28 Fees / taxes for the management of ELVs



Source: see Table 2-12 below

Table 2-12 Producer Responsibility Organisations and fees supporting the management of ELVs identified

	Management of EPR / existing PRO	fee	infor-mation	fee / tax for management of ELVs	Source at end of table
AT	OECAR Österreichische Shredder			OECAR in 2022: the fee for producers is € 3.10 per vehicle placed on the market; minimum per brand and year: € 500, maximum per brand and year is € 15.500 each plus VAT. Österreichische Schredder in 2022: the fee for producers is € 1.50 per vehicle placed on the market, plus annual lump sum of € 100. The fees are used for the management of the PRO.	WWW
BE	Febelauto	No		According to its own understanding febelauto's network covers all (!) ATFs in Belgium and Luxembourg. Febelauto does explicitly not take the responsibility of the importer for free take back nor recycling quota.	1)
BG	Bulgarian Recycling Company AD		No		WWW
BG	Ecobulcar				WWW
CY	No information	No			2)
CZ	no PRO; the fund is managed by the State Environmental Fund (Czech Republic):			Vehicle owners pay the recycling fee pay when registering used vehicle. The fee is determined by compliance with the emission limits: CZK 3 000 (app. 120 €) if the emission limits EURO 2, CZK 5 000 (app. 200 €) if the emission limit values EURO 1, CZK 10 000 CZK (app 400 €) in if non-compliant with a) and b). The fee is paid to support the collection, treatment, recovery and disposal of ELVs and their parts, for infrastructure development and for support of alternative fuel vehicles.	1)
DE	no PRO	No			1)
DK	Stena / Dansk Bil-Retur			Car users pay 85 DKK (ca. 11 €) per year and per registered vehicle. Pay-out of 2200 DKK (ca. € 286) to the last owner when handling out to ATF and receiving a COD	1), 3)
EE	Eesti Autolammutuste Liit	No			2)
EL	EDOE	No			1)
ES	no PRO (but SIGRAUTO)	No			1)

	Management of EPR / existing PRO	fee	infor-mation	fee / tax for management of ELVs	Source at end of table
FI	Suomen Autokierrätys Oy			The joining fee is 300 € for those producers who has imported 49 or less cars / previous year, 600 € for 50-99 imported cars; 1200 € for 100-199 imported cars; 1500 € for 200-999 imported cars and 2000 € for 1000 or more imported cars. The amount of annually subscription fees varied in 2014 from minimum 3,20 €/car for those producers who imported more than 3000 cars/year to maximum 18,92 € for those who imported ten or less cars/year. These annually subscription fees cover mainly the administration costs of PRO.	1)
FR	no PRO	No		France adopted recently and amendment to its legislation. To be seen whether this will cause the establishment of PROs and a fee.	4)
HR	Environmental Protection and Energy Efficiency Fund			Management fee to Croatian Environmental Protection and Energy Efficiency Fund, in the amount of 600 HRK/1000kg (approx.€ 800/1000 kg). The Fund covers the costs of the entire ELV management system and ensures the fulfilment of the prescribed objectives of reuse/recovery/recycling: a) Compensation for the last owner when handing over an ELV to ATFs. the pay-out (for a complete ELV) is 1000 HRK/1000 kg (ca € 130/1000 kg). or an incomplete ELV the pay-out is 500 HRK/1000 kg (ca. € 66/1000 kg); b) Compensation for the collector - for collection, storage, and transport of ELVs to ATFs: 150-450 HRK/1000 kg (≈ € 20-60/1000 kg) depending on the distance between the pick-up point and ATF; in the case of transport distance of more than 150 km: the fee amounts to 0,80 HRK/km/t (≈ € 0,105/km/t) of vehicles transported.	1)
HU	No pro but Car Rec		No		www
IE	ELVES			Ireland announced for 2023 fees of 20 € per unit (one-time payment). If a Producer were to self-comply, registration fees would be paid to local authorities. The fees paid to the PRO ELVES are used to support the operation and objectives of their operation – improving the processing of ELVs in Ireland, primarily ensuring ELV reuse, and recovery targets are met and delivering public awareness around the correct way to scrap a vehicle.	1)
IT	no PRO	No			5)
LT	GIA AGIA	No			1)
LU	1 PRO + x Individual	No			2)
LV	1 PRO + x Individual	No			2)
MT		No			1)
NL	ARN			The fee was in 2002 45 € and declined to 30 € per vehicle in 2022. Based on the fee ARN today organises, monitors and continually optimises disposal and processing of end-of-life	1)

	Management of EPR / existing PRO	fee	infor-mation	fee / tax for management of ELVs	Source at end of table
				vehicles. All of the almost 300 partners in the recycling chain can function optimally through a fair distribution key. The details of the distribution are not known.	
PL	2005 -2015: National Fund for Environmental Protection and Water Management			From 2005 to 2015 all natural persons placing vehicles on the Polish market, as well as smaller importers, were required to pay a charge of PLN 500 (just under 110 €) for each vehicle. The manufacturers and importers marketing large quantities of vehicles (those who were required to ensure the vehicle collection network) were exempt from the duty. The funds were deposited by the National Fund for Environmental Protection and Water Management. In 2016 the fund is abolished.	6)
PT	Valorcar			The financial provision for each vehicle placed on the national market for the first time and covered by the current ELVD (M1 and N1 vehicles) is for new and used vehicles 1.2 €. For used vehicles produced (first registered) before 3/Feb/2010 the Financial Provision is 5,0 per vehicle	3)
RO	no PRO		No		2)
SE	Bilretur / Bil Sweden	No			1)
SI			No		-/-
SK	Auto Recycling + 3 individual			PRO Autorecycling is charging its members with 24 € per vehicle. Not all producers/importers entered the PRO; individual systems are existing in parallel.	1), 2)
IS			No		-/-
NO	Autoretur			A) Recycling fee: In 2009 the stakeholders agreed upon a long-term risk sharing model in dependence of the scrap prices (in case of low scrap prices ATFs receive compensation form EPR). The agreement also addresses specific long distance transport cost from ATFs to shredders. A recycling fee of 62,50 NOK (8 EUR) must be paid to the Producer Organisation. B) Car owners pay upon first registration 2 400 NOK to the government for a deposit; Pay-out to the last owner when ELV is delivered to ATF: 3 000 NOK (approx. € 288).	2), 7)
LI			No		-/-
UK	2 PROs	No			2)
CH	Stiftung Auto Recycling		No		WWW

Sources:

1) MS Q 22: Replies of 14 Member States to a questionnaire in March 2022, not published

2) BIO IS 2014: BIO Intelligence Service (2014): Development of Guidance on Extended Producer Responsibility (EPR), Commissioned by European Commission – DG Environment

3) EU WG ELVD: 2016-11-22: Presentation at the EU Working Group on ELVs held the 22 November 2016 in Brussels, not published

4) EU WG ELVD 2022-03-11: Presentation at the EU Working Group on ELVs held the 11 March 2022 in Brussels, not published

5) ADA: personal information from Associazione Nazionale Demolitori Autoveicoli, via Henk Jan Nix (EGARA)

6) EGARA 2021: personal information from Henk Jan Nix (EGARA)

7) S. Sveinsvoll (2019): Siri Sveinsvoll (NBF – Norwegian Car Dismantler Association): The Norwegian ELV System: Presentation at the 4th international conference recycling of vehicles in the country and abroad "practice and experience" 18-20 September 2019.

2.3.3 What is the problem and why is it a problem?

2.3.3.1 Description of the problem

Currently in most countries the so called “shared responsibility” is applied, where Producers
Currently in most countries the so called “shared responsibility” is applied, where Producers
demonstrate (either individually or jointly in a PRO) the compliance with the requirement that ELVs are taken free of charge back from the consumer by contracts with ATFs confirming the free take back. Details of contracts with ATFs, e.g. whether there is compensation for ATFs, are usually not disclosed. From diverse stakeholders it is known that the free take back declarations are issued by ATFs without or with marginal compensation for the ATFs. This system is based on the assumption that it is economically feasible to comply with the requirements of the ELV Directive without cost compensation by Producers.

Currently this is possible as:

- Recyclers achieve the required recycling rate by applying the definition of recycling in the ELVD which allows (in contrast to the WFD) to account backfilling as recycling or declare landfilling of the mineral fraction as a recycling operation as mineral shredder residues are used for road construction purposes at landfills.
- In the ELVD the “point of calculation” is not defined (in contrast to the recycling targets of the WFD and the PPWD). As a result, it is not known at which point in the recycling chain the mass is accounted for recycling and whether additional losses apply after this point
- The current ELVD requires a limited amount of removal in order to promote recycling:
    - removal or catalysts,
    - removal of metal components containing copper, aluminium and magnesium if these metals are not segregated in the shredding process,
    - removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,
    - removal of glass.

    These stipulations do not consider the quality of recycling and cross contaminations for material recycling and almost all countries allow to segregate the mentioned materials in the shredding process. This applies for glass as well, even if it is not explicitly mentioned that glass can be separated in the shredder as well. Electric and electronic components are not considered for removal in the current ELVD (Annex I, Section 4, Treatment operations in order to promote recycling)

More challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, might require more effort at ATFs. Such effort might be as such not economically viable and cannot be covered by revenues or would reduce the profits of the ATFs (which would reduce the competitiveness of ATFs with the illegal sector). New developments like accidental electric vehicles and the removal (and storage) of EoL Batteries are expected to be not economically viable too, at least during the next ten years when only a limited number of EV will occur as ELVs.

While we are of the opinion that Article 8a of the WFD is applicable for ELVs as EPR schemes exist, the awareness to comply with these minimum requirements is limited.

The current system is not future-proof and currently only economically viable reuse, and recycling is conducted[165].

In addition, the system is exposed to strong competition of the illegal sector. Such competition will become more relevant if the ATFs are exposed to more challenging requirements.

In March 2022, several producers are exposed to anti-trust investigations in the ELV sector. The reasoning for the investigations is not known to us yet and to what extent its related to the (current) producer responsibility requirements.

Conclusion on this section:

The provisions in the ELV Directive on the producers' responsibility for the management of ELVs are limited when compared to the obligations for producers in other sectors to contribute financially to the waste management phase of their products, pursuant to the Waste Framework Directive and other EU waste legislation (for example electric and electronic equipment, batteries or packaging) where financial provisions are specified explicitly.
This has an impact on two important elements linked to the implementation of the ELV Directive (the collection of ELV and the recycling/re-use rate of materials from ELVs).

- First, while the car manufacturers have in many MS contributed to ensure that systems are in place to ensure the **collection** of ELV in accordance with the provisions of the ELV Directive, their involvement to address the problems of "missing vehicles" has remained limited. This is in contrast to other economic sectors where producers, usually through EPR schemes, play an important role in making sure that waste deriving from their products are properly collected and reported as such to the competent authorities.
- Second, the absence of clear provisions in the ELV Directive on the responsibility of producers hampers the transition of the automotive sector to a **circular economy**.

This leads to a situation where:

- The economic viability of the ELV dismantling/recycling sector is fragile and hardly allows them to meet the current targets on recycling and re-use set out in the ELV Directive and do not provide an economic incentive to properly depollute and dismantle relevant parts;
- there is limited interest for car manufacturers to consider the recyclability/re-usability of the materials that they are using for the production of vehicles, nor on the quantity and quality of recycling fractions like steel, aluminium and copper/ EEC / non-ferrous.

In addition, there is no incentive for the dismantling/recycling sector to dismantle, recycle or re-use materials or components like plastics, electronics or glass, as these operations generate costs which cannot be covered through the revenues resulting from the sale of these materials and components. As a result, the rate of recycling or re-use of these materials remains very low

The environmental benefits (expressed in credits for reduced $CO_{2\,eq}$ emissions for recycling) are displayed for instance for glass in Figure 3-12 demonstrating a potential credit for better management of glass of around 140 000 t $CO_{2\,eq}$ in 2035. The environmental and economic impacts for other materials regard higher recycling rates and / or higher quality of the recyclate are discussed in section 3.1 on the impacts of measures addressing circularity.

[165] Reuse of parts (and sells for remanufacturing) contribute to the profits of ATFs. Regards the complete economic situation of ATFs pls refer to section 2.3.2.4 Existing Producer Responsibility Organisations at page 89

Furthermore, even for materials which are accounted as fully or nearly fully recycled under the ELV Directive (steel and non-ferrous metals), there is no incentive to perform high-quality recycling, such as ensuring that steel or aluminium scrap from shredding contain minimum levels of contamination by other metals (i.e. copper). This reduces the value of such steel or aluminium scrap and the possibility to use them in a number of applications.

The lack of profitability of the dismantling/recycling sector jeopardises the attainment of the objectives of the ELV Directive and would be an obstacle to the attainment of more ambitious targets designed to ensure a higher recovery of all materials in ELVs, a better quality of the recyclates and subsequently lower environmental impacts in further downstream treatment.

The market conditions therefore do not allow to internalise the costs linked to high quality recycling and re-use of materials from ELVs and the current EU regulatory framework does not address this problem either.

Some Member States have enacted measures to oblige car manufacturers to cover some costs linked to the implementation of the ELV Directive, either through the establishment of fees paid to the administration or the establishment of producer responsibility schemes. These measures are mostly focusing on the obligations under the ELV Directive to ensure the collection of ELV and their delivery to ATF. They do not address the costs linked to the compliance of obligations linked to the dismantling and recycling/re-use of materials, parts and components of ELVs.

There is therefore currently no harmonised approach at the EU level which would ensure the financial profitability of comprehensive and high-quality recycling and re-use of materials, parts and components from ELVs.

2.3.3.2 Description of the problem drivers

Market failure: The current system is purely economically driven. Insofar the dismantlers and recyclers must assess the risk of investments in high quality recycling and volatile prices for recyclables. So even if the investment is profitable today, it might be discarded as too risky due to unclear expectation on volatile revenues for recyclates. The market conditions (high investment causing fixed costs, volatile prices of scraps, competition with prices of virgin materials…) make it challenging for dismantlers/recyclers to perform recycling in line with the current targets and in consequence environmental costs are not internalised. This prevents getting to higher quality and more quantity of materials recycled in the future.

Market failure: As soon as political ambitions regard CE will increase (or prices for steel / Aluminium/catalytic converters drop significantly) the system of the “shared responsibility” between Producer and recycler is at risk to become unprofitable business for ATFs. In this case, it is likely that ATFs seek to escape their obligations and began to behave illegally (and it is not always possible to have inspection or supervision by public authorities) and illegal operators (avoiding all economically not attractive operations) will become more attractive to the last owner as such operators will be able to pay a higher compensation to the last owner, compared to the fully compliant ATF.

Regulatory failure: Today there is no clarification which compliance cost shall be covered by the producers in such a way that gap between compliant and non-compliant operations is sufficiently bridged.

Regulatory failure: The current definition of recycling is too lenient, even not at the level of the Waste Framework Directive (WFD). More advanced criteria, beyond the WFD, regards the quality of the recyclate, with the aim to avoid downcycling, are not established in the current ELV Directive. In consequence and in combination with the not defined contribution of producers to the compliance costs, the dismantlers and recyclers have no incentives or ambition to improve quantity or quality of recycling.

Regulatory failure: Lack of proper EPR provisions in the ELV legislation as for instance the often-mentioned lack of clear responsibility on who shall cover which compliance cost (producer / dismantler/recycler)

Market failure/regulatory failure: The potential to improve efficiency and effectiveness in terms of high-quality recycling through two-way information exchange and improved cooperation is not being realised due to a lack of incentives (or legal requirements):

- Producers miss to learn from dismantler/shredder to design the vehicles for reuse and recycling, avoiding unnecessary dismantling/repair effort and avoiding cross contaminations in recycling fractions.
- ATFs do not have access to information on reuse (digital key) and remanufacturing and on components worth for dismantling for recycling as profitable revenues from high quality recycling can compensate the dismantling effort.
- Cooperation between recyclers and producers is rare when it comes to developing improved recycling technologies and infrastructures to increase the quantity and quality of recycling, especially in the case of new recycling capacities and technologies for newer lightweight materials and electric powertrains.
- Producers are not aware/do not respect the need of long-term perspective for high investment in advanced recycling technology.

Currently, such exchange is limited to information on parts which are legally to be dismantled (IDIS information). A distinct definition on minimum information exchange / cooperation can gain the potential for reuse and recycling mentioned above. Such exchange would make it attractive to act as a legal operating ATF and also attractive for OEMs, as it might reduce the compliance cost to be compensated.

2.3.3.3 Key players and affected population

Directly involved as stakeholders of EPR schemes are producers and ATFs and also shredders as far as it comes to more advanced quality requirements for the shredder output/PST. Public authorities might be involved in the governance or supervision of the collective/individual PROs. The affected population are all vehicle users, depending on the level of required compliance and in consequence the compliance cost, which are subsequently most likely added to the price of the product.

2.3.3.4 Why should the EU act?

The EU established in 2018 the WFD Art 8a the general minimum requirements for EPR schemes that have been established before 4 July 2018. These EPR schemes shall comply with Article 8a by 5 January 2023. The ELV sector is excluded from Art 8a (4a) and the current ELV Directive (lex specialis) established in 2000 thus much before the WFD does not specify how the producers shall contribute to the compliance with the targets. The current regime is purely economically driven, disregarding advanced environmental requirements (circular economy/high quality recycling), contributes strongly to the illegal dismantling sector[166] and is missing to provide specifications for the cooperation of the producers and dismantlers/recyclers.

[166] See sections on "missing vehicles": no incentives apply to register as ATFs and report CoDs, instead illegal operators have an economic advantage of around 300 € per ELV.

Product and waste management legislation like the WEEE Directive (2012), the Packaging Directive (2018) and the draft for the Batteries Regulation, considered as lex specialis in the WFD Art 8a too, elaborate in much more details on the responsibility of the Producers.

As (used) vehicles and ELVs are traded across the EU, discrepancies in the EPR requirements for Producers on the one hand and ATFs and shredders on the other hand would cause unintended shipments between Member States which would violate the principle of proximity (art 16 WFD).

Therefore, and to establish economically a level playing field (similar rules applying to all economic actors in the EU single market with similar EU rules on the protection of the environment (so similar contributions from OEMS across the EU to support dismantling/recycling and similar support to dismantling/recycling sector) it is necessary that the basic rules for the cooperation of producers and the ELV sector and the obligations of the MS in this regard are defined at EU level.

2.3.4 Which objectives should be achieved?

The EPR Scheme for ELVs shall become future-proof and support the CE including high quality recycling and enable investments of the recycling sector which are, under the current situation, considered as too risky.

The specific objectives are to support higher quantity and quality of recycling and re-use in the automotive sector (so higher rate of recycling, especially for materials where it is currently low, and higher quality of recycling for other materials currently officially accounted as recycled, but too often with low quality).

Other elements of the EPR shall trigger the design of new vehicles for CE.

More specific objectives are to ensure transparency and a fair distribution of costs linked to the treatment of ELV, in line with the polluter-pays principles (specification of WFD Arts 8a (4a))

Specification of other elements of Art 8a WFD in the lex specialis as for instance rules for the fee modulation (Art 8a (4b)) or governance aspects (Art 8a (5)) and others.

2.3.5 What are the measures to achieve the objective?

The measures are grouped as follows:

1) Specifications of the General minimum requirements (WFD Art 8a): Obligations for Member States how to establish EPR schemes
2) Specifications of the General minimum requirements (WFD Art 8a): Obligations for Producers:
   a) to support better collection,
   b) to support high quality recycling,
   c) to support design for recycling,
3) Advanced European EPR
4) Other advanced economic instruments / incentives

2.3.5.1 Specifications of the General minimum requirements (WFD Art 8a): Obligations for Member States how to establish EPR schemes

1.1 The new ELV legislation will set out an obligation for all MS to establish national EPR schemes in compliance with WFD Article 8/8a and will, for some aspects provide specifications

1.2 MS shall report on implementation of the minimum requirements (WFD Art 8 and 8a) and the specific requirements under the new ELV Regulation.

Reasoning: No sufficient evidence available whether and how the MS established the minimum and specific requirements for the ELV EPR schemes.

1.3 Member States shall appoint an independent competent authority (clearing house) to monitor the compliance with the minimum requirements addressed in the WFD Art 8/8a and the other requirements added by the “lex specials” for ELVs. Such independent competent authority shall also monitor the average effort for the obligatory compliance operations and the revenues from these obligatory compliance operations and to define, as necessary, financial compensation of compliance operation to ATFs (the last applicable only if the measure compliance cost offsetting is established) and moderate the implementation of the fee modulation Reasoning: this is a specification of WFD Article 8a(5) and Art 8a (4b)

2.3.5.2 Specifications of the General minimum requirements (WFD Art 8a): Obligations for Producers

2.1 Producers to be responsible for the collection of vehicles at holder's premises[167] and abandoned vehicles free of charge for the last holder.

Reasoning: specification of WFD Art 8a(3) point (b).

2.2 Producers to cover the costs for communication/awareness-raising campaigns designed to improve the collection of ELV

Reasoning: re-introduction of the Art 8a (4a), second dash: currently this aspect is excluded for the ELV Directive, but shall be re-introduced by the revised ELV Regulation

2.3 Producers responsible for the establishment of a notification/ reporting system for ELV, CoD and final cancellation of the registration as explained in measure

a) "Obligations for dismantlers /recyclers to check and report on ELVs / CoDs" (page 165)

b) Support to the international notification system as explained in measure "Improve the exchange of information between national registration authorities including obligation for MS to provide reasons for de-registration." (page 165)

Reasoning: this is a specification of WFD Article 8a(1) point (a) and (c).

2.4 Producers responsible to provide rules, software, and plausibility checks for the monitoring of material flows, with the aim to demonstrate compliance with RRR targets. The interfaces for the ATFS and shredders shall be a single contact point / interface (not a different system for all brands) making it most comfortable to the ATFs and shredders to apply the system (and demonstrate compliance).

Reasoning: this is a specification of WFD Article 8a(1) point (a) and (c).

2.5 Producers responsible to support monitoring and reporting on illegal activities in the sector to responsible authorities (police and environmental inspectorates)

Reasoning: As reported at a meeting of the German Ministry of the Environment, the illegal operators are well known to the legal operators, but the legal operators are reluctant to take legal action for two reasons: They are afraid of the time involved in such proceedings, and they are afraid of being personally attacked.

2.6 Producers responsible to cover costs linked to the training of staff from dismantling/recycling sector (for example to acquire the necessary skills to remove batteries from electric ELVs), as well as the reporting, via digital means, by this sector on the attainment of the recycling/reuse targets set out in EU legislation.

[167] As included in the French Climate and resilience bill (2021): Article 32, https://www.legifrance.gouv.fr/jorf/id/JORFTEX00043956924

2.7 Producers responsible to provide easier access to harmonised information (advanced IDIS) as addressed in Measures

- "2.1.f) Obligatory reporting requirements on the use of materials that affect dismantling and recyclability to facilitate identification of incompatible practices" (page 116)
- 2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars" (page 120)
- "Improved communication on hazardous substances in the automotive value chain" (page 123)

2.8 Fee modulation for collective EPR schemes:

Producers shall provide the national competent authority (clearing house) with data relevant for the fee modulation. The national competent authority (clearing house) shall propose/ publish criteria for the fee modulation in close and transparent cooperation with the producers and the stakeholders of the dismantling and recycling sector. The producers shall provide this information together with the information document they provide on reusability and recyclability in the context of the European Union vehicle RRR type approval. For vehicles with type approval before these provisions entered into force, the producers shall provide these data for all types the latest 2 years after this obligation entered into force. Small series and end-of series limits as defined in Annex V of the Regulation (EU) 2018/858 [168] are exempted.

The modulation of total EPR fees can be based on criteria such as:

- Weight of a vehicle (the production of a heavier vehicle requires the use of more primary resources than the production of a lighter one)
- Type of vehicles (combustion engine vehicles, BEV, HEV, PHEV, FCEV, others)
- how much the lifetime / the use phase of components can be expanded by repair, re-use and remanufacturing at reasonable costs,
- The expected level of recyclability/ re-usability of materials and components, based on the 3R type approval declarations
- dismantling time of parts which need to be removed prior to shredding under the new legislation to allow for re-use, remanufacturing or recycling
- the share of materials disturbing recycling / polluting recyclable materials during the recycling process,
- the share of components difficult to repair, reuse, remanufacture or recycle,

[168] Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC

- the level of recycled content (metal, plastics, other),
- The presence and location of hazardous substances

The fee modulations for the national EPR schemes shall be effective at the latest by four years after the regulation entered into force and EPRs shall prove that the modulation effectively contributes to CE and is not marginal to the producers.

If necessary, a detailed methodology/guidance would be established to render the above-mentioned criteria more operational.

> EC entitled to develop guidelines / implementing acts <

Reasoning: this is a specification of WFD Art8a(4)b: The fee modulation shall create economic incentives for those OEMs that advanced compared to the standard in terms of reusability, remanufacturing, and recycling of the product.

2.9 Compliance Cost offsetting

The Producers shall offset compliance cost if these costs are not recovered by the result of the distinct operation. The decision on the required level of the offset shall be discussed in close cooperation with the stakeholders under. The national competent authority / clearing house shall establish procedures for the cooperation, moderate this cooperation and take and publish regular decisions on the level of the offset for different compliance operations.

> EC entitled to develop guidelines/implementing acts <

2.9a Establishment of an obligation for producers to cover costs of the dismantling sector, linked to mandatory dismantling of parts and components prior to shredding, as laid down in the future legislation (i.e. the fees paid by producers should amount to the difference between revenues generated by the sale of these parts/components and the costs linked to their dismantling)

Examples

- The effort of ATFs for the (destructive) dismantling of catalytic converters (and storage and transport to recyclers) is compensated by the revenues for the separated catalytic converters. Offsetting of the compliance cost is not required.
- The effort of ATFs for the (destructive) dismantling of glass, electric and electronic components and large plastic components (and storage and transport to recyclers) is not compensated by the revenues for the separated material. Offsetting of the compliance cost is required.
- The effort for the dismantling of a traction battery from an electric ELV, the storage and the transport to a recycling facility is often not compensated by revenues

received for selling the battery[169]. This is in particular the case if the traction battery is from an ELV after (technical total loss) accident. Offsetting of the compliance cost is required.

Reasoning: specification of Art 8a (4a) WFD. As demonstrated in section 2.3.2.3 "Economic situation of the sector" on page 184, the illegal sector has in different scenarios higher benefits compared to ATFs of about 250 € to 300 € per ELV. In consequence, ELVs are directed in high numbers to the illegal sector. The difference of the benefit between legal and illegal will increase if ATFs shall carry out additional non-profitable obligations in the future to address the Circular Economy aim of the EU. In consequence, more vehicles would be directed to the illegal sector if compliance cost were not compensated.

2.9b Establishment of an obligation for producers to cover costs of the recycling sector, linked to requirements for higher amount and/or quality of recycling (costs linked to the difference between revenues generated by the sale of these materials and costs linked to their recycling, as well as costs linked to training of staff for these dismantling operations and possible investments, for ex. new recycling technologies).

Reasoning: specification of Art 8a (4a) WFD.

2.3.5.3 Advanced European EPR

3.1 EPR Schemes for intra EU Trade (delegated / implementing act)

In case of EPR schemes or DRF schemes apparently unfair allocation of funds between Member States might be caused. To overcome such adverse effects, a transfer of funds together with the export of the used vehicle might be an option.

For this purpose, the EC shall be invited to develop criteria to ensure cross-border cooperation concerning extended producer responsibility schemes for ELVs (see Article 8(5) of the WFD, where this was already foreseen for municipal waste, but has not been done yet). This is important to ensure that EPR schemes properly cover the costs of vehicles which are treated at the end of their life in a Member State which is different from the MS where these vehicles were put on the market.

Reasoning: Used vehicles are traded within the EU in high numbers. For instance, Germany reports statistically documented exports of used vehicles to EU countries in 2018 of 1.95 million plus 0.15 million vehicles of statistically unaccounted exports to EU countries[170]. If a fee is collected for these vehicles when placed on the market this fee is not available to the dismantlers/ shredders where the vehicles was exported to.

[169] This is currently and for the next year expected as the number of such batteries is very small but preparedness for the management is cost expensive as employees need specific education/training and storage needs specific heat controlled and fire-proof containers. Transport is expensive too, as for the next year only limited amounts are shipped, and specific permits are required for the shipment.

[170] German Environment Agency & Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (6 July 2020): Jahresbericht über die Altfahrzeug-Verwertungsquoten in Deutschland im Jahr 2018

3.2 European EPR for the European market (feasibility study)

To assess the opportunity of a harmonised European wide EPR system instead of many national EPR systems, the EC will initiate a working group with Member States and relevant stakeholders to discuss possible options and their advantages and challenges. The EC shall prepare a feasibility report on the results of this working group two years after the Regulation entered into force.

Reasoning: The introduction of an EPR system at EU level rather than at Member State level could be interesting, as the type-approval of vehicles is harmonized for all vehicles placed on the European market (a type-approval in one Member State is recognized in all other Member States). Information requirements are for many aspects the same and procedures and software might be harmonised. Such system would also enable to regulate the transfer of collected EPR fees from the exporting country to the importing country.

It is assumed that such an approach would be appreciated by producers, however the concept is premature and needs more preparation time and cooperation with stakeholders on details.

2.3.5.4 Advanced economic incentives

4.1 Deposit Refund (DRF) Schemes managed by OEMs.

DRF schemes are described in detail in section 2.2.5.2.3. In principle such DRF schemes can be managed by public authorities / public fund management as it is done for the two existing systems in Denmark and Norway. Despite this existing experience it is possible that such DRF schemes are managed under EPR obligations as it is the case for some DRF schemes under the Packaging and Packaging Waste Directive.

As the measure under section 2.2.5.2.3 is developed as voluntary measure, the MS are free to opt whether DRF schemes shall be managed by public authorities or by producers.

4.2 Green Public Procurement (GPP)

The EU GPP criteria are developed to facilitate the inclusion of green requirements in public tender documents. While the adopted EU GPP criteria aim to reach a good balance between environmental performance, cost considerations, market availability and ease of verification, procuring authorities may choose, according to their needs and ambition level, to include all or only certain requirements in their tender documents.[171]

The currently valid document on GPP criteria for road transport addresses for purchase, lease or rental of cars, light commercial vehicles (LCVs) and L-category vehicles with low environmental impact the following aspects[172]:

- TS1. Type-approval CO2 value

[171] https://ec.europa.eu/environment/gpp/eu_gpp_criteria_en.htm (accessed: 10 June 2022)

[172] COMMISSION STAFF WORKING DOCUMENT: EU green public procurement criteria for road transport; SWD (2021) 296 final; Brussels, 18.10.2021

- TS2. Air pollutant emissions
- TS3. Energy consumption display
- TS4. Traffic information and route optimisation
- TS5 Minimum warranty
- AC1. Lower CO2 emissions
- AC2 Energy efficiency
- AC3. Improved air pollutant emissions performance
- AC4. Zero tailpipe emission capability
- AC5. Speed limiter
- AC6 Extended warranty

The Commission's Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) in Seville/Spain is leading the GPP criteria development process on the basis of an annual GPP work plan which is coordinated with the EU Ecolabel workplan. This work plan is adopted in consultation with the informal GPP Advisory Group (GPP AG).

The aspects of repairability, remanufacturing, reusability and recyclability are not considered so far in the last version of the GPP criteria for road transport.

Information with this regard can be derived from the revised RRR type approval and the information provided by the OEMs for the modulation of EPR fees. Today this information is not available yet.

The EU Directive on Energy Efficiency (EED) is currently under review[173], inter alia with the aim to strengthen the obligatory application of the procurement criteria for a broader scope of contracting authorities (see Article 7 in the draft revision).

The measure would be to include an Article in the revised ELV Regulation similar to Article 70 of the draft Batteries Regulation[174]. The Article shall introduce additional criteria for GPP: aspects of repairability, manufacturability, reusability, and recyclability. Two years after entry into force of the Regulation the EC shall provide detailed specification of the criteria and the relation to Directive 2014/24/EU by a delegated act.

[173] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on energy efficiency (recast); Dossier interinstitutionnel:2021/0203(COD), Bruxelles, le 20 juin 2022

[174] EU Commission (COM(2020) 798 final; 2020/0353: Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

2.4 Extension of the vehicle categories in scope of the ELV Directive

2.4.1 Introduction

In an impact assessment, when analysing the burden and benefits of amending a legislative text, the question of the appropriateness of the scope of the legislation is one that is often asked. In the case of the ELVD, the question of an extension of the vehicle categories in scope was raised in earlier studies, e.g., in the Evaluation of the ELV Directive (Williams et. al 2020) as well as in the *Scoping Study to assess the feasibility of further EU measures on waste prevention* (European Commission 2022c). The possibility of extending the scope to additional vehicle categories is sought to analyse the possibility of incentivising a circular approach in the production and end-of-life treatment of vehicles currently outside the scope of the ELV Directive.

The current scope of the Directive (according to ELVD Art. 2.1) includes cars and vans classified as M1[175], light-commercial vehicles classified as N1[176] (< 3,5 tons), and three-wheel motor vehicles as defined in Directive 92/61/EEC 1992[177] but excludes motor tricycles (which are of type L5e as defined in Regulation 168/2013 2013[178]). The study focusses on assessing the need and feasibility of expanding the scope of the ELV legislation to the following type-approved road vehicles:

- L vehicles (powered two- and three-wheel vehicles, mopeds, motorcycles (incl. motorcycles with side-car) and quadricycles), type approved through REGULATION (EU) No 168/2013, referred to as powered two- and three wheelers (PTW) in the following;
- M vehicles (used for the carriage of passengers, e.g. cars and buses), N vehicles (used for the carriage of goods, e.g. lorries), and O vehicles (trailers including semitrailers), type approved through REGULATION (EU) No 2018/858 with the exemption of vehicle category T (agricultural tractors).

Expanding the scope of ELVD to non-type approved e-bikes, ships, planes, trains, agricultural and non-road mobile machinery (NRMM, T-approved), and military purposes & space is not part of the assessment. These vehicles have a common the characteristic that they are non-road vehicles, with the exemption of non-type approved (electric) bicycles. Main reasons for not considering the inclusion of non-road vehicles under the scope of ELVD are that they have own regulations, e.g., for e-bikes or ships, or series in which they are produced are very small, e.g., trains or NRMM. Also, their type-approval is separate to that of road vehicles and in particular does not address objectives of the 3R Type approval. Details can be found in section 6.1.1.

[175] Category M1: Motor vehicles designed and constructed primarily for the carriage of persons and their luggage and comprising not more than eight seating positions in addition to the driver’s seating position. Vehicles belonging to category M 1 shall have no space for standing passengers. The number of seating positions may be restricted to one (i.e. the driver’s seating position). See Regulation (EU) 2018/858.

[176] Category N1: Motor vehicles designed and constructed primarily for the carriage of goods and having a maximum mass not exceeding 3,5 tonnes. See Regulation (EU) 2018/858.

[177] Council Directive 92/61/EEC of 30 June 1992 relating to the type-approval of two or three-wheel motor vehicles (repealed by Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles)

[178] Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles Text with EEA relevance

As on section 7.4.2 discussed, the question also arises as to whether this results in consequences for the scope of Directive 2005/64/EC 2005[179] on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability (3R Directive), and what might be the effects / impacts thereof. Closely connected with ELVD, the 3R Directive ensures that ELVD design requirements are fulfilled. The link between the two Directives is further discussed in Annex II of this report, where sections 7.2.2.2 and 7.4.2 (both in Annex II) specifically focus on the scope of the 3R Directive and its comparison with the scope of ELVD. As the process according to 3R Directive (section 7.2.3, Annex II) is part of the general process of type approval and in particular Regulation of EU 2018/858[180], its functioning is independent of the ELVD. Nonetheless, it is important to consider how the two Directives are kept aligned and how this is to be monitored in the future. Because this study is intended to support the IA of the ELVD, the before-mentioned question only plays a role in a few places.

2.4.2 Current Situation

In the EU, 322 million vehicles were registered in 2020. Currently, by unit, ~83 % of all vehicles are within the scope of ELVD (~74 % Passenger cars (M1 type) and ~9 % lorries (N1 type)) resulting in 17% of vehicles (by unit) that are not covered (line 2 in Table 2-13 plus 1,2% from special purpose vehicles). In terms of mass, about 33 % (~159 million tons of the stock; lines 4 & 5 in Table 2-13 plus 2% from special purpose vehicles) are not covered by the Directive[181]. See the full data and calculation in the Annex I (Table 6-2).

Table 2-13 Overview of units and weights of PTW, buses, lorries and semi-trailers in 2020

	PTWs (L)*	Buses (M2, M3)	Lorries (N2, N3)	(Semi-)Trailer (O)
Stock in 2019/20	22.296.012	703.368	6.218.833	18.250.515
Percentage by number (See Table 6-2)	6,9%	0,2%	1,9%	5,7%
Average weight (without payload) per vehicle (range)	84 kg – 282 kg (ADEME and SURPLUS MOTOS 2022)	8 t – 13,5 t (EC 2015)	2 t – 14,5 t (EC 2015)	2.64 – 7,84 t (see Annex, Table 6-8)
Total weight of stock in 2019/20	4.080.170 t	7.561.206 t	51.305.372 t	95.815.204 t

[179] Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 on the type-approval of motor vehicles with regard to their Reusability, Recyclability and Recoverability and amending Council Directive 70/156/EEC

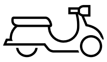
[180] Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC

[181] A recent publication (2022c) reported that a share of 19% by weight (94 million tonnes) was not covered by the ELVD. However, this study did not include the trailers and semi-trailers. According to the data in Table 6-2, trailers represent ~5,7% of all vehicles by number and ~18,1% by weight.

(See Table 6-2)				
Percentage by weight (See Table 6-2)	0,8 %	1,4 %	9,7 %	18,1 %

Source: Eurostat 2021 for stock of PTW and (semi-)trailers in 2019; PRIMES (European Commission 2022b) for stock of buses and lorries in 2020. A full overview of data is provided in Table 6-2 (Annex I).
Notes: (*) The Eurostat dataset is not consistent with the L-type-approval categories of (EU) 168/2013. It is assumed that in addition to the indicated number of motorcycles, 10-15% of additional L-type approved vehicles might be on the market.

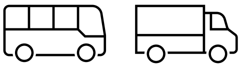
Information that provides an overview of the current situation of end-of-life treatment and circularity of vehicles not in scope of ELVD is rare. Therefore, the stakeholders' descriptions represent an important reference for describing the status-quo.



Looking at powered two-wheelers (PTW), only a very small number is returned to recyclers, i.e., to authorized treatment facilities (ATFs) as parts are supposedly removed by the owners and specialized operators beforehand. Figures as to the numbers of PTW treated in ATFs cannot be provided due to the lack of data. As far as it is known, there are no specific PTW recyclers ('never seen one', says the European Association of Motorcycle Manufacturers ACEM). Compared to other types of vehicles, such as cars, PTW have no 'chassis'. Thus, a component which represents a considerable amount of vehicle's material is not available. This means that the material from PTWs that could potentially be sent to shredder after removal of components is very little. In general, 'car dismantlers say that they would gladly take the PTWs [if they would get them]. Standard tools can be used, dismantling is easy, no investments nor additional training of recyclers is needed. Car recyclers receive accidental PTW but not the end-of-life PTW.' (ACEM 2021)

In general, stakeholders reported that the practice of reuse is more established for PTW as well as for trucks and buses than for passenger cars (ACEM 2021; ACEA/Volvo 2021; ANERVI/AETRAC 2021). This is supported through reuse statistics for PTW in Finland (SMOTO 2021) and best-practice examples for heavy duty vehicles from literature (Saidani et al. 2018). The reuse rate of the parts for PTW at Finish operators specialized in the handling of motorized two-wheeled vehicles was found between 60 and 70%. At around 95%, the reuse rate is even higher for practitioners at motorcycle clubs (hobbyists). On the other side, at operators specialized in car handling, the reuse of parts from PTW is only around 10% (see Annex, Figure 6-3).

In 2019, the EU motorcycle sector had 389 000 jobs and contributed around 21.4 billion euros to the gross domestic product across Europe. In terms of tax revenue, 16.6 billion euros can be attributed to the motorcycle industry, which is particularly important in the large markets such as Germany, France, Italy, the UK and Spain. Export of European and UK-based companies in the motorcycle sector to non-European customers worth around 2.1 billion euros each year. The most important export markets include the USA, Switzerland, Australia and Japan. (Dervisevic 2021) With regards to masses or weights motorcycles are significantly lighter than cars: motorcycles on average weigh less than 10% to 15% of a car. Also, the number of parts is smaller than that of cars. This in consequence will lead to lower recycling masses and less parts available for reuse. (ACEM 2021)



While PTWs can be treated at car recyclers, buses and lorries[182] require treatment at specialized dismantling and recycling facilities. Lorry and bus dismantlers and recyclers require larger spaces due to the larger size of the vehicles, e.g., larger space for storing ELVs, and they require different equipment for the depollution or to work with specific components, e.g., steel parts are thicker in lorries. At present, national ELV and general waste legislations oblige dismantlers and recyclers to pre-treat, i.e., de-pollute, end-of-life lorries. (ACEA/Volvo 2021; ANERVI/AETRAC 2021) Lorry recycling infrastructure is different in different EU MS: In Spain, 25-30 ATFs exist that treat ELV lorries. ‘Heavy duty vehicles that have been received by ATFs in Spain in 2021 were around 7.000 units,’ says a representative of SIGRAUTO (Workshop 2022). Additionally, according to ANERVI/AETRAC, Lithuania, Estonia and Latvia have a strong business in lorry treatment. In many countries, e.g., France, the number of end-of-life lorries is expected to be too small for specialised ATFs to be economically viable. According to a representative of ADEME, ‘today, there are only nearly 20 specialised companies in France’ (Workshop 2022). Generally, lorry recycling is considered a profitable business due to the high number of metals (EGARA 2021). Thereby, means costs can be topped by the revenues from recycling and spare part sales. ‘Buses are a bit different – the engines are similar to trucks. The parts of the steering can be used, and they are probably also exported. There is more waste on a bus, because it has a lot of glass and sometimes the coach has (laminated) aluminium or other funny materials’, EGARA (2021) says.

Stakeholders reported that the practice of reuse is more established for trucks and buses (as for PTWs) than for passenger cars (ACEM 2021; ACEA/Volvo 2021; ANERVI/AETRAC 2021). Looking at lorries, according to ANERVI/AETRAC (2021), ‘there is a specialised market for parts from lorries across Europe. There is a high demand for and well established communication on the availability of spare parts A flourishing market for spare parts suggests that repair and reuse play an important role in the end-of-life treatment of lorries. ACEA/Volvo (2021) comments that ‘reuse […] is already strongly driven by the market’ and adds that ‘certain components that are very expensive can also be refurbished and reused – like engines, turbo chargers, catalysts, starter engines. So, everything is already designed to allow the easy replacement during the lifetime of a lorries. We already design for reuse. Customers demand delivery over 20-30 years for spare parts. It is driven by supply and demand.’ Another business model is the leasing of vehicles, e.g., SCANIA (2022) considers ‘a shift towards servicisation’, thus, ‘transport as a service, mobility as a service, vehicles as a service, shared services, operational lease, rental’.

A study by Saidani et al. (2018) supports these statement (details are described in Annex I, section 6.1). Information on or any estimation of a reuse rate for parts from lorries is lacking. For buses and trailers, information on the extent of reuse of parts is not available from stakeholder interviews.

Main materials of trailers are steel, plastics, light metals, e.g., aluminium, textiles (for curtains), and wood. ANERVI/AETRAC says that ‘an ATF that can manage trucks, can also manage the trailers. Sometimes they do specialised dismantling campaigns for a certain type of trailer’, e.g. temperature controlled boxes that need additional treatment steps due to the removal of coolants.

[182] Eurostat differentiates between road tractors and lorries, however, whenever this report refers to ‘lorries’ vehicles for transportation of good >3,5 tons are referred to including road tractors.

2.4.3 What is the problem and why is it a problem?

2.4.3.1 Description of the problem

The Evaluation (Williams et. al 2020) has identified that, though the majority of vehicles is covered by the ELVD, 'gaps remain' with regards to vehicles other than M1 and N1. Against the background of numbers presented above in terms of what is not covered by the Directive by weight these gaps are considered significant. The following subsections present and describe six problems associated with the vehicles not covered under the ELVD (no ranking):

1) The potential to contribute to the CE of a large share of vehicles is not exploited yet
2) Missing traceability for vehicles not in scope of ELVD
3) For vehicles not in scope of ELVD, there is no legal incentive to design for circularity
4) For vehicles not in scope of ELVD, the current legal setup is insufficiently harmonized across the EU
5) Inconsistency between scopes of ELVD and 3R Directive
6) Increase of the total amount of vehicles

The potential to contribute to the CE of a large share of vehicles is not exploited yet

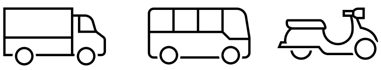
The overall problem is that the potential to contribute to the circular economy of a large share (17% by unit, ~ 47 million, or 33% by mass, 159 million tons; Table 2-13) of vehicles in the EU market (but outside the scope of the ELV Directive) is not exploited yet: Table 2-14 displays the dimensions of material streams to be expected from ELVs not in scope of ELVD: Based on the expected number of ELVs, **the average sum of materials from powered two- and three wheelers (PTW), buses and lorries that became waste in 2020 amounted to more than 7,54 million tons.** It is expected that this is an underestimation due to missing data on other types of L-type-approved vehicle categories of (EU) 168/2013. T**he average sum of material from PTW, buses and lorries that are expected to become waste in the year 2030 increase to more than 10,14 million tons,** which is an underestimation just like above.

Table 2-14 Dimensions of material streams from ELV not in scope of ELVD

	PTWs (L)*	Buses (M2, M3)	Lorries (N2, N3)	(Semi-)Trailer (O)***
Nr. of ELV expected in 2020	1 336 572	28 061	212 025	1 007 722
Total sum of material from ELV expected to became waste in 2020**	0,11 – 0,38 million tons	0,22 – 0,38 Mio tons	0,42 – 3,00 million tons	2,66 – 7,90 million tons
Sum in 2020	ø 7,54 million tons (range: 3,42 – 11,66 million tons)			
Nr. of ELV expected in 2030	1 557 104	31 359	263 158	1 402 422

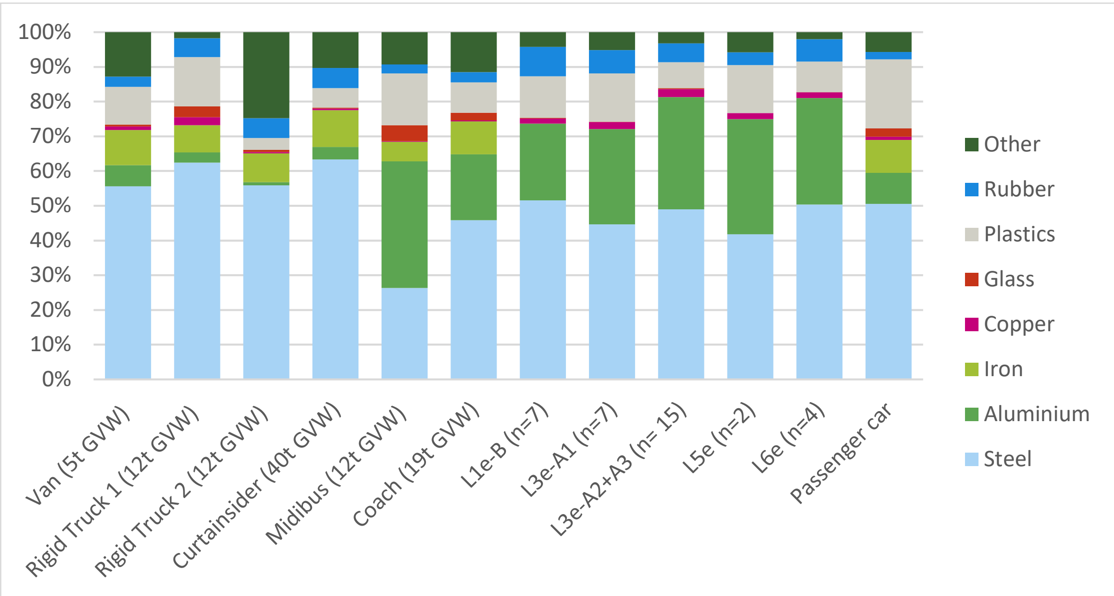
	PTWs (L)*	Buses (M2, M3)	Lorries (N2, N3)	(Semi-)Trailer (O)***
Total sum of material from ELV expected to become waste in 2030**	0,13 – 0,44 million tons	0,25 – 0,42 million tons	0,53 – 3,82 million tons	3,70 – 10,99 million tons
Sum in 2030	ø 10,14 million tons (range: 4,61 – 15,67million tons)			

Source: ELVs: Oeko model based on stock in Table 6-2; sum of material: range; calculated based on data in Annex I chapter 6.1.3.
Notes: (*) underestimate, an additional amount of plus 10-15% of L-type approved vehicles can be expected.
(**) The numbers are given per year, i.e., 2020 and 2030. It is not a sum of material expected to become waste until 2030.
(***) (Semi-)Tailers have a high variety in total weight and material composition. It was not possible to obtain generalized data or to assume their material composition due to the high variability in the vehicles. See examples for the weight of trailers in the Annex (6.1.1).



The **material composition** of selected lorries, buses and PTWs shows that steel, aluminium, iron, copper, glass, plastics and rubber are the main materials with regards to their weight in the vehicles (Figure 2-29). Absolute numbers of the total weight and of the individual material fractions are provided in the Annex (chapter 6.1.3). A differentiated material composition per vehicle with different drivetrain (other than M1 and N1) is lacking.

Figure 2-29 Material composition of examples of lorries, buses and PTWs compared to cars



Note: It is assumed that Plastics represents thermoplastics. Foams and elastomers were included in "others" where primary data indicated these materials specifically.
Abbreviation: GVW=gross vehicle weight.
Source: (Wolff et al. 2020; Ricardo-AEA 2015; ADEME and SURPLUS MOTOS 2022; Bouter et al. 2020) See absolute values and attribution of sources per vehicle in the Annex (Table 6-11).

In almost all examples, except for the midibus, the steel fraction has the highest shares with 42% (L5e) up to over 60% (rigid truck 1 and curtainsider). Aluminium plays an important role in buses and PTWs, however, from the available data, wrought and cast aluminium fractions cannot be distinguished. Iron can be found in lorries and buses, but not in PTWs. In percentages, copper fractions are highest in PTWs. As expected, glass fractions are highest in buses. There is no vehicle type that leads the comparison in terms of percentages for plastic.

It should be noted that sources of information are different for different vehicles. It is possible that authors of different studies attributed different individual materials to the group of plastics. If primary data was regrouped for the purpose of this study, data on elastomers and foams, specifically, was included under 'others'. It is assumed that 'plastics' represent recyclable thermoplastic fractions. Depending on the source of information, the group of other materials contains elastomers, foams, textiles, leather, lead, glass-fibre reinforced materials (in trucks), paint, zinc or magnesium. Knowing that this is a high variety to be grouped under 'others' but considering the less significance of the weight of the group of other materials, the variety is considered acceptable. In the example of the rigid truck 2, glass-fibre reinforced material has an individual share of 16% of the total vehicle.

Based on the weight, material composition and fleet data, it is possible to outline the dimension of materials from end-of-life vehicles that are currently not in scope of the ELVD. This would imply that these materials may not enter recycling streams, their environmentally sound treatment is not ensured and the possibility to steer the sector outside the scope of ELVD towards circularity is not given. The data presented in Table 2-14 and Figure 2-29 is used in the quantitative impact assessment to further characterize material streams which are used as a basis for the assessment.

Missing traceability for vehicles not in scope of ELVD

An additional factor leading to losses of materials for the EU, is the missing traceability: Export of vehicles and illegal waste operations are a problem for all vehicles, including M1, N1, and lorries, buses, PTWs etc. because it is leading to material losses. Member States are obliged to collect statistical data on the ELVs in scope (Commission Decision 2005/293/EC[183]). However, statistics on ELVs other than M1 and N1 vehicles does not exist. There is no specific waste code for PTW, lorries or buses to separate them from waste cars. Thus, the overall dimensions of yearly numbers of ELVs others than passenger cars (M1) and light duty vehicles (N1) are unclear.

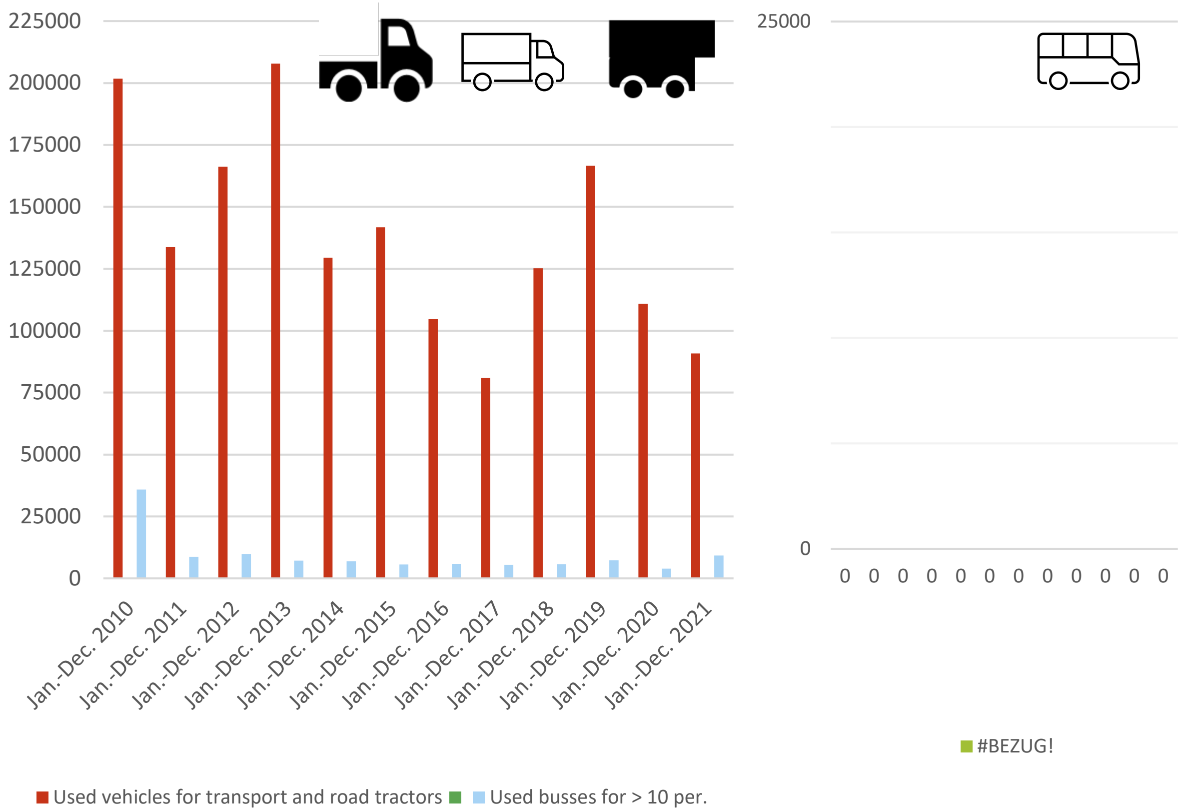
However, there is statistical data on the export of used vehicles (EU trade statistics database, European Commission 2022a). According to answers to Slido questions during the stakeholder meeting (Workshop 2022), the export to non-EU-countries (as second hand vehicles) is the typical EoL scenario for the majority (> 50%weight) of buses, lorries and trailers. For PTW, the most common EoL scenario is dismantling for reuse. Motor vehicles, trailers and semi-trailers are highly traded goods, e.g., according to the German Federal Statistical Office these vehicles 'continued to be Germany's most important export goods in 2019.' (Destatis 9 Mar 2020) And the fact that African countries adopted polies and import restrictions for used vehicles including lorries[184], shows that the export of used lorries is part of that viable business.

[183] For Eurostat (yearly reporting), MS they are asked to name the "total number of vehicles of ELV" and number of CoD issued. Ideally the CoD issued by ATF should be shared with the national authority and the number of CoD should reflect the real number of ELVs arising in the country. COMMISSION DECISION 2005/293/EC of 1 April 2005 laying down detailed rules on the monitoring of the reuse/recovery and reuse/recycling targets set out in Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles.

[184] 'Egypt and South Africa, for example, have banned the import of used vehicles. Morocco has an age restriction for imported Light-Duty Vehicles (LDVs) and Heavy- Duty Vehicles (HDVs) of five years and requires vehicles to be at least Euro 4.8 Libya has set an age restriction of ten years for Light-Duty Vehicles and Heavy-Duty Vehicles in 2019.' (2020).

The export data for the period of 2010-2020/21 was analysed for used lorries (vehicles used for transport and road trucks), buses for >10 per. and (semi-)trailers within the context of this study in order to understand the aspect of export of 2nd-hand ("used") vehicles as part of the problem of vehicles of unknown whereabouts. Extra EU Export data is considered robust as customs collect this data for trade purposes[185]. The data is available in the Annex (chapter 6.1.5).

Figure 2-30 Extra EU Export of used vehicles for 2010-2021 in numbers.



Source: EU trade statistics, European Commission (2022a), , Product Codes: 87012090 (used road tractor); 87021019, 87021099, 87029019, 87029039 (used buses); 87042299, 87042399, 87043299 (used lorries); 87163980 (used trailers). Data in Annex I, Table 6-9.

When comparing the numbers for four types of vehicles, namely road tractors[186], lorries, trailers and semitrailers and buses, Figure 2-30 (and data in Table 6-9, Annex I) shows that

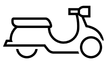
- On average, 80 120 used road tractors and 76 839 used vehicles for transport were exported per year. Both vehicle groups together relate to ~74% of expected waste lorries (Stock in 2020 (PRIMES): 6 218 833, Nr. of ELV expected in 2020 (Oeko model): 212 025).

[185] This is different for intra EU trade data which is less robust, however, for the purpose of this analysis, only extra EU trade data has been assessed.

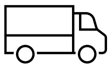
[186] Eurostat and trade statistics differentiate between lorries and road tractors. For the reason of simplifying most of the analysis does not differentiate between these two vehicle categories but when speaking about lorries, road tractors shall be understood to be included. For the model of ELVs, lorries

- On average, 75 074 used (semi-)trailers were exported per year relating to ~8% of expected waste lorries[187] (Stock in 2019 (Eurostat 2021): 18 250 515, Nr. of ELV expected in 2019 (Oeko model): 976 946).
- On average, 9 327 used buses are exported per year, this relates to ~34% of the expected ELVs (Stock in 2020 (PRIMES): 703 368; Nr. of ELV expected in 2020 (Oeko model): 27 658).

Generally, the number of exports decreased, at least for road tractors, buses and trailers; even if excluding the year 2010 which seem to show exemptional high export numbers. Authors of a Dutch study (Netherlands Ministry of Infrastructure and Water Management, Human Environment and Transport Inspectorate 2020) provide an argument for the general trend: West-African countries ‘have decided that as of January 1, 2021, they will only import used vehicles with a minimum Euro 4/IV emission standard. Considering this, it is noteworthy in our findings that the vast majority of the used vehicles (more than 80%) currently exported to these countries will not meet their future import criteria. They are too old and below Euro 4/IV emission standard. Moreover, several emission control systems are not present, functioning, or removed’. Renault Trucks considers that the increasingly complexity of the exhaust emission control system and the hybridization of truck engines will make exporting trucks to non-EU countries more difficult. Therefore, one solution has been to develop a network of specialised companies for treating trucks that links the dismantling network with repair networks to allow a high level of referencing for parts. (contribution from France, MS meeting 2022).



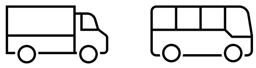
For PTWs, there are no codes for the trade in used products. Thus, the aspect of export of 2nd-hand (“used”) vehicles as part of the problem of vehicles of unknown whereabouts cannot be studied for this vehicle category.



The ~157,000 used lorries (vehicles for transport + road tractors) leaving the stock per year potentially represent 1.1 million tonnes of waste. Based on the average material composition of lorries (according to Table 6-7), this represents a material flow of about 670 000 tons of steel, 106 000 tons of iron, 34 000 tons of aluminium, 10 000 tons each of copper and glass, 80 000 tons of plastics and 61 000 tons of rubber (see Annex Table 6-11). Used lorries are exported to Jordan (TOP 1), Ukraine, Afghanistan, Serbia and Saudi Arabia (in the row of accumulated exports from 2010-2020).

In addition to statistical numbers, an exemplary study is presented showing that problems associated with export of used vehicles are real: Export of lorries (the report refers to ‘heavy duty vehicles’) to African countries was studied in the Netherlands as part of a broader study on exported vehicles to Africa. ‘We have inspected a group of thirty-eight diesel vehicles. […] Eighteen vehicles are lorries for the carriage of goods, like trucks. […] Diesel lorries are from sixteen different brands. The five most prominent brands are Mercedes, Volkswagen, Man, Iveco, and Hyundai. […] Our desk study indicates that a significant part of the used vehicles exported to Africa is often very old and very similar to end-of-life vehicles recycled in the Netherlands. The “leakage flow” to Africa involving uncontrolled treatment of vehicles causes environmental harm if hazardous liquids or other hazardous substances leak into the environment and causes related injuries to the health of the people handling such materials inadequately. There is also a risk of losing secondary raw materials.’ (Netherlands Ministry of Infrastructure and Water Management, Human Environment and Transport Inspectorate 2020)

[187] As the Nr. of ELV expected was modelled based on Eurostat, this data is less profound compared to the other vehicles in this chapter modelled in accordance with EU reference scenario 2020 or PRIMES data.



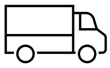
The photographs of buses and lorries in Figure 2-31 have been taken in Nigeria and Greece. They support the findings of the export data analysis in their conclusion that the problem of traceability and unknown whereabouts exists in practice, also for lorries and buses. One of the pictures suggest that vehicles might be parted out substantially, another that vehicles are "disposed of" in the natural environment. Several pictures taken in Nigeria are showing vehicles with German writing (advertisement).

Figure 2-31 Buses and lorries of unknown whereabouts.

Note: Pictures in middle and downer row have German writing though photos were taken in Lagos, Nigeria.
Source: left upper corner by G. Mehlhart (2018, Kreta, Greece), others by A. Manhart, Oeko-Institut (2009, Lagos, Nigeria).

For vehicles not in scope of ELVD, there is no legal incentive to design for circularity

One important aspect to support circularity is the design. So far, there is little incentive to design and produce vehicles in a way which limits the use of primary materials and increase the use of secondary materials: For vehicles not in scope of ELVD, the waste framework directive (+ MS specific regulations, if exists) applies. However, EU regulation on the design for circularity (e.g., 3R Type approval, hazardous substance requirements) of such vehicles does not exist. Also, the waste framework directive does not include design aspects specifically. Some stakeholders admit that the current contribution of the sub-sector of vehicles not in scope of ELVD is limited: For instance, according to the Spanish industrial vehicle recycler's association "at the moment, lorry producers are not aligned with the vision for End-of-life of the vehicles. This means, that they currently do not have any objectives to optimize dismantlability etc." (ANERVI/AETRAC 2021)



A trend for reducing the weight of vehicles is expected as in the case of cars (chapter 2.1.2.1). In one example presented in Figure 2-29 ('rigid truck 2'), glass-fibre reinforced material has an individual share of 16% of the total vehicle. It is not possible to say, how many of such vehicles there are in the total EU lorry fleet. Depending on the materials used for weight reduction, this could have a negative effect on increased emissions in the production phase, e.g., if aluminium is used to replace steel, or could have an effect on the recyclability of such vehicles, in cases where non-recyclable, e.g., carbon-fibre based materials are replacing recyclables. In the best case, 'lorries are highly recyclable: 85% of their weight consists of iron, steel and aluminum. One third of a Volvo Group's lorry is produced from recycled materials. The high degree of commonality of Volvo Group's products facilitates the remanufacturing and reuse of spare parts' (Saidani et al. 2018). However, lorries 'concentrates less on recycling technologies and more on materials that are more ambitious for environmental impact reduction (e.g., lighter materials = positive impact on use phase | lighter vehicles mean less energy needed to use the vehicle *[comment of author: or higher payload]*). In design considerations a larger importance in given to the use phase of vehicles, especially to weight (to save on energy consumption *[comment of author: or increased payload]*); if the energy mix becomes 'greener', it might be that impacts in other life-cycle phases will gain in importance. Load carrying capacity reduces the number of lorries on the road – as you can transport more goods.' (ACEA/Volvo 2021) Besides environmental benefits, as load carrying capacity are of the priority product priorities for lorries (SCANIA 2022), there is a direct economic incentive to reduce weight in the case of lorries as it directly adds to load carrying capacity.

Typical materials in lorries can be replaced by lightweight materials, entailing a weight reduction potential each. The higher the weight reduction potential, be better the energy efficiency, or the higher the payload, in the use phase of the vehicle, see Table 2-15. High weight reduction potential is attributed to various composite materials.

Table 2-15 Lorries: Strategies for weight reduction focus on composites

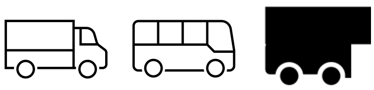
Lightweight material that can be used as a substitute for typical materials in lorries	Material replaced	Weight reduction potential archivable through substitution
Carbon Fibre Composites	Steel	50-70%
Magnesium	Steel, Cast Iron	30-70%

Aluminium	Steel, Cast Iron	30-60%
Glass Fibre Composites	Steel	25-35%
Advanced materials*, includes metal matrix composites	Steel	10-30%
Advanced high strength steels	Mild Steel, Carbon Steel	10-30%
Steel and cast iron (propulsion)	Mild Steel	0-15%

Source: (U.S. Department of Energy 2013)
(*) Note: Encompasses titanium, nickel alloys, metal matrix composites

Inconsistency between scopes of ELVD and 3R Directive

The 3R Directive is an aspect closely related to the problem mentioned before. In relation to the design requirements set out in the ELVD, the 3R Directive plays an important role in ensuring that vehicles placed on the market comply with ELVD design requirements. The report attached to this study in Annex II has the aim to provide a targeted review of the 3R Directive with a focus on the interlinkages between ELVD and 3R Directive. It was identified, that currently, the scopes of ELVD and 3R Directive are similar but not identical. Exemptions from the Directive vary among the two legislations. Both include passenger cars classified as M1 and light-commercial vehicles classified as N1 (< 3,5 tons) in the scope. In terms of the exemptions, small series and multi-stage built vehicles are generally exempt from 3R Directive but not mentioned in ELVD. Special purpose vehicles are generally exempt from the 3R Directive too, however, they are in scope of ELVD[188] but exempt from Art. 7 provisions of ELVD. A tabular overview covering the mentioned and additional differences in the scopes is provided in Table 7-6 (Annex II).



Major discrepancies exist in relation to vehicles produced in small series and for multi-stage-built vehicles. The fact that the multi-stage built vehicles and small series are not specifically mentioned under ELVD effectively means that the ELVD requirements, including the Art. 7 (3R targets), apply for multi-stage built vehicles and vehicles produced in small series, if M1 and N1 type approved. See examples for such vehicles in section 7.4.2 (Annex II). On the one hand side, these vehicles might be produced in small series, but in that case, there is no exemptions for them in the ELVD, thus, they need to comply with ELVD. On the other hand, these vehicles might comply with the criteria for special-purpose vehicles specified in the general type-approval (Regulation 2018/858, Annex I, Part A). If so, they are exempted from Article 7 provisions of ELVD (but not generally). To conclude, if multi-stage built M1 or N1 vehicles (whether produced in a small series or not) do <u>not</u> fulfil the criteria for special purpose vehicles– which is considered only in a few cases - it is assumed that the compliance with the 3R targets, hazardous substance provisions etc. is not ensured. There is no statistical evaluation possible on EU level on the extent of the problem, nor it is on MS level as the data is most likely not collected. It is understood from ACEA/Volvo (2021) that nearly all N2, N3, and possibly M2, M3 and O vehicles are multi-stage build vehicles. When assessing the need and feasibility of expanding the scope of the ELV legislation to N2, N3, M2, M3 and O vehicles, aiming to use the 3R Directive to ensure design for circularity for vehicles placed on

[188] In its frequently asked questions chapter, the ELV Guidance Document (EU, 2005) clarifies that motor caravans are in scope. This is explained based on Directive 70/156/EEC, which defines motor caravans as a special purpose M category vehicle.

the market, the discrepancies of ELVD and 3R Directive in relation to multi-stage build vehicles need to be overcome. The process of multi-stage type approval is explained in the Annex (chapter 6.1.6).

For vehicles not in scope of ELVD, the current legal setup is insufficiently harmonized across the EU

It can be understood that the waste management of motorcycles, trucks and buses is currently not subject to regulation at EU level. However, some MS require that the treatment of motorcycles and trucks is ensured and/or environmental permits for facilities are requested through vehicle-specific or general waste legislation. This is the situation at least in Spain, France, Flanders/Belgium, Lithuania, Italy, Hungary, Netherlands, and Germany. There is no regulation on end-of-life of vehicles not in scope of ELVD in Greece and Finland. For the majority of MS, requirement for treatment in ATFs exists and subsequently the deregistration based on Certificates of Destruction (CoDs). (EU MS ELV IA Survey 2022; EGARA 2022b; ACEM 2021)[189]

Examples of the design of the regulation are

- Spain: Differentiated waste codes. While 160104* is the EU waste code for ELVs[190], in Spain, there are 160104*-10 (cars, vans) and 160104*-20 (other vehicles) Real Decreto 265/2021, Anexo VIII *Codification Ler-Veh*[191]*.* The coming into force was on 15.04.2021.
- The Netherlands: A voluntary EPR for scooters for mopeds and mopeds up to 50 cubic centimetres, the Scooter Recycling Nederland (SRN), was founded by importers, dealers and garages in 2011 (Auto Recycling World 2021). 'The network exists of 180 delivery points and 65 scooter dismantlers (mostly cars dismantlers that do scooters as a side job). Aim is collection without costs for the last owner and sustainable recycling.' (EGARA 2022b) The system is voluntary at present. According to the SRN webpage (BOVAG; RAI 2022), 25 000 scooters were scrapped at drop-off points of 1.2 million scooters in the Netherlands.
- Italy: Vehicles other than M1 and N1 are governed by the waste framework legislation in part IV of the Legislative Decree n. 152 of 3 April 2006 and subsequent amendments, in particular by article 231, and subsequent amendments, which transposes Directive 2000/53/EC. The legislative decree D.Lgs 152/06, Article 231 '*End-of-life vehicles not covered by D.Lgs 209/03'*[192] details how motorcycles must be managed. e.g., the technical requirements of the ATF motorcycles and for the dismantling phases (depollution and demolition) are the same.
- The French anti waste bill's[193] scope, the EPR scheme especially, was expanded to 2,3-wheel vehicles and quadricycles, thus, the EPR scheme shall apply for these vehicles as well (ADEME 2020). The rules come in force as of 01.01.2022. It includes the obligation to hand over ELVs to ATFs, the obligation to take back all ELVs incl. abandoned and impounded, together with the issuing of CoDs.

[189] Both lists of MS that have or do not have regulations for other vehicles than M1 and N2 are not exhaustive. For the MS which are not named, the situation is unclear.

[190] COMMISSION DECISION of 18 December 2014 amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European Parliament and of the Council

[191] https://www.boe.es/eli/es/rd/2021/04/13/265/con

[192] https://www.normattiva.it/atto/caricaDettaglioAtto?atto.dataPubblicazioneGazzetta=2003-08-07&atto.codiceRedazionale=003G0227&atto.articolo.numero=0&atto.articolo.sottoArticolo=1&atto.articolo.sottoArticolo1=10&qId=&tabID=0.59010272527045&title=lbl.dettaglioAtto&generaTabId=true

[193] https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000041553759

- In the Czech Republic, all end-of-life vehicles are dealt with in the "Act on End-of-Life Products" (542/2020 Coll. 2020). With regards to vehicles, only vehicles of armed forces and non-road mobile machinery are excluded. Vehicle-specific rules are laid down in Part III (Section 103-112). Additional rules are set in the '*Decree on details of the management of end-of-life vehicles*' (345/2021 Coll. 2021), among others provisions include various measures on reuse[194]. This decree came into force on 1 October 2021.

From Italian legislation, no evaluation is yet available due to the short time that the legislation is in place (Ministerio para la Transición Ecológica y el Reto Demográfico, Italy 2022). Also, the laws in Spain, France and the Czech Republic have been in force for one or less than a year, it has not been confirmed by representatives, but it can be assumed that there are no evaluations of their impact or effectiveness available at this point of time. Also in Italy, according to information from ISPRA (2022) to date, no specific studies have yet been carried out for waste streams from PTW and/or lorries due to the fact that the calculation of reuse, recovery and recycling targets is not required for these vehicles. Also in Lithuania, which had indicated in the MS survey that there are specific laws for PTW and/or lorries, there is no study on the waste management of these vehicles (Ministry of Environment of the Republic of Lithuania 2022).

The MS-specific regulation of the treatment of ELVs other than cars and vans does not (yet) ensure that problems similar to those identified in the Evaluation of the ELVD (section 1.1) does not exist for other vehicle types. Contributions by EGARA (2022b) describe the problems in some MS:

- 'Regardless of the regulations in **Poland**, about 65% of vehicles are dismantled in the grey zone';
- In **Spain**, 'there are owners who sell them [mopeds and motorcycles] without knowing their final whereabouts, or who buy them assuming the road tax [has been paid] and disassemble them to sell their parts, without having the authorization of an ATF.';
- In **the Netherlands**, 'sometimes export is used to end registration so the owner can do with the bike or remains whatever he feels like. For us is this another reason to plea for compatible national registration systems (or an EU system)'; and 'problems that we have are sometimes owners that are reluctant to hand over the remains or the papers, or the storage address already took some parts, sometimes even destroyed parts to use in insurance fraud. These broken parts will be put on other accident motorcycles in order to increase the claim.';
- ARN (2021) comments on the experiences with the **Dutch** scooter recycling network that 'OEMs or producers [are] willing to do something coming together and set up a system, but you have to cope with free-riders if there is no legislative enforcement to support the willing group. […] it was quite hard as it is not the same product, not the same infrastructure, not the same players on the market […] So it's hard to […] copy it for other vehicles. To give examples of difficulties of the system: Due to less strict other rules on deregistration for mopeds as for cars it is difficult to ensure that all mopeds arrive at ATFs, [or] if an ATF is licensed to treat ELVs it was not automatically permitted to treat mopeds, so additional permits were needed.'
- For **Greece**, where no ELV regulation exist for vehicles other than M1 and N1, the contribution from EGARA explains that 'without a legal framework, without government

[194] The decree regulates […] 'h) the extent and manner of keeping records of materials and parts for reuse by the processor of end-of-life vehicles; i) the method for calculating the level of reuse and recycling or other recovery of selected end-of-life vehicles and their parts; j) the conditions of preparation for the re-use of reusable parts and their storage; k) the extent of the data kept in the End-of-Life Vehicle Information System; l) the particulars of the proof of the repairability of the vehicle and of the functionality of the vehicle part.' (345/2021 Coll. 2021).

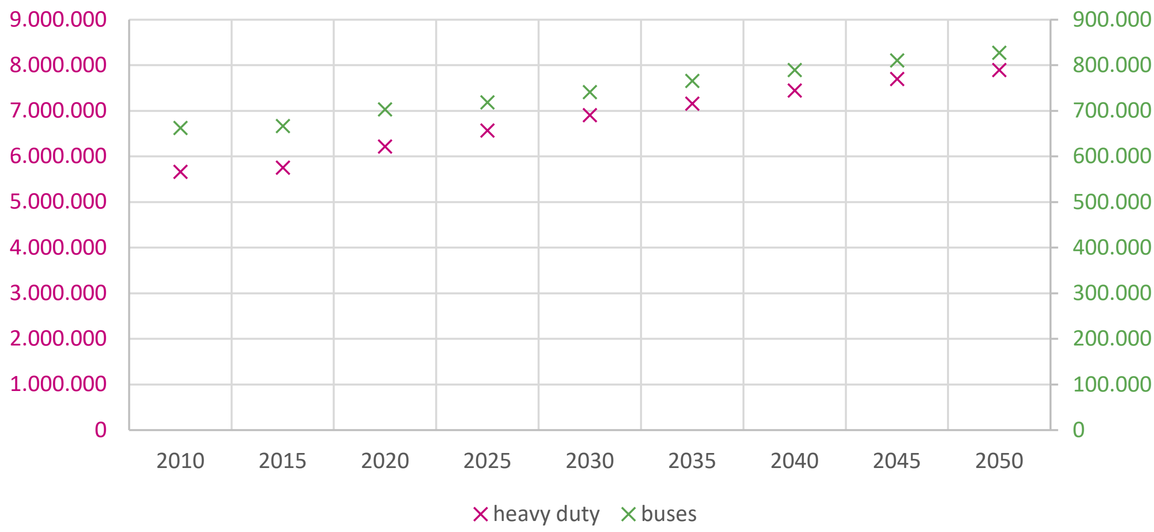
inspections and without controls on registration status of vehicles 90% of motorcycles and trucks are illegally dismantled.'

- In **France**, 'the presence of parallel markets is even greater in motorcycles than in cars (up to 10 times higher). Many parts are resold online: they are untraceable and unchecked.'
- 'In practise, the systems [in **Finland**] allow dismantlers to [issue] CoDs [for motorcycles]. And some do so. Heavy vehicles, tractors etc. don't require [a] CoD neither, but especially for trucks, CoDs are often [issued].'

Increase of the total amount of vehicles

Materials from vehicles not in scope may nowadays be recycled and components from these vehicles will be reused if economically viable. However, there is no obligation to achieve minimum targets nor EU wide mechanisms for reporting on the achieved rates. It is expected that the number of vehicles further increases and consequently the loss of materials too (**Figure** 2-32; a plus of more than 2,2 million lorries, i.e., plus ~40% compared to 2010, and 165 000 buses, i.e., plus ~25% compared to 2010): In 2030, potential losses of materials from ELVs not in scope of ELD could amount to 10,14 million tons (range: 4,61 – 15,67 million tons; see Table 2-14).

Figure 2-32 Growth in the numbers of vehicles



Source: Fleets based on PRIMES-TREMOVE (European Commission 2022b).

Relations to other problems

From above, it becomes clear that the problems relate to other problems of the ELV Impact Assessment Study displayed in the intervention logic (section 1.1.1), i.e.:

- problem 2 'design, production and EOL are not sufficiently circular',
- problem 3 'large number of 'unknown whereabouts': Not all vehicles are collected and recycled', and
- problem 4 'lack of economic incentives' applies to vehicles not in scope of ELVD.

2.4.3.2 Description of the problem drivers

The following is a list of general problem drivers in relation to all vehicles not in scope of ELVD. Further below, in section 2.4.3.4 'why the EU should act', for each of the four vehicle categories under consideration (PTW, lorries, buses, trailers) the most important problem, problem drivers and reason why the EU should act are named.

Problem drivers in relation to the market

It is expected that reuse and repair play an important role in prolonging the lifetime of PTW, lorries and potentially buses, based on the limited information, e.g., on reuse for PTW in Finland (SMOTO 2021), it can be concluded that a) individuals and small garages play an important role in the repair and (EoL) treatment market, and b) that reuse is less in case of car ATFs handling PTW, if not specialized in treating PTW. As a result, in the case of a), the more different operators exist, the more difficult it is to control ATF requirements, licenses etc. For b), it is clear that imperfect information for (car) ATFs hinders even higher reuse quota, at least for PTW where not such system as IDIS exists (there is an IDIS for lorries).

In relation to circular design, from the available information, e.g., the high reuse rates and viable repair businesses across, it is concluded that the market for vehicle categories other than cars and vans is working so that these vehicles are designed circular in respect of longevity and repairability. However, this cannot be substantiated, as exact numbers are not available. For design aspects considered under the ELVD today, namely, hazardous substances, plastic coding and recyclability (3R targets), the market situation is unclear. Though, the ELV substance prohibitions do not apply, it is probable that at least for similar components, hazardous substances have been substituted as the suppliers are shared with vehicle suppliers and will not necessarily continue manufacture for vehicles of a small market. Nonetheless, the composition of PTW, lorries and buses is different from passenger cars, with motorcycles having more plastic parts and lorries and buses applying additional materials in the stages built on the base vehicle. In that sense the prohibited substances may be applied in other applications or also in cases where more extreme use conditions (e.g., heavy duty of trucks) place higher demands on the material reliability.

Design for recycling, more specifically the 3R targets, are expected to be a greater challenge. It is unclear whether the market will be addressing design-for-recycling in a sufficient manner. In case of a regulatory intervention, stakeholders emphasize that there is no data basis to conclude on realistic ambition levels for 3R targets. In relation to the increase of lightweight materials for lorries, the associated trade-off in relation to CO_2 emission reduction during use phase compared to recyclability should be analysed well to set political priorities and avoid misaligned incentives in one or the other direction.

It is not unusual that from an economical point of view revenues generated from exporting a used vehicle, though close to its end-of-life, can be higher than revenues generated from the treatment of the vehicle, at the end of life (see the problem described in chapter 2.2.3). An export of a used vehicle close to its end-of-life could mean that they may be subjected to unsound treatment with lacking minimum depollution and dismantling requirements. This may especially be the case in countries where there is no (general waste) legislation in place that covers vehicles. In the EU, examples are Greece or Finland, but this relates also to non-EU countries to which end-of-life vehicles are exported to. Also, when end-of-life vehicles are left standing around in nature without any waste treatment, there is a risk of uncontrolled leakage of polluting liquids. In that case, one can speak of a market failure in relation to externalities. However, this is not only a market but as well a regulatory, i.e., enforcement, failure which is also addressed below.

There are small signs that the export of used vehicles might decrease in the future. Arguments presented above are a more selective approach in which vehicles shall be on the roads in import countries in Africa, Renault referred to the increasing complexity of lorries, also hybridization and electrification that could decrease export volumes. As a consequence, the markets for used vehicles might diminish.

Problem drivers in relation to the existing regulation

In light of the developments of high-level policy goals, namely the Green Deal and the Circular Economy Action Plan, since the time when ELVD came into force, the aspect of circularity has won in importance. The finding that the potential to contribute to the CE of a large share of vehicles is not exploited yet, suggests focusing the regulatory intervention to encounter problems associated with a lack of circularity for all vehicles, i.e., not just cars and vans. Tools and incentives are missing to motivate circular design in general and for addressing the trade-off between strategies for greenhouse gas emission reduction (from the use phase of vehicles) and recyclability explicitly. The existing “mechanism” to control the design of vehicles placed on the market, the 3R Directive, has shown some shortcomings when comparing the scope of ELVD and 3R Directive, see Annex II, chapter 7.2.

Vehicles not in scope of ELVD are in scope of MS-specific regulation. Many MS require that the sound treatment of PTWs and/or trucks is ensured and/or environmental permits for facilities are requested through vehicle-specific or general waste legislation. This is the situation at least in Spain, France, Flanders/Belgium, Lithuania, Italy, Hungary, Netherlands and Germany. There is no regulation on end-of-life of vehicles not in scope of ELVD at least in Greece and Finland (EU MS ELV IA Survey 2022; EGARA 2022b; ACEM 2021)[195]. In the case of a single market, as in the EU, and against the background that extra EU export is expected high in numbers and associated with environmental problems in the importing countries, different treatment rules in different EU countries should be avoided. Thus, as far as there is no EU-wide common legislation, there is a risk that non-uniform rules will create loopholes. So far, regulators have no tool available and there are no enforcement mechanisms nor incentives to tackle the problem of loss of material through missing traceability and exports for vehicles other than cars and vans.

In general, limited information on the numbers of ELVs other than cars and vans, missing export statistics for PTW and a lack of information on the material streams of waste from these vehicles make it difficult to describe the problem to the full extent. In relation to end-of-life PTW, lorries, buses and trailers, there is no adequate scientific evidence to show that the market is fully intact, e.g., in relation to reuse, that harm to the environment can be excluded. Or, to give another example, there is also no adequate scientific evidence that information for ATFs and recyclers is sufficient to recycle the materials from waste cars at the highest quality possible.

Generally, with an increase of the total amount of vehicles of all categories, it is expected that the total amounts of waste from ELVs increases in the future which is expected to add to the described problem driver, or in relation to trailers to the size of the unknown problem.

2.4.3.3 Key players and affected population

[195] Both lists of MS that have or do not have regulations for other vehicles than M1 and N2 are not exhaustive. For the MS which are not named, the situation is unclear.

The most relevant players and stakeholder affected by the problem…

1) … of the CE potential not being exploited are authorities for whom the lack of the availability of data affects fact-based decision making in relation to measures to take in line with political priorities, such as the CEAP. Indirectly, this effects the general society which has an interest in achieving progress and political priorities being followed.

   Other players affected in relation to the problem that the potential to contribute to the CE of a large share of vehicles is not exploited yet:
   - In encountering the trade-off between non-recyclable light weight material for emission reduction during use phase and recyclability, manufacturers play a key role for decision making in relation to material choices
   - Information to recyclers may be lacking, e.g., in the case of PTW for which no IDIS-equivalent system is set up so far
   - That there is no incentive to design for recycling may affect the quality of recyclates that can be obtained from shredders, meaning a potential loss of materials or material quality as well as possibly affecting the revenues of shredders.
   - The (non-)availability of or investment in installation of larger facilities (to “accept” trucks and buses), of PTW-dedicated ATFs nearby or missing tools (to allow dismantling from different types of vehicles) is the limiting factor to the capacity of EoL treatment
   - The presence of hazardous substances as impurities or at higher levels in ELV recyclates may result in downcycling, indirectly meaning that more primary materials will need to be extracted for use in new vehicles, which is associated with energy costs and environmental impacts.

2) … of missing traceability for vehicles not in scope of ELVD are ATFs and legal shredders, as well as societies in non-EU countries or/and where ELVs are disposed of illegally in the nature. Arguments are the following:

   - ATFs compete with illegal garages and illegal exporters – which may be capable to pay higher prices as they do not comply with all legal requirements. For vehicles not in scope of ELVD, there is no legal incentive to design for circularity
   - Due to illegal export and treatment by illegal and legal garages not being ATFs the ATFs have less turnover than expected and ATFs business might be less profitable / not profitable.
   - Illegal export limits the turnover of shredders and the generation of recyclable fractions.
   - Illegal treatment facilities, or facilities where no law exists, may not comply with the environmental standards for ATFs leading to environmental pollution.

   Other players affected by missing traceability for vehicles not in scope of ELVD:
   - Companies shipping used vehicles legally to another EU Member State or to third countries, which sometimes derive important revenues from this activity, but face competition of illegal SS.
   - MS authorities & National vehicle registration authorities shall control ATFs and type approval registrations
   - Citizens, not taking due care what is happening to their vehicle might receive higher prices for their ELV when it is sold to non-ATFs.
   - Citizens are affected, based on their obligations as owners, for example related to the registration and de-registration of vehicles, e.g., temporary (de-) registration of vehicles, or for buying reused parts.

3) … that EU-wide harmonisation in EoL rules is not ensured, are end-of-life operators encounter different legal setups in different EU MS creating an uneven-playing field

2.4.3.4 Why should the EU act?

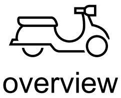
Problems of the ELVD have been identified in the Evaluation (Williams et. al 2020) and have been described above. For vehicle types other than M1 and N1, it was found that they have in common with M1 and N1 vehicles the problems of design, production and EOL not being sufficiently circular and a 'large number of 'unknown whereabouts', i.e., not all vehicles are collected and recycled'. With the decision to amend the ELV legislation, EU regulators have found that ELV legislation has an added value to address – after amending and improving – the identified problems in relation to the various vehicle categories. Acting on EU level means to close regulatory loopholes that exist between EU MS, avoid potential 'loss' of material resources and to avoid leakage of pollutants where no or unsound treatment is applied, thereby contributing to a level playing field.

This revision of ELVD represents a possibility to introduce legal clarity for the group of vehicles that are multi-stage and/or produced in small series but are not special purpose vehicles in relation to Art. 7 of ELVD. It should be noted that amendments to the scope of ELVD without parallel amendments in the scope of the 3R Directive and/or different means to create legal clarity for vehicles in scope of ELVD but not in scope of 3R Directive, create regulatory inefficiencies. It is in the hand of EU legislators, to acknowledge and potentially draw conclusions in relation to the identified discrepancies in the scopes of ELVD and 3R Directive.

ELVD Recitals display the initial intention of ELVD. Though, differently important for different vehicle types, arguments presented there are still valid to justify EU action based on the problem described above, e.g.,

- 'to minimise the impact of end-of life vehicles on the environment';
- 'to ensure coherence between national approaches';
- 'to ensure correct waste management, where waste [components and materials] should be reused and recovered, and
- that preference be given to reuse and recycling';
- 'that economic operators set up systems for the collection, treatment and recovery of end-of life vehicles'; and
- 'that last holder and/or owner can deliver the end-of life vehicle to an authorised treatment facility'. (Directive 2000/53/EC 2000)

2.4.3.5 Summary of problem, problem drivers and reason for EU action per vehicle category



PTW: In the EoL and repair business, there are many individual operators, i.e., little control for regulators, thus, a high potential for illegal operations. Presumably, treatment information for waste management operators is limited, but a complete overview of material streams and the sector in general (and in relation to potential illegal operations, though it was reported for France by EGARA (2020)) is lacking, among other things because the different vehicles in the group of PTW are very diverse and each MS deals with PTW in a different regulatory way. Whether insufficient design-for-recycling or export of used vehicles plays a role is unclear due to the lack of data. Presumably, multi-stage type approval, i.e., the problem of the discrepancy between the scopes of ELVD and 3R Directive, does not play a role for PTW. The general material composition of PTW, e.g., more plastic, and application of materials outdoor poses different requirements to the materials selected. In that sense the substances prohibited for N1 and M1 vehicles or other substances may be applied.

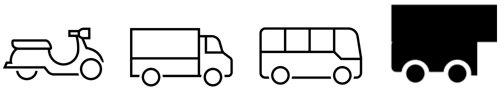
Lorries: The lack of control on extra-EU export (~74% of expected ELVs) and transboundary shipment of ELVs within the EU is probably the biggest problem driver in relation to trucks, mainly because EVLs do not have to be reported by the MS. Illegal treatment facilities, or facilities where no treatment law exists, may not comply with the environmental standards for ATFs leading to environmental pollution. In the area of circularity, the use of lightweight, non-recyclable materials is probably relevant. As well as substances, that might be hazardous could be applied in component parts for lorries in cases where more extreme use conditions (e.g., heavy duty of trucks) place higher demands on the material reliability. The relevance of the discrepancy between the scopes of ELVD and 3R Directive for lorries, mainly in relation to multi-stage build vehicles, and the lack of knowledge about EoL material flows is identified.

Buses: Compared with trailers and lorries, there are far fewer buses in the stock, i.e., fewer that reach the end of their lives per year. Compared to lorries, the relative share of used buses exported is also lower (~34% in the cases of buses). Nevertheless, the lack of export control is probably a considerable problem, see photos. In terms of material composition, buses are special: Glass (from the windows) and textiles (from the seats) are probably more common than in any other vehicle category. Steel and aluminium are also important materials. The weight is similar to that of lorries, probably weight reduction plays a role, but details are not known. It can be assumed that the circularity potential is not exploited.

(Semi-)Trailers: In terms of the entire fleet, trailers account for less than 6% by unit, but ~18% by weight. The variability of these vehicles is high, the material composition also varies greatly depending on the trailer type. Little is known about the end of life of trailers. Export trade statistics show that ~ 75 000 trailers are exported per year (~8% of expected ELVs). This is little compared to other vehicles discussed above. Therefore, it is concluded that there is a large mass of materials from trailers for which there is currently no information available on their end-of-life (and for their design). It is therefore unclear whether the CE potential is exploited, where the levers for the CE lie, or whether there are problems with inadequate treatment. For (semi-)trailers, the problem and its drivers can only be inadequately described greatly affecting authorities in fact-based decision making in relation to measures to take in line with political priorities.

2.4.4 Which objective should be achieved?

The EU industry as a whole is identified to be 'too linear, and dependent on a throughput of new materials extracted, traded and processed into goods, and finally disposed of as waste or emissions.' (EU Green Deal, EC (2019)) This relates to all players engaged in economic activity around vehicles including the non-M1- and non-N1 vehicles. The general objective of the intervention should aim at obtaining contributions from the whole vehicle sector to the targets set out in the EU Green Deal (European Commission 2019) and the Circular Economy Action Plan (European Commission 2020a), namely to increase the circularity of respective vehicles. Therefore, the objective is to *ensure a comprehensive coverage of the sustainable* *production and waste management at EoL (dismantling, sorting, reuse, recycling, recovery, disposal) of all relevant vehicles by the ELV Directive*.



This should apply to all materials and components of the vehicle, including vehicles currently outside the scope of the Directive, promoting a circular approach in the production and end-of-life treatment of vehicles. Also, this objective includes the option to react to the identified 'large number of 'unknown whereabouts', i.e., that all vehicles are collected and recycled. In the attempt to achieve this objective, first, the extension of scope of the ELV legislation, and second, the harmonisation of EU wide of ELVs other than M1 and N1 will build the basis.

Obtaining information is an important objective for all four vehicle categories: Most important in the short term is the introduction of a reporting of ELVs as laid down in EC Decision 2005/293/EC for M1 and N1 as they lay the foundation for measures for increasing the collection of vehicles. For PTW, buses and trailers, it is also about (one-off) information to characterise the EU-wide EoL market, i.e., number, location and type of operators, throughput of their facilities, recycling efficiencies, etc. Data for the EoL of lorries is already available for individual MS, e.g., Spain (ANERVI/AETRAC 2021), but the overall EU overview is missing for all categories of vehicles. In relation to PTW, data on exports of used vehicles is lacking as well as information for waste management operators. While export data for used buses and trailers is available, it is unclear whether recyclers are lacking information needed for the recycling of buses and trailers.

Though data is limited, there is a certain amount of expected ELVs that has to be dismantled and recycled in the EU (after subtracting a certain percentage for export and additional vehicles that are not recycled but just stand around). And though it is expected that dismantling and reuse/sale of used parts is established for the four groups of vehicles, it can be expected that certain fractions enter the recycling. In the short term, it should be the objective to be able to quantify these material streams (per vehicle category), so that in the long term identify assess and identify the need for measures that ensure design for recycling, high quality of recyclates and the highest quantities of recyclates possible; and with that, measures to ensure that vehicles placed on the market comply with the design rules. A detailed assessment of the scope extension with currently available data can be found in Annex I, section 6.10.

In order to avoid leakage of pollutants from unsound treatment in illegal operations, another objective should be the formalisation of the EoL sector, where not formalised already today. Authorized, that means formalised, treatment facilities are the stakeholders to report to MS authorities, based on CoDs, the number of ELVs treated. In this respect, formalisation supports the reporting of ELVs, thus, the robustness of the numbers.

2.4.5 What are the measures to achieve the objective?

2.4.5.1 Measures to achieve objective 1: Ensure a comprehensive coverage of the sustainable production and dismantling of all relevant vehicles by the ELV Directive

The pre-condition to ensure the achievement of the above-mentioned objective is the extension of the scope of ELVD and 3R Directive to L vehicles[196] referred to as powered two- and three wheelers (PTW) in the following as well as M vehicles (used for the carriage of passengers, e.g. cars and buses), N vehicles (used for the carriage of goods, e.g. lorries), and O vehicles (trailers including semi–trailers)[197] with the exemption of vehicle category T (agricultural tractors). To be precise, special purpose vehicles[198] and multi-stage build[199] vehicles of category M2,3, N2,3, and O (considered not relevant for L-type-approved vehicles) or such vehicles built in small series[200] are covered by the measures. Only when vehicles currently outside of the scope of the ELVD enter the scope of the two Directives, the existing tools of the Directives and measures under consideration in relation to the other objectives of this study can be applied.

Measures to achieve objective consist of the following.

- Information to waste management operators
- MS reporting (via Eurostat) on ELVs by number
- OEM and ATF reporting to EC: One-off reporting obligation on characteristics of the end-of-life market
- Hazardous substances restrictions
- ATF treatment
- Full 3R Type Approval
- Design for circularity
- Reuse & Recycling
- CoD (traceability)
- Advanced traceability
- Export restrictions
- EPR for all vehicle types

[196] Powered two- and three-wheel vehicles, mopeds, motorcycles (incl. motorcycles with side-car) and quadricycles, type approved through REGULATION (EU) No 168/2013.

[197] Type approved through REGULATION (EU) No 2018/858.

[198] According to Regulation 2018/858/EU: ‘special purpose vehicle’ means a vehicle of category M, N or O having specific technical features that enable it to perform a function that requires special arrangements or equipment, and characterised through Regulation 2018/585/ EU, Annex 1, Part A, point 5.

[199] as referred to in Regulation 2018/858/EU. The multi-stage procedure (described in article 22(1) of the mentioned Regulation) is a procedure where “one or more approval authorities certify that […] an incomplete or completed type of vehicle satisfies the relevant administrative provisions and technical requirements” (Regulation 2018/858/EU, article 3(8)).

[200] In the Regulation 2018/858, the general type-approval regulation in force today, the annual limits per Member State are 500 units for O1, O2, and 250 for M1, M2, M3, N1, N2, N3, O3, O4. The EU-wide annual limits are 1 500 for M1, N1, N2, N3, and 0 for other categories.

The description of the measures differs in detail. A short description is provided below, while detailed descriptions can be found in other parts of the report (references can be found below each measure). Generally, it should be noted that some of the measures to achieve objective 1 shall only apply to vehicles that are not yet in scope, some measures apply to M1 and N1 already in the current version of ELVD, and a third set of measures are being considered as new provisions for M1 and N1 as well as for those not yet in scope of ELVD, i.e., such measures might apply to all vehicles covered under the new legislation.

2.4.5.1.1 Information to waste operators

Generally, in order to dismantle parts for reuse or separate recycling in a safe and environmental manner, ATFs need information, e.g., as to location and method for dismantling components that need to be depolluted or recycled separately or that can be reused. Currently, though not considered ideal, at least for lorries, such information is provided through IDIS. A PTW-specific IDIS does not exist. Still, dismantling for reuse is said to be common for PTW.

Future legislation shall foresee a provision that ensures that operators of waste vehicles other than M1 and N1 have access to the required information. In relation to M1 and N1, ELVD already obliges OEMs to provide certain types of data to ATFs and additional requirements are under consideration for M1 and N1 vehicles, possibly added as an obligation for provision of data as part of the 3R Type approval process. At least the same information as for M1 and N1 vehicles shall be provided to non-M1-N1 vehicle dismantlers, if relevant to these dismantlers. The list of information requirements for waste operators should be double checked with ATFs of PTW, lorries, buses or trailers to see if they see the need for information for supporting circularity in addition to the information required for M1 and N1 vehicles (or information that is not needed for vehicles of other categories).

Vehicle specifics: The majority of the items for which information is required is considered vehicle-unspecific, though, the information as such will differ from passenger cars. A list of additionally required vehicle-specific information will be different for the different vehicle categories, but such lists are not yet available.

Expected Outcome: Same access to information is considered one factor to create a level playing field for dismantlers. If in the future implemented together with the ATF requirement (as explained below), a dismantler might deal one vehicle category today but could expand their business to other vehicle categories in the future. Thus, especially waste operators not (yet) specialised in the treatment of certain vehicles, e.g., PTW may benefit from the information provided to reduce dismantling times or get an idea of component parts that are beneficial for removal, e.g., due to the material composition.

Affected Stakeholders: Vehicle manufacturers and their suppliers

2.4.5.1.2 MS Reporting on ELVs by number

Today, through the ELVD, Member States are obliged to collect statistical data on the number of ELVs in scope of ELVD (Commission Decision 2005/293/EC) which was introduced to monitor the reuse/recycling and reuse/recovery targets set out in the ELVD. Under specific objective 2.4, through measure 2.4.F) REVISION OF COMMISSION DECISION 2005/293/EC ON THE CIRCULARITY ASPECTS (see section 0), it is foreseen to revise the reporting for M1 and N1 vehicles.

Statistics on ELVs other than M1 and N1 vehicles do not exist. Under this measure, the reporting on the vehicle fleet shall be established for new vehicles. As for M1 and N1 vehicles today, for Eurostat (yearly reporting), MS shall be asked to name the "total number of vehicles of ELV"[201]. Dependent on whether the measure 2.3 F is amongst the preferred measures to address the problems associated with the objective 2, it shall be reflected whether a revised Commission Decision 2005/293/EC (measure 2.3 F) shall fully apply to new vehicles, or whether the reporting on the vehicle fleet shall apply for non-M1-N1 vehicles, but not other parts of the revised Commission Decision 2005/293/EC.

Vehicle specifics: Changes are expected to be different in different MS and different per vehicle category as reporting on ELVs already exist in some MS for some vehicle categories, e.g., Spain for lorries. The highest effort is expected for PTW for which the possibility to obtain temporary deregistration is important. It shall be ensured that a seasonal, i.e., half-year, deregistration of motorbikes is possible at minimum additional administrative burden to the owner.

Expected Outcome: The reporting on the end-of-life vehicles, e.g., through registration and de-registration, where applicable, facilitates Member States to identify the extent of problems associated with missing vehicles. It is considered a contribution to closing the lack of knowledge hindering authorities in fact-based decision making.

Affected Stakeholders: MS authorities, ATFs/dismantlers

2.4.5.1.3 One-off reporting on EoL (OEMs and ATFs to report to MS which report to the EC)

The aim of the measure is to provide a comprehensive description of the way under which vehicles outside the scope of ELVD are currently treated at end-of-life and how the design/production of such vehicles takes circularity aspects into account.

The measure requires

(i) economic operators (OEMs and ATFs) either involved in production or EoL treatment of motorbikes, trucks, trailers and buses to provide information on the design, production and EoL treatment of their vehicles within one year of entry into force of the new rules, and

[201] If implemented together with the measures on ATF requirements and that CoDs shall be issued for vehicles other than passenger cars, the real number of ELVs arising in the country could be collected based on the CoD issued by ATF.

(ii) the Commission to investigate the waste management of other vehicles not yet in scope of ELVD and produce a report within two years of entry into force of the rules.

The report shall include an assessment of the potential gains (or losses) for the circular economy (i.e. amounts and types of parts and materials that can be reused or recycled) that could be leveraged if such vehicles are included in the scope of the ELV legislative framework. The report should also assess which rules and provisions that were agreed on for M1 and N1 in the new ELV legislation should apply to vehicles other than M1 and N1 in the future.

In principle, Member States shall report to the European Commission. For this purpose, the Commission shall adopt a delegated act/implementing rule or provide a template/guideline laying down the format for data to be reported. Information to be reported shall depend on the provisions to apply to new vehicles in scope from entry into force of legislation but also on provisions that will be decided at a later point of time. This may include new provisions to be added to the ELVD for passenger vehicles (i.e., if recycled content targets are added, data will need to be reported to allow estimating what target rate would be relevant for new vehicle types in scope). It is thus expected that the reporting format will be established shortly after the legislation comes into force (within one year), with the MS expected to submit the report one year later. The format for reporting on end-of-life treatment of vehicles new in scope should include a list of information requirements on:

- the treatment capacities of end-of-life trucks, buses and motorcycles,
- the estimated amounts of reuse parts and of recycled materials (including breakdown into material composition),
- description of typical treatment routes of an ELV of these types, e.g. dismantling, recycling, shredding, PST, etc.
- Potentially: recycled content, …

This measure is closely linked to the ‘circularity strategy’ under consideration for M1 and N1 vehicles under specific objective 2.1. It is also a different type of design of the measure ‘design for circularity’ (chapter 2.4.5.1.8). It differs in the actor obliged to report, in the frequency of reporting, and this measure may allow a focus on new vehicles in scope whereas the measure ‘design for circularity’ (chapter 2.4.5.1.8) points to all vehicles in the future scope of ELVD specifically.

Vehicle specifics: MS specific; highest effort expected for PTW

Expected Outcome: The reporting on the end-of-life of vehicles facilitates Member States as well as the European Commission to identify the extent of problems associated with missing circularity of vehicles that are not in scope of ELVD today. It is considered a contribution to closing the lack of knowledge hindering authorities in fact-based decision making.

Affected Stakeholders: MS authorities, manufactures and their suppliers, EoL stakeholders

2.4.5.1.4 Hazardous substance Restrictions (based on Art. 4 ELVD).

Under this measure, it is foreseen to restrict the four heavy metals mentioned in Art. 4 of ELVD for new vehicles entering the scope of ELV legislation. Experiences from the RoHS Regulation (Directive 2011/65/EU 2011) suggests that a minimum period of 2 years is needed to allow OEMs to collect information from the supply chain through a survey to get an overview of where hazardous substances are used and where exemptions may be needed to allow a longer transition or to develop substitutes. After it is clear where exemptions may be needed, another 1,5 to 2 years would be needed to allow submission of applications for these exemptions, for their assessment and where justified, for amendment of the list of exemptions. Legally, existing exemptions could apply to new vehicles in scope from the moment the legislation entries into force, allowing OEMs to put non-compliant vehicles on the market for a transition period of four years to allow for the processing of justified new exemptions. Alternatively, the substance prohibitions could apply after a four-year transition period, throughout which new vehicle OEMs would need to apply for all exemptions relevant – those already listed as well as necessary new ones.

Vehicle specifics: This measure shall be applicable to all vehicle categories. Though, different exemptions from the restrictions will be needed for the different vehicles, as shown through various stakeholder contributions. Independent of the preferred option for the specific objective 2.4 ‘ensure elimination of hazardous substances in vehicles’ in relation to the future legislation to deal with additional hazardous substances in vehicles, differentiation for the different vehicle categories will be required.

Expected Outcome: Already today, REACH is of relevance for hazardous substances in the vehicles whether in scope of ELVD or not, e.g., model-based information on SVHC to be provided to customers on demand (Art. 33 of REACH) and parts related information can be found in SCIP database. The avoidance of the heavy metals in waste from vehicles is expected to provide environmental and health benefits from formalized treatment and less environmental burden from vehicles dropped in nature.

Affected Stakeholders: Manufacturers and their suppliers, EoL stakeholders

2.4.5.1.5 Obligation that vehicles are dismantled in ATFs

M1 and N1 vehicles shall be brought to authorized treatment facilities (ATFs) according to Art. 5 & 6 of ELVD. It is the aim of this measure to apply the existing rules for ATF treatment to vehicles other than passenger cars. Under objective 3, the ATF-provision might be strengthened with additional enforcement, e.g., minimum requirements for sector inspections and penalties for illegal operators. Dependent on the preferred option in relation to these measures addressing the problems in relation to missing vehicles, it is still to be decided whether the potentially stricter enforcement rules shall apply to the waste operators dealing with new vehicles. Given that car ATFs might deal with PTW, and that lorry ATFs can dismantle trailers etc. it might be considered that the same rules apply to all ATFs independent of the vehicle category they are specialised on, but this cannot be further developed at this stage.

For new vehicles, stakeholders stated that heavy duty vehicles are already dismantled in ATFs (at least in some MS), but that there are no motorbike-specific ATFs (ACEM 2021; ANERVI/AETRAC 2021). Nonetheless, the dismantling of motorbikes can also be performed by passenger car ATFs (ACEM 2021). It is thus assumed that only a short transition period would be needed to apply the obligation of treatment of new vehicles in scope in ATFs, e.g. one year.

Vehicle specifics: Though the ATFs may differ, e.g., need larger spaces and other tools, the measure as such is not vehicle specific.

Expected Outcome: On the sides of benefits, environmental benefits are expected from formalised treatment and externalised costs will be internalized (distribution effect, economic). For some countries, one expected outcome is that informal jobs will be formalized. For this measure the burden can be attributed to administrative costs.

Affected Stakeholders: Vehicle owners, ATFs/dismantlers, MS authorities

2.4.5.1.6 Obligation to give a CoD to the last owner of the vehicle

In combination with the obligation to treat vehicles in ATFs, this measure shall ask that a certificate of destruction (CoD) is given to the last owner of the vehicle (by the ATF), which would be necessary for deregistration. At a minimum, through this measure the same provisions shall be established for vehicles not yet in scope of ELVD as for M1 and N1 vehicles today.

Among the measures to address the problem of missing vehicles (in relation to objective 3.1) the OBLIGATIONS FOR DISMANTLERS /RECYCLERS TO CHECK AND REPORT ON ELVS/CODS is under consideration(see details under section 2.2.5.1.5). Dependent on the preferred option in relation to this measure (amongst others) it is still to be decided whether the new obligation to check and report ELVs on the number of CoDs shall apply to the waste operators dealing with new vehicles.

The provision shall be formulated so as not to create obstacles for the reuse market.

Vehicle specifics: not vehicle specific.

Expected Outcome: This measure facilitates Member States to identify the extent of problems associated with missing vehicles. It is considered a contribution to closing the lack of knowledge hindering authorities in fact-based decision making.

Affected Stakeholders: Vehicle owners, ATFs/dismantlers

2.4.5.1.7 3R TA provisions

Currently, the 3R Directive provides a mechanism for ensuring that M1 and N1 vehicles that are placed on the market comply with certain requirements, including the ELV heavy metal restrictions and the targets specified under ELV for reuse, recycling, and recovery. It is currently being considered to change the 3R Directive, e.g., so that the calculation applied to establish whether vehicles comply with the reuse, recycling, and recovery targets reflects the actual targets achieved at end of life more precisely. OEMs may also be required to provide evidence on the benefits in the use phase that are achieved when significant amounts of materials that are not recyclable at the time POM prohibit fulfilment of the targets.

Through this measure, the scope of the 3R Directive shall be aligned with the potential future scope of the ELVD, thus, extended in the same way than the scope of the ELVD. Provisions of 3R Directive shall apply without exemptions and including the above-mentioned considered measures for the 3R type-approval of M1 and N1 vehicles.

Please note that the measure to include multi-stage build M1 and N1 vehicles in the 3R Directive is discussed elsewhere in this report (add reference) together with other measures to amend 3R Directive for M1 and N1 vehicles.

Vehicle specifics: In relation to the mechanism of the 3R Directive, to ensure that vehicles brought to the market comply with certain requirements, this measure is not vehicle specific. Even the methodology for calculation of the recyclability rate, ISO 22628:2002(E), is per its title intended for 'road-vehicles' referring to ISO 1176 'road vehicles – masses – vocabulary and code' (ISO 1176:1990) but not M1 and N1-specific. However, the ambition level of the 3R targets is vehicles specific, but not covered by this measure (however, covered by another measure). This is because it is a ELVD requirement directly taken over to the 3R Directive. Still, in some placed vehicle-specific differentiation is needed. Among, others, this measure requires a vehicle-specific Annex V of 3R type approval directive (referred to in Art. 7 of the same Directive) which refers to component parts which shall be deemed to be non-reusable for the purpose of calculating the 3R rate and that may not be reused according to the specifications of new vehicles in scope.

Expected Outcome: For vehicles other than passenger cars, some the general process/methodology of the 3R type-approval is expected implementable, as already today, these vehicles are being generally type approved. Also, it is expected that vehicle types that will be new in scope of the ELV framework and/or 3R Directive could use the same methodology for calculating the recyclability and recoverability. The potential benefits of the measure are difficult to imagine without a link to ELVD requirements such as hazardous substance restrictions or 3R targets which are discussed as separate measures.

Affected Stakeholders: Authorities, manufacturers

2.4.5.1.8 Design for circularity

Though the ELVD refers to the need to promote more circular design of vehicles (design that facilitates waste management at EoL), it does not set any specific measures as to how this is to be achieved. It is thus currently being considered whether to require OEMs to develop and submit a "circularity strategy" that will need to fulfil minimum information requirements. At the first stage the strategy would report on the current status quo (how much recycled content is used, what methods are applied to facilitate easier dismantling, etc.). An updated report would need to be submitted every 5 years. Allowing the ambition of minimum information requirements to increase, meaning that this measure starts as a soft one but could become more stringent if needed. In addition, implementing a recycled content target or plastics is being considered and could be considered in the future for additional materials (e.g., REE or magnets, glass and rubber). See the detailed description above (for detail see section 2.1.5.1.3).

Under this measure, the preferred measure for design-for-circularity measure for M1 and N1 vehicles shall be considered for categories L, M2,3, N2,3, and O in identical manner (among the measures 2.1.a to 2.1.c, excluding 3R type-approval-related measures (excluding measures 2.1.d to 2.1.i) which, for non-passenger cars, are covered by another measure.

Vehicle specifics: not vehicle category specific.

Expected Outcome: It is assumed that this measure could lead to benefits over time, though this depends to a large degree on what is the preferred option for M1 and N1 vehicles, e.g., whether there are minimum information requirements and how they will develop from one reporting period to another.

Affected Stakeholders: Authorities, manufacturers and their suppliers

2.4.5.1.9 Reuse & Recycling

The ELVD requires M1 and N1 vehicles to fulfil a reuse+recovery and recycling+recovery target (thereafter referred to as 3R targets). However, it is considered that there is potential to increase the reuse of components. To this end, a few measures are being considered for implementation to promote reuse and remanufacturing. Definitions for these terms are to be included in the legislation. The level of reuse is to be monitored by introducing reporting requirements that will refer to a monitoring target. Measured that are to promote the demand for reused and remanufactured components could be implemented and though not targeting reuse, measure developed to increase and improve recycling may also have a positive effect on reuse. On recycling, aside from the reuse, recycling and recovery targets that need to be achieved, the Directive also makes certain provisions as to parts that are to be depolluted or removed form vehicles and treated in a certain way. Here too, additional measures are under consideration: to expand the list of components that must be removed from the vehicle prior to shredding (e.g., glass, EEC, etc.), to establish material specific targets in some cases (e.g., plastic) or to require the application of certain shredding and post shredding processes through compliance with EoL standards. The existing targets are also being looked at to consider if their level of ambition is to be changed, also in the case that a calculation point is implemented in the reporting requirements for vehicles. See the detailed description above (see measures described under section 2.1.5.3 and section 2.1.5.4).

Under this measure, the preferred measure for design-for-circularity measure for M1 and N1 vehicles shall be considered for categories L, M2,3, N2,3, and O in identical manner, though with vehicle specifications where needed as detailed below.

Vehicle specifics: individual per vehicle category

Expected Outcome: The measure contributes to a larger amount of material being reused, larger amount of material to be recycled and of higher quality of recycled material. Among others, reduced CO_2 emission and other environmental impacts from new material extractions are the environmental benefits thereof. On the economic side, revenues from spare parts and recycling are expected to rise for recyclers and dismantlers.

Affected Stakeholders: Authorities, manufacturers, EoL stakeholders

2.4.5.1.10 Advanced traceability

Here, advanced traceability is referred to in contrast to the measures that were earlier presented on MS reporting on ELVs by number and obligation to give a CoD to the last owner of vehicles. These two measures are designed to at least establish rules comparable to the existing rules for M1 and N1. However, it has been shown that the existing rules are not sufficient to address the problem. Thus, under objective 3, measures are considered for M1 and N1 vehicles to improve. Amongst the preferred measures in relation to advanced traceability are those grouped in policy option 3A mainly targeting enhanced reporting and enforcement, e.g., ATFs to improve reporting on CoDs. See the detailed description above (see details on measures under section 2.2.5.1).

Under this measure, the preferred measures under specific objective 3.1 (Ensure that all ELVs are treated in accordance with the requirements of the ELV Directive) for M1 and N1 vehicles shall be considered for categories L, M2,3, N2,3, and O in identical manner.

Vehicle specifics: not vehicle specific

Expected Outcome: Based on advanced traceability, it shall be possible to assess whether all ELVs are directed to authorised treatment facilities (ATFs) or not. The existing concerns about environmental impacts, losses of potential recyclables if not directed to legal treatment facilities, economic losses for the formal sector, and social impacts for informal sector workers shall be overcome.

Affected Stakeholders: Authorities, vehicle owners, illegal second-hand operators

2.4.5.1.11 Export restrictions

The intention to regulate the exports of vehicles is building on the problems associated with missing traceability and intra-EU trade on the one hand side, and on problems associated with extra-EU export, e.g., environmental, health and social risks for the countries of destination caused by (old) used vehicles imported. Thus, under objective 3, measures are considered for M1 and N1 vehicles to improve, e.g., an improved definition of what is an ELV and coupling export with a road worthiness certificate. Under this measure, the preferred measures under specific objective 3.2 (Reduce levels of illegal dismantling and illegal export of ELVs) and 3.3 (Establish enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards) for M1 and N1 vehicles shall be considered for categories L, M2,3, N2,3, and O in identical manner.

See the detailed description for above measures under section 2.2.5.2).

Vehicle specifics: Not vehicle specific. However, considered highly relevant for lorries, buses and trailers, but the current situation and relevance is unknown for PTW.

Expected Outcome: From implementation of measures to restrict the export, it is expected that no (non-depolluted) ELVs is exported to non-OECD countries, that the rules of the Basle Convention and Waste Shipment Regulation are applied, and that no used vehicles exported which would generate environmental adverse impacts the receiving countries.

Affected Stakeholders: Authorities, illegal second-hand operators

2.4.5.1.12 EPR for all vehicle categories

More challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, might require more effort at ATFs. Such effort might be as such not economically viable and cannot be covered by revenues or would reduce the profits of the ATFs (which would reduce the competitiveness of ATFs with the illegal sector). The relevance of compliance cost offsetting for ATFs will depend on the various measures listed above. As for the M1 and N1 vehicles, the establishing of an EPR is considered an individual measure. Thus, under this measure, an EPR shall be established for the vehicle categories L, M2,3, N2,3, and O in identical manner to the EPR rules that shall be established for M1 and N1 vehicles See the detailed description above (section2.4.5).

Details of such measure highly depend on the decisions in other places and cannot be provided at this stage.

Vehicle specifics: The mechanism of EPR is not vehicle specific. But, in the transposition, vehicle-specific fees etc. may be required.

Expected Outcome: If relevant, the main outcome of establishing an EPR would be the compliance cost offsetting for ATFs. As for M1 and N1 vehicles, it is expected that an EPR ensures transparency and a fair distribution of costs linked to the treatment of ELV, in line with the polluter-pays principles. The EPR Scheme for ELVs shall enable consideration of Circular Economy beyond the simple economic viability considering the efficiency of the EPR requirements regards environmental impacts, cost and social impacts.

Affected Stakeholders: manufacturers, EoL stakeholders

3. Impact assessment

3.1 Circularity

3.1.1 Baseline

The baseline reflects what would happen under a "non-policy-change" scenario without new policy intervention, and assuming realistic implementation of existing legislation.

Though the design of vehicles is mentioned in the current ELVD, aside from the prohibition of hazardous substances, there are no clear requirements on the design of vehicles. As is currently the case, any actions at this stage taken by manufacturers to increase the circularity of vehicles are voluntary. Such actions are expected to continue and to increase in magnitude, however at a slow pace:

- IDIS will continue to be applied by manufacturers to provide information to ATFs on the depollution and dismantling of vehicles and it can be expected that its level of harmonisation will increase, however a significant number of ATFs do not use IDIS and without specific action to change this situation, this is not expected to change. Data that is not included in IDIS (e.g., on dismantling of parts not addressed under Annex I.3-4 of ELVD and on digitally "locked" parts) will probably continue to be available only on other platforms at a cost. It can be expected to be used mainly by larger ATFs and those servicing only vehicles of a small number of OEMs.
- Though some manufacturers are active in developing the design of their vehicles to allow easy dismantling of certain components (e.g., windows, wire harness, etc.), the information does not always reach all ATFs, reducing the number of benefits that such actions can achieve. This is expected to persist,
- Manufacturers that already target the increased inclusion of recycled content in the design of their vehicles will continue, but such efforts are still not implemented in the majority of vehicles at significant amounts, and this will probably not change significantly,
- The phase-out of the ELVD prohibited mercury, cadmium and hexavalent chromium has been achieved, but some uses of lead can be expected to prevail in the coming years. Additional substances are regulated through other legislation (e.g., POPs and REACH Regulations). This situation of multiple legislation may not have a negative effect on the phase-out of hazardous substances but results in a higher administrative burden for the vehicle production sector. It would not be expected to change in the baseline.

The ELVD requires that minimum targets of reuse, recycling and recovery be achieved at EoL, and OEMs are required to demonstrate how they achieve these targets through the 3R Type Approval process. However, it will remain questionable whether this demonstration reflects the situation at EoL, seeing as e.g., material losses are disregarded, the calculation method only refuses market entry of vehicles with substantial amounts of non-recyclable materials and reuse is not addressed through this demonstration. Reaching these targets was possible in most MS in the past but is becoming increasingly difficult. The expected changes in the design of vehicles, increasing the amounts of plastics and materials with unclear recyclability with a view of reducing weight can be expected to change the balance between the share that is reused and recycled and that recovered or even worse landfilled. Achieving the reuse and recycling target of 85% is expected to become harder in the following years. Some MS can be expected to introduce individual regulation to ensure higher levels of reuse and recycling (e.g., France), but it is expected that others will have an increasingly harder time complying with the current targets.

3.1.2 Policy Options

3.1.2.1 Identification of discarded measures

With the aim to have a shortlist of measures for further assessment, all measures have been checked for viability. This step is not to be confused with the impact assessment itself and therefore does not include all categories of impact assessment (economic, social and environmental) nor does it look into the detailed effects regards proportionality or impacts for the different stakeholder groups (like e.g., consumers and SME).

The details of this viability check are displayed in Annex VI, section 6.4.1. In result the following measures are discarded and not shortlisted for the detailed assessment:

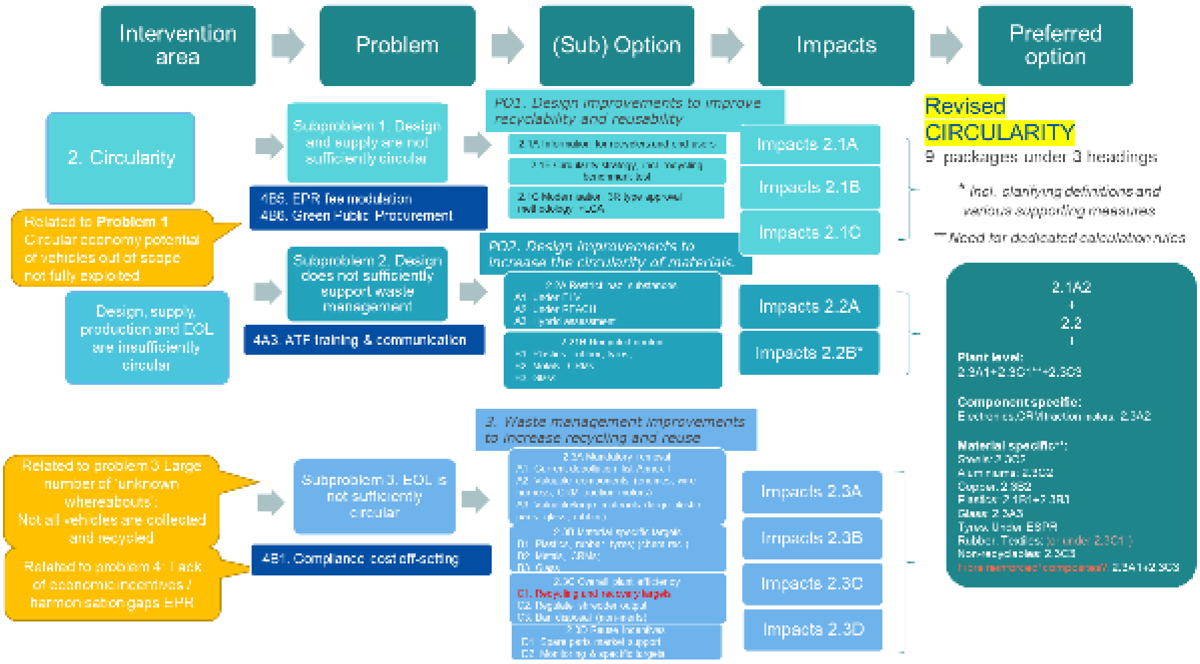
- 2.1.a) OEM voluntary pledges campaign to increase circularity (2.1.5.1.2)
- 2.1.b) EC non-binding guidelines on how to improve circularity in vehicles (2.1.5.1.3)
- 2.1.g) Establishment of mandatory recycled content targets for materials used in cars – currently discarded for glass and rubber (2.1.5.1.8)
- 2.1.h) Obligatory due diligence for materials used in vehicles (2.1.5.1.9)
- 2.3.c) Voluntary activities of OEMs and their suppliers to promote the application of reused and remanufactured components (2.1.5.3.3)
- 2.3.d) Voluntary activities of Member States to promote circularity (2.1.5.3.4)

The remaining measures are shortlisted and are grouped for policy options in the following sections.

3.1.2.2 Policy option overview

The various measures were considered in the development of three general options for review. See Figure 3-1 below.

Figure 3-1 Overview of policy options for circularity objectives 2.1-2.4



These options are based on a top-down approach, meaning that the analysis of the policy options would look at the vehicle as a whole, through general assumptions as to how design and end-of-life requirements affect the treatment of vehicles and the resulting amounts of material that can be reused, recycled or recovered from them. An assessment in this fashion would either remain quite vague, for example as to how specific materials are affected, or would be quite complex to carry out in a way that allows an understanding of the materials to be reused, recycled or recovered and how these are affected by various measures. This approach creates the impression that a measure can either be applied, affecting all relevant components and materials in the vehicle or it cannot be applied, however the reality is that some measures may be more suitable for addressing certain materials while for other materials a different approach would be preferable (i.e., a different measure or sub-set of measures). It also has very little flexibility to accommodate changes at later stages, i.e., in the combination of measures considered under a specific option, as assessments would be taken at vehicle level and not at the level of single components and/or materials.

However, against the background information provided in the current situation sections, it is already clear that a further specification of the measures, detailing to which materials and/or components they apply, and to which not, would allow making the measures more fit for purpose. Variations in the scope of applicability could also be applied to differentiate between the policy options but their specification requires a separate bottom-up analysis, looking at different materials or components separately, to allow a better understanding of the applicability of each measure.

Thus, a bottom-up approach was developed and is documented in the next section to allow an analysis at the material level for most measures and in some cases also at the vehicle level. Methodologically, an initial assessment was run to understand the various affects and the ranges of impacts where these could be quantified. In some cases, measures were analysed as a sub-set of measures at vehicle level (for example for design measures) and in others a more detailed approach was taken, looking at the measures of relevance for a specific material and performing the analysis for the material in relation to the measures that appeared to have the highest potential for (positive) impacts. Assessed impacts were then considered in the re-specification of policy options (see sections 3.1.2.2.1 through section 3.1.2.2.3 below) that addressed three levels – design improvements affecting the circularity of materials; design improvements affecting the reuse and recycling at EoL; and waste management improvements affecting the treatment stage directly. These were considered again in a revision of the analysis at material and vehicle level which is documented below. Presenting the results at this level leaves more flexibility to consider different combinations of measures should this be relevant.

Finally, after a re-specification of the single measures was possible (where relevant), results of this analysis were combined to understand the impacts of specific policy options that address all levels and that are presented together with the results of their analysis in section 3.1.12 at the end of this chapter.

The following options are thus considered as a starting point and were subjected to further refining at a later stage, after the specification of sets of measures for analysis at the material and vehicle level and following the analysis at this level. The resulting policy measures and their analysis are detailed later on in section 3.1.12.

It is noted that there is a gap in the implementation of measures referred to in the policy options developed for the design stage and measures that have been developed directly for the waste management. Due to the long lifetime of vehicles, it is expected that impacts of measures affecting design will only be visible in ELVs arriving at EoL after this so-called lifetime gap, i.e. after 15 years or so.

3.1.2.2.1 Policy Options 2.1: *Design improvements to increase the circularity of materials.*

Focus: materials

Objective: increasing the circularity of materials

On the one side this is done through creating a demand for recycled content in the manufacture of vehicles and on the other by considering substances that should be prohibited in the manufacture of vehicles so as not to create obstacles for the use of secondary materials recovered from them in the future.

The measures included under this option aim to change the design of vehicles with a view to reducing the use of primary raw materials in the production of new vehicles, through a higher uptake of recyclable materials. It therefore aims at addressing the environmental footprint of the automotive sector, linked to the production phase of new vehicles and renders this production phase more circular. The measure focuses on the materials for which recycling rates and use of recycled materials are currently very low (plastics, magnets containing rare earth elements, other CRMs). According to Maury et al. (2022) in the baseline only 2% recycled content of plastics is assumed. These low levels indicate that, if left to market forces alone, the automotive industry will continue to be dependent on the use of primary raw materials and the environmental footprint linked to the production phase of new vehicles will continue to grow. To address this situation, regulatory intervention is needed, through the setting of mandatory targets for the use of recycled content for plastics, REEs contained in magnets and possibly additional CRMs used in EVs. The measures proposed under this option have a high level of prescriptiveness, requiring OEMs to apply changes to their design and production that may be implemented via changes in the 3R.

At the final stage of treatment, the presence of certain substances (hazardous but in some cases a substance can be disruptive to recycling even without having hazardous properties), can hinder the usability of materials recycled from the vehicle, in some cases also hindering their recycling altogether. To limit such impacts, the ELVD already prohibits that vehicles contain 4 heavy metals, with a number of exemptions still allowing use in specific cases. Measures have been developed to enhance these prohibitions, also through the consideration of the legal framework chosen for the regulation of substances in vehicles. Such measures affect the vehicle and more specifically its materials at the design stage, with the goal of contributing to the general circularity of the vehicle.

Policy option 2.1 includes the following measures:

Title of measure	Chapter	Effective by	Implemented via:
2.2.a): Restriction of substances in vehicles	(2.1.5.2)	*2025*	*3R (and ELV or REACH/ROHS)*
2.1.g) Establishment of mandatory recycled content targets for materials used in cars	(2.1.5.1.8)	Various dates depending on the material and target	3R

Measures addressing the elimination of hazardous substances (specific objective 2.4) are assessed separately. Measure 2.1.g on a recycled content targets is considered a design requirement and is thus clustered under this policy option. However it is tightly connected to the measures addressed under specific objective 2.4 (increasing recycling rates of…). As this measure is material related it will be considered as an alternative (or in combination) with other measures that address reuse and/or recycling of the material that is to be affected (e.g., plastic).

3.1.2.2.2 Policy Options 2.2: Design improvements to increase recyclability and reusability

Life-cycle stage: design (prevention)

Focus: vehicle

Objective: Improved recyclability and reusability

Under this option, to allow a large flexibility in how the objectives are achieved, the measures address information or reporting requirements that would require OEMs to make changes in design to comply, however without prescribing how the design of vehicles is to be changed.

Policy option alternatives to be investigated under 2.2 include the following measures:

No	Title of the measure	Chapter	Effective by	Implemented via:
2.2A: Better compliance	Adaptation of the 3R Directive to the new Type approval Framework Regulation (see details below) + proper definition of types of vehicles (see detail below) + 2.1.d) Provisions for improving the relation between the 3R Type approval process and ELV waste management performance. + 2.1.e) Option for OEMs to submit life cycle data as part of the 3R type approval process to justify the use of materials where recycling is not yet established + 2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars + 2.2.b: Improved communication on hazardous substances in the automotive value chain	(2.1.5.1.4 in combination with 2.1.5.1.5) (2.1.5.1.10 in combination with 2.1.5.2.2)	2025 2027 2025 (existing platforms) or 2027 (type approval submissions and/or DPP)	3R 3R *ELV + 3R*
2.2B: Better Compliance + Circularity strategy	In addition to the measures included under 2.2.a, the following measure also included: 2.1.c) Obligation for OEMs to develop and implement a circularity strategy for increasing the circularity of vehicles	(2.1.5.1.3)	*2025*	ELV+3R
2.2C: Better Compliance + Circularity strategy+ minimum levels of recycled content	In addition to the measures included under 2.2.a, an information obligation would also be introduced in the form of an obligation to declare the level of recycled content applied for materials for which a recycled content is specified under ELV	(2.1.5.1.8)	2030/2035	(ELV+) 3R

Additional details are given for the three policy option alternatives specified above in the following:

- Policy Option 2.2A: Better Compliance Option: This option includes adaptation of the 3R Directive to the new Type Approval Framework Regulation. This would include the possibility to perform Conformity of Production and Market Surveillance tests for vehicles that have already been type approved ad put on the market. Should such tests result in a vehicle being identified as non-compliant, it would be possible to require a recall of all vehicles of the same model put on the market for repair of for being taken out of the market and to sanction manufacturers up to 30,000 Euro for each non-compliant vehicle put on the market. In this option, the definition of types of vehicles would also be revised in order to facilitate application of the requirements and a declaration of the manufacturer that none of the hazardous materials regulated (under ELV and/or REACH) are present in the vehicle. In relation to the obligations for OEMS to provide information on the vehicle composition and on methods and times of dismantling, this could be performed through existing platforms like IDIS or RMI or through the development of a digital product passport and shall be discussed in more detail in the impact assessment of these measures.

- Policy Option 2.2B: Better Compliance + Circularity strategy: Aside from the measures included under Policy option 2.2.A, this alternative also includes a measure for OEMS to submit a circularity strategy and revise it on a bi-annual basis.
- Policy Option 2.2.C: Better Compliance + Circularity strategy+ minimum levels of recycled content: Aside from the measures included under Policy option 2.2.A ad 2.2.B, this alternative also includes a declaration obligation on the content of recycled content, in particular in alignment with ELV measures specifying a minimum recycled content target for specific materials (e.g. plastics). The information of the percentages of recycled materials achieved in line with obligatory targets, would also be included in the Environmental Vehicle Passport, already foreseen in the Euro 7 Regulation proposal as a measure to inform consumers of the circularity of vehicles. It includes a declaration of the manufacturer of all the percentages of recycled materials present in a new vehicle type.

These measures will be assessed separately at vehicle level and are only considered supporting measures, facilitating the implementation and compliance with other measures but not having a significant impact when implemented independently.

Measure 2.1.e (section 2.1.5.1.5) has a direct relation on the use of non-recyclable materials in vehicles and will be assessed at material level in this respect in relation to “non-recyclables”.

3.1.2.2.3 Policy Options 2.3: Waste management improvements to increase recycling and reuse:

Life-cycle stage: EOL (end-of-pipe)

Focus: vehicle, parts, materials

Objective: improve reuse and recycling of the vehicle, it’s components and materials.

End-of-life oriented sub-options aim at improving the quantities and qualities of reuse and recycling through requiring waste management operators to comply with certain practices, to achieve certain targets and in some cases to align technologies with minimum standards. These can have a direct effect on the practice of waste management, sometimes being very rigid and sometimes leaving more flexibility as to how an objective is to be achieved.

Policy option 2.3 includes the following measures:

Title	Chapter	Effective by	Implemented via:
2.4.a) Align definition of ‘recycling’ with the WFD **2.4.f) Revision of Commission Decision 2005/293/EC on the circularity aspects**	2.1.5.4.1 2.1.5.3.6	*2025* *variable*	*ELV*
2.1.c) Obligation for OEMs to develop and implement a circularity strategy for increasing the circularity of vehicles **2.4.b) Making it mandatory to remove certain parts/components before shredding to encourage their Reuse and recycling**	(2.1.5.1.3 2.1.5.4.2)	*2025*	*ELV*
2.4.c) Set material-specific recycling targets for a selection of materials **in combination with**	2.1.5.4.3 in combination with 2.1.5.4.5	2030 (monitoring point by 2027)	*ELV*

Title	Chapter	Effective by	Implemented via:
2.4.e) Increase (?) current re-use and recycling targets and/or ban disposal or landfilling of waste from ELVs		2030	
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing in combination with 2.3.e) Establish provisions to support the market of used spare parts	2.1.5.3.6 in combination with 2.1.5.3.5	2027 2027	*ELV*
2.4.d) Regulate shredder/post shredder facilities to	2.1.5.4.4	Variable	*ELV*
2.3.a) Clarify definition of re-use in the ELV Directive vs re-use and preparing for re-use in the Waste Framework Directive in combination with 2.3.b) Introduce a definition of remanufacturing and specific provisions to support remanufacturing	2.1.5.3.1 in combination with 2.1.5.3.2	2025	*ELV*

The effectiveness of most measures is often dependent on the specific material or component in focus and its current status of reuse and recycling. For each material, the combination of measures that will be the most effective in improving reuse and/or recycling will differ based on the specificities of that material. In this sense, the compilation of measures analysed for each material/component group is specified in the next section.

3.1.2.3 Specification of the options at material and vehicle level

The options described above remain at the general level, prescribing which measures are to be applied under which option, but without clarifying how this would apply to specific materials or to the vehicle as a whole. However, for some materials, some measures will be more effective than others whereas some measures may have a low viability. For this purpose, a second stage is applied to specify a set of viable measures for each material, which will be the focus of the assessment of impacts that follows. This stage also clarifies which measures shall be analysed at the material level, whereas the general analysis will then be based on a compilation of the material specific costs and benefits, and which measures shall be analysed at the vehicle level. Thus, the following table specifies the measures to be considered for each material as well as the set of measures to be assessed only at vehicle level. It is also specified how other areas will be linked into the assessment. The table uses a colour code to clarify (for each material and at vehicle level): which measures will be reviewed in detail as they are considered viable and are expected to result in significant benefits and which are discarded at this stage for various reasons (detailed).

	Steel	Aluminium	Copper	Plastic	Glass
2.1.c: Circularity strategy					
2.1.f: Incompatibility reporting					
2.1.g: Recycled content target				x	x premature
2.2.e: Promote reuse market	x	x	x (e.g., engines)		
2.2.f: Reuse monitoring (& component specific targets)	x	x	x**		
2.3.a: Exclusion of backfilling				x	x

	Steel	Aluminium	Copper	Plastic	Glass
2.3.b: Mandatory dismantling	x	x	x	x	x
2.3.c: Material specific recycling target (calculation point)	x	x	x	x	x
2.3.d: Regulate shredder/post shredder	x (to reduce copper content)	x (to allow alloy separation and reduce losses)	x (to reduce copper losses)		
2.3.e: Ban disposal of waste				x (to increase separation of individual polymers and reduce losses)	

	Non-(established) recyclables	Rubber - Premature	Textiles - Premature	CRMs (including NdFeB magnets)*	EEC	Vehicle level
2.1.c: Circularity strategy						x
2.1.f: Incompatibility reporting						x
2.1.g: Recycled content target		x	x	x		
2.2.e: Promote reuse market		x		x	(x)	
2.2.f: Reuse monitoring (& component specific targets)		x		x	(x)	
2.3.a: Exclusion of backfilling	x	x	x			
2.3.b: Mandatory dismantling	x	x		x	x	
2.3.c: Material specific recycling target (calculation point)		x	(x)	x		x
2.3.d: Regulate shredder/post shredder	x (to increase separation of non-recyclables)	x (to increase separation of rubber and reduce losses)	x (to increase separation of textile and reduce losses)			x
2.3.e: Ban disposal of waste	x	x	x			x (and increase (?) of targets)

Originally, it was considered to set material specific targets for textiles and rubber. After in-depth analysis of the current situation 2.1.2.5, it is recommended not to include these materials at present. It is expected that the alignment of the recycling definition of the ELVD with the WFD together with the harmonisation of reporting (e.g., not allowing materials used for road surfacing in landfills or for filling underground mines to be accounted for in the reporting as recycling) and the ban of disposal or landfilling (measure described under section

2.1.5.4.5) will require the development of recycling technologies for these materials (e.g., chemical recycling) to ensure an alternative manner for their recycling. It cannot yet be estimated how such developments will change the recyclability of these materials over time and what measures could be suitable to improve the level of recycling.

The feasibility of setting up targets for REE and CRM materials is unclear at this stage. For PGM, particularly those included in the catalytic converter, collection and recycling is already very high. For REE, though a few recycling technologies exist, capacities are not available in the EU. It is also not clear when the amount of relevant collected fractions (e.g., NdFeB magnets) from ELVs would justify the realisation of such capacities. The feasibility of such target(s) will be analysed by JRC in the coming months, therefore in this study the consideration of a target for, i.e., neodymium magnets will not be assessed in detail.

The assessment of a recycled content target for plastic has been performed by the JRC and is documented in a separate report. The current assessment will summarise relevant results to ensure a comparison to the other measures to be assessed can be established but will not revise the assessment nor reproduce it in its entirety.

Measures relating to definitions and reporting are for the most part considered to be supportive in nature to the implementation of the other measures. They will be assessed for the most part on a qualitative basis but will only be discussed in detail where their individual application could result in an improvement of the level of recycling of a certain material (i.e., glass and alignment to the WFD recycling definition).

Looking at the various measures in the impact assessment in a communal way would require either a simplification of impacts (risking high uncertainties) or developing a very complex modelling system to allow consideration of impacts on different materials in parallel. This is related to different materials having different problems in the current situation and thus needing to be considered differently for each measure. To first allow addressing the current situation of each material differently (and in one case a component group), the various measures are analysed at material level to allow concluding in each case which measures are more appropriate in the context of the specific material at hand. After an initial analysis, scenarios are drawn at material level, allowing an understanding of how the relevant scenarios affect each material. This allows making assumptions as to the amount of material in specific components or in the vehicle in general as to what treatment routes will apply under each scenario for the material stream. Subsequently this later allows compiling the analysis at vehicle level to understand how materials are differently affected when measures for reuse and recycling measure are applied to the vehicle as a whole.

Thus, in the next sections, the analysis of different measures is applied in some cases at vehicle level and in others at the material level. The first section looks at the general design measures at vehicle level. Still related to design, in the next sections the impacts of different measure are analysed for non-recyclable materials, making a link in the scenarios between design and waste management to show how the type approval of vehicles can affect the number of non-recyclables that later need to be dealt with at EoL through other measures. As the last section on design, the analysis of measures on hazardous substances in vehicles follows, which are looked at more broadly due to the nature of the measures at hand. To understand the measures developed for reuse and recycling, but also for recycled content, the next sections analyse measures from the material perspective for: steel and copper, which have some interrelations, aluminium, glass and plastic and finally EEC on the basis of their contents of precious and critical materials. The material level analysis allows the specification of each measure for the different materials (i.e., which component is it relevant to dismantle to address specific materials) but also in what cases materials can be excluded from a certain measure (e.g., for which materials should recycling targets be considered and at what level in each case. This data is then gathered in the following analysis at the vehicle level that allows integrating the specifications and concluding how different measures will allow achieving different levels of reuse and recycling in the various scenarios and what this means for recovery and for process inefficiencies.

How the EPR measures (see section 2.3.5) shall link to the measures addressed in this part will be assessed as necessary at the material level (e.g., materials the treatment of which could require compensations) and/or vehicle level (e.g., training of ATFs) at the end of the specific section.

Finally, a compilation will be provided for policy options constructed at vehicle level to allow compiling the various impacts and to compare this with measures developed under other chapters.

3.1.3 Method of analysis applied

In the following sections, as explained above, separate analysis' are presented. A first section refers to analysis of measures in design. Most measures are analysed at vehicle level, including in the policy option on hazardous substances and this is complemented with a material level analysis for non-recyclables. The second section focuses on the end-of-life stage and begins with separate analysis of specific measures at material level. This includes separate sections for steel, copper, aluminium, glass, plastic and EEC which is actually a component level analysis, however related to these components being rich in various precious and critical metals. The material analysis often looks at an example component at least in part in order to allow better quantification of costs. Thus, the material/component level sections are followed by a last analysis at vehicle level or the reuse and recycling measures that sheds light on impacts at this level.

The sections are structured as follows. They begin with a listing of measures identified in section 3.1.2.3 as relevant for analysis at material and/or vehicle level. In an initial analysis it is explained why the analysis focuses on the assessment of some of the measures and discards other. This is followed by a section in which the baseline for comparison is characterised as well as the scenarios for assessment. These often refer to a single measure, however in a few cases combinations are also propose, explaining the grounds for such grouping. A qualitative analysis is specified to already pint to the main impacts and expected results. A quantitative analysis then follows, which begins with a presentation of initial assumptions for the assessment. In this section, it is often specified for the component or material flow under investigation, which shares have been assumed in the analysis to calculate material flows. Then impacts are presented for the environment, economic impacts and social impacts. The section concludes with a comparison of the various costs and benefits and some initial conclusions. Where relevant EPR considerations are discussed, followed by a proposal of the scenarios to be included for the final analysis of the preferred option.

The analysis is based on data collected from various sources. To calculate impacts in most cases the model described in annex I 6.9 is applied. Data on the composition of a specific components or a material in the vehicle is used as a basis to calculate material flows at component or vehicle level. On this basis and with the use of LCA data, environmental impacts are calculated for global warming potential. Furthermore, where data is available, the material flows are applied to calculate cost related to revenues from sales of secondary materials and related dismantling costs which also allow some assumptions as to social impacts (impacts on employment). Other impacts are presented based on date from the literature or stakeholder statements with a view to quantification of impacts where possible.

3.1.4 Analysis of measures on the design of vehicles and preparation for their being put on the market (vehicle level)

Three alternative options were shortlisted for improving the design of vehicle with a view to increase recyclability and reusability, including the following measures:

Title	Chapter
Adaptation of the 3R Directive to the new Type approval Framework Regulation + Proper definition of types of vehicles + 2.1.d) Provisions for improving the relation between the 3R Type approval process and ELV waste management performance. + 2.1.e) Option for OEMs to submit life cycle data as part of the 3R type approval process to justify the use of materials where recycling is not yet established+	(2.1.5.1.4 in combination with 2.1.5.1.5)
The manufacture of vehicles and vehicle components makes use of numerous materials of both primary and secondary nature. Some of these are sourced from countries (outside the EU) where the local governing conditions and/or the level of performance of mining and processing facilities may not ensure the provision of human rights, the health of workers and/or of nearby residents, or the prevention of adverse impacts on the environment. Where the manufacture of vehicles has a high dependency on material sourcing from such countries, this can contribute to adverse impacts on society and on human health and the environmental. To prevent such impacts, vehicle manufacturers could be required to perform due diligence when sourcing materials to produce vehicles and their components from high- risk countries. This can be related either to primary materials that are sourced from conflict-affected or high-risk areas or to secondary materials sourced from countries that do not ensure a minimum level of environmental performance and/or of minimum social working conditions. At horizontal level, in relation to the sourcing of minerals from conflict-affected or high-risk areas, Regulation 2017/821/EU lays down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from such areas. The sourcing of e.g., tin, tungsten, tantalum, niobium and gold minerals and metals for vehicle manufacture would be addressed through this Regulation, making an ELV obligation redundant. In some cases, there may be other materials used in vehicles sourced from countries that do not ensure that the sourcing and processing of such materials is environmentally and socially sound. For such cases, due diligence obligations could be included in the Directive, similar to those currently proposed for the new regulatory framework for batteries. This would include a provision, laying down obligations for OEMs to perform due diligence on the supply of certain materials (primary and secondary), and to declare on the risk of occurrence of adverse impacts and on strategies for their mitigation. Declarations on such actions, including third party verification would need to be made available to authorities as part of the type-approval process and for MS inspections. A list of materials (e.g., REE) for which this is to be obligatory would be included in the future legislation for vehicles, also specifying thresholds for each material as to the amount of use contained in a vehicle above which the obligation would comply. The annex would be updated continuously, in relation to the thresholds and if necessary, also as to the materials specified therein. There is also a need to consider the requirements set out in the Corporate Sustainability Due Diligence Directive. The CSDD is a horizontal legislation that focusses more generally on the *behaviour* of companies and addresses the entire value chain for all goods and services. It will implement the due diligence requirements of the proposed Batteries regulation by introducing a *value chain* due diligence related to raw materials (and goods and services) that are *not* covered in the Batteries Regulation. Both build on the OECD due diligence guidance, making implementation coherent. Expected outcome: It is currently not clear which materials could be addressed through a due diligence obligation to be included in the future ELV legislation. Materials addressed under other legislation (or in focus of future sectoral legislation such as the Batteries Regulation) are not used in large amounts in vehicles. In parallel, the European Commission has published a tender to review the functioning of Regulation 2017/821/EU, which towards 2026 could both lead to adaptations in future due diligence requirements as well as in the materials for which such requirements are necessary.	

Title	Chapter
2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars+ 2.2.b: Improved communication on hazardous substances in the automotive value chain	(2.1.5.1.10 in combination with 2.1.5.2.2)
In addition to the measures included under 2.2.a, the following measure is also included: 2.1.c) Obligation for OEMs to develop and implement a circularity strategy for increasing the circularity of vehicles	(2.1.5.1.3)
In addition to the measures included under 2.2.a, an information obligation would also be introduced in the form of an obligation to declare the level of recycled content applied for materials for which a recycled content is specified under ELV	(2.1.5.1.8)

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

All of the proposed measures are considered to be feasible (aside from inclusion of multi-stage vehicles under type approval already discarded above for passenger cars and thus not discussed here again). In this sense, all measures are to be assessed in the sections that follow and detail is here is provided on the main objectives to be achieved and on how the assessment is structured.

- Revisions to be performed to the 3R Type-approval (2.1.d) in combination with the obligation in some cases to submit life cycle data (measure 2.1.e) are expected to assist type approval authorities in distinguishing between vehicles that can be type approved and those that should not. This has to do with the way that the type approval process, and in particular the calculation of the 3Rs reflects the actual ability of achieving the targets at EoL. Though it is not considered that the new calculation method shall allow to forecast the future, however materials with low recyclability or with a low recycling efficiency will be better reflected in the calculation. Where this will then show that the targets cannot be met, this will lead to type approval rejections in the short term and to vehicles being designed in a more circular way in the mid-to long term. In relation to materials considered to be non-recyclable at the time of the type approval, measure 2.1.e shall only allow use of such materials in large volumes when it is proven that this reduces the total environmental impacts of a vehicle. Where this is not the case, the use of such materials shall be limited, thus also increasing the circularity of the vehicle fleet over time. This latter measure is investigated separately at material level under section 3.1.4.7.1.
- Measure relating to the provision of information build on existing provisions in the ELVD (2.1.2.5.10 in combination with 2.1.5.2.2). Though OEMs are already obliged to provide data to ATFs to facilitate waste management, it is observed that data is not always sufficiently available. The measures proposed thus aim at improving harmonisation and accessibility to data that would support the dismantling of components and materials and a more circular waste management.
- The measure for developing a circularity strategy (2.1.c) is not expected to directly affect the type approval of individual vehicle types. It rather only serves the purpose of ensuring that the OEM has a strategy in place to improve circularity over time. Though information is to be specified in some cases also at vehicle level, it would not necessarily affect actual type approvals which shall be decided on case by case in light of the compliance of the OEM with the obligations specified for the design of the vehicle in the 3R legislation and/or in the ELV legislation. Nonetheless, it will allow the authorities to observe progress of OEMs in increasing the circularity of vehicles and could lead in the long term to introduction of additional provisions where efforts are not observed to be far reaching enough.
- Measures requiring a declaration on the level of recycled content in specific vehicles are only relevant in cases that including a minimum rate of recycled content (i.e. achieving a target) is obligatory, though where a target is under consideration or to come into force in

the future, it could also be useful to observe the development of the sector in this area. Though the declaration could trigger some additional use of recycled content, this is considered marginal if a mandatory target has not been set. The differing impact in this case can be seen in the material level assessment for plastics, where recycled content level obligations are under consideration (see section 3.1.9.1). In this section, only the costs related to providing such declarations are taken into consideration.

3.1.4.1 Scenarios for quantitative analysis

At present the type-approval does not facilitate the provision of information on the vehicle composition to ATFs. Though in theory, the 3R Directive requires OEMs to submit a strategy "to ensure dismantling, reuse of component parts, recycling and recovery of materials", such strategies are quite general in nature and data on dismantling is provided to ATFs through IDIS, though not addressing all components and materials for which such data would support circularity.

More importantly, though, the 3R type approval requires OEMS to show how they comply with the 3Rs, the calculation for showing this and information provided during the practical application of the 3R process of type-approval does not reflect whether parts can be reused nor how this affects the achievability of the targets. As there was no monitoring of the 3R Type-approval process and results in relation to the actual fulfilment of targets at EoL in the past, it cannot be said to what degree granted 3R type-approvals reflect the actual achievement of the 3Rs at EoL, however the fact that recyclable materials are accounted for as 100% recycling, ignoring any material losses, suggests that the format and process are not fit for purpose, particularly with the expected development towards vehicle light-weighting which shall increase the use of materials with no or less established recycling. Similarly, the fact that a material with a TRL above 4 is currently considered as 100% recycled at EoL, but does not necessarily reach this level at EoL, suggests that the calculation is not sufficiently reflective of EoL.

3.1.4.1.1 Baseline

The 3R Type-approval Directive and process remain the same, with the result that over time more vehicles are placed on the market that cannot fulfil the 3R targets at EoL:

- In some cases, this is related to the use of non-recyclable materials that will not be recyclable at EoL and could affect the general fulfilment of the targets at MS level. This is for example currently the case with vehicles that use large amounts of carbon fibre reinforced plastics, which is looked into separately under section 3.1.9.1.
- In other cases, this is a result of certain materials being considered as 100% recyclable but being downcycled (e.g., glass) or used in large amounts for recovery (e.g., rubbers, plastics). With the increased use of plastics expected for light-weighting, this could lead to the current level of 85% recycling not being achieved over time. In particular, in the short term, with the expected increase in electric vehicles in the vehicle fleet, the fact that Li-Ion batteries, accounting for a significant weight of the vehicle, and still far from being 100% recycled, will make achieving the targets increasingly more difficult.

It is assumed that this is already the case today for a small number of vehicles, however, that in the older fleet vehicles using e.g., non-recyclables, large quantities of plastics and Li-Ion traction batteries are still rare. This means that vehicles fulfilling and going beyond the targets dominate the vehicles arriving at EoL and can still compensate for those that do not. By 2035, more vehicles with e.g., high volumes of non-recyclable materials, large amounts of plastics and Li-Ion traction batteries shall reach EoL and for the comparison with other scenarios, these are assumed to result in only 70% reuse and recycling being achieved at vehicle level (based on new calculation point concept). To substantiate this, Figure 3-22 shows an analysis of the amounts assumed to be recycled, reused, recovered and “lost due to process inefficiencies” in 2035 of all collected ELVs in the baseline, suggesting that around 18% of all materials in the fleet would be “lost” and 9% recovered.

The new type-approval Regulation (EU) 2018/858 which applies since 1 September 2020 and introduces the specific rules on market surveillance activities applicable to automotive products. Article 8 of Regulation (EU) 2018/858 sets out the obligations for market surveillance authorities. It includes a minimum requirement for the number of tests to be carried out by market surveillance authorities in each Member State, requiring one test for every 40,000 motor vehicles registered in the MS during the previous year and no less than 5 tests per MS. 20% of the tests carried out are required to be emissions tests. The Commission also now has the capacity of carrying out test and inspections to verify the compliance of vehicles, systems, components and separate technical units.[202]

However, there is no specification as to the focus of market surveillance tests other than those carried out regarding emissions and thus, it is unclear how many activities will be focused on the 3R Type approval and its correlation with actual fulfilment of the 3R targets at EoL without this being specified as a necessity, e.g., in the 3R Directive. The same is true regarding the EC’s capacity to carry out inspections of vehicles, though here with the increased understanding that the 3R Directive may not be sufficiently effective, some inspections could be expected. However, without a change of legal obligations, it is not clear how these could contribute to improving the situation in the baseline.

As there are no provisions in the Directive requiring manufacturers to take action to increase circularity, such activities will continue to take place at small scale on a voluntary basis but will not result in significant benefits in vehicles put on the market until 2035.

As for provision of information, OEMs will continue to use IDIS to provide ATFs with information on the localisation and methods for dismantling components with depollution or dismantling obligations specified under Annex I of the directive. However, obligations only refer to a small number of components and are in some cases vague (e.g., plastic treatment, weight of Al or plastic parts that need to be dismantled). Information on dismantling of components for the purpose of reuse and digital keys for enabling dismantling and re-installation of locked components, shall only be provided through RMI data, with only few ATFs making use of such data due to the low level of harmonisation and the cost of data. In result, the level of reuse shall remain low (assumed 8% in 2035, see Figure 3-22) and the quality of recycling may also not reach its full potential for some materials. Information on the use of hazardous substances in different components is provided to the SCIP data base in a format considered to be impractical for the use of waste management operators. Though data on the use of hazardous substances and CRMs in supplier components is understood to be available to OEMs in the IMDS system, it is not available to waste management operators, and this would not be expected to change in the baseline.

3.1.4.1.2 Scenario Design 1: Better compliance option

The 3R Type-approval directive is to be aligned with the type-approval framework Regulation (EU) 2018/858. This will lead to general coherence but will also allow ensuring that a minimum of market surveillance tests performed will be focused on 3R Type approval aspects. It is assumed that this would concern at least 1 test per MS per year.

[202] Personal communication with DG GROW from 19.08.2022.

In addition, the Commission will use its capabilities to perform dismantling tests of 5 newly approved vehicle types put on the market in each year, with the objective of checking to what degree they can be dismantled in reasonable time in a way that supports a higher reuse rate and a higher level of high-quality recycling. Both market surveillance activities and EC dismantling and shredding tests, will contribute to a better understanding of vehicle composition that can achieve the 3R targets at EoL. In consequence, however, some vehicles may be identified that do not sufficiently comply with the 3R Directive and ELVD provisions and this may lead to a need to recall such vehicles, replacing them with complying ones, also sanctioning the respective OEM with up to 30,000 Euro for each non-compliant vehicle.

The definition of “vehicle type” will be revised, ensuring that any provisions that affect vehicle design or communication on vehicle composition shall be implementable at the vehicle type level. This will ensure that e.g., information on components with a dismantling obligation or potential and on components containing hazardous substances will be made available as required by the legislation at vehicle level.

The 3R Type-approval procedure shall be changed to be more specific and better match with the reality of how materials in vehicles can be recycled, re-used or remanufactured. To show that a vehicle submitted for type approval can fulfil the 3R targets, OEMs will need to:

- change the design of vehicles to include at least 85% of materials with a TRL above 9, excluding losses related to tyres, and/or
- change vehicle design to ensure a higher dismantlability of components with dismantling obligations or a high potential for reuse and high-quality recycling when recycled separately (without undergoing shredder operations), and/or
- ensure that materials used in volumes above 10 kg with a TRL of 8 and below contribute to the vehicle’s environmental performance

In this sense, the recyclability and reusability of a vehicle can be expected to increase and ensure that the rates of reuse and recycling will increase in comparison to the baseline. For the purpose of comparison and based on the analysis of reuse and recycling measures at vehicle level, this is assumed to result in at least 74% reuse and recycling being achieved at vehicle level (based on the new calculation point concept). This level is assumed in the analysis at vehicle level in the case that all provisions are applied, however not taking into consideration the impact of a revision of the 3R Directive and better access to data. It is possible that the measures included under the vehicle design scenarios would increase the reusability and recyclability of vehicles a bit further, though there is no data to allow this to be quantified.

This scenario would also require manufacturers to provide more information on the vehicle composition, including data on the dismantlability of components with a potential for reuse and/or recycling (dismantling method and time). As part of the process, OEMS are to be required to provide:

- the EPR scheme with data necessary for fee modulation (e.g., on components for which the preferable treatment route is slightly below economic feasibility),
- dismantlers with data on the dismantling of materials and components with a depollution obligation (annex I(3) of ELVD), with a dismantling obligation (annex I(4) of ELVD), or with a reporting obligation due to the potential for reuse (to be included as part of annex I or in a new annex) - free of cost and in a harmonised manner),
- dismantlers with data to unlock and enable reuse of parts with a digital–key - at a reasonable cost and in a harmonised manner,
- dismantlers with data on component interchangeability between models and brands, to allow maximising reuse of components - at a reasonable cost and in a harmonised manner,

- dismantlers upon request with data on the location and content of hazardous substances in specific components of specific vehicle models.

To facilitate the provision of data, OEMs could decide to use existing or new web-based platforms or to develop a digital product passport. If IDIS is used, it is assumed that it shall be harmonised further, following exchange with ATFs to ensure that it shall later enjoy a higher acceptability and usability (at least 10,000 of the 12,000 ATFs operating in the EU). In this case, IDIS would be assumed to be used for all information that needs to be made available without costs to ATFs. If the RMI platforms shall be used, this is assumed to only be applied for information that can be provided to ATFs at a “reasonable cost and in a harmonised way”[203]. The vehicle sector is currently working on a vehicle digital product passport[204] and could decide to develop it further to also cover such information in this initiative. For compliance, provision of data shall be considered fulfilled when access is given to the authority through the same method that it will be made available to dismantlers and the EPR: e.g., a web-platform (like IDIS) or a digital product passport so that the availability of the data, its accessibility to certain actors and its level of harmonisation can be ensured.

In addition, OEMs will be required to perform a dismantling and shredding test on a vehicle (prototype) as part of the type approval process of each type. Documentation on the results of this test shall be submitted together with an application for type approval. It is assumed that only vehicles for which the test supports that waste management will allow achieving the target shall be submitted to type approval, however the available data will enable the EPR schemes to develop fee modulation if necessary for vehicles. In parallel, it can be assumed that particularly in the first years of implementation, that OEMs may in some cases have a dismantling and shredding test performed on a vehicle (prototype), with the result that the vehicle designed is revised prior to 3R type approval. To consider such cases, it is assumed that in 2035 for every 4 vehicle’s types submitted to type approval, at least one will have had a dismantling and shredding test performed twice.

3.1.4.1.3 Scenario Design 2: Better Compliance + Circularity strategy

In addition to the measures addressed under scenario Design 1, OEMs will be obliged to submit a circularity strategy every 5 years that refers to minimum reporting requirements set forth in an annex of the ELVD. This could require specification of the state of certain elements (e.g., use of recycled content – see detail in measure description). The ambition of the minimum information requirements could change with time, requiring certain targets or actions to be fulfilled within a certain duration.
In principle, though the proposed circularity strategy is to replace the current strategy that OEMS must submit in line with 3R Directive Article 6(3), the requirements will be more stringent and thus it is anticipated that OEMS will need to review their existing strategies

[203] From a personal communication with DG GROW from 19.8.2022, it is understood that in accordance with Article 63 of Regulation (EU) 2018/858, a manufacturer may charge reasonable and proportionate fees for access to vehicle repair and maintenance information which shall not discourage access to such information by failing to take into account the extent to which the independent operator uses it. Delegated Regulation (EU) 2021/1244 amends Annex X to Regulation (EU) 2018/858 and introduces a reference to standard EN ISO 18541 ‘Road vehicles – Standardized access to automotive repair and maintenance information (RMI)’ with the aim of facilitating the exchange between manufacturers and independent operators of vehicle RMI by establishing the technical requirements and procedures for access to that information. Even though, that Regulation will only apply 30 July 2023, it is already an indication of the requirements that manufactures will need to follow by that date and lcarifies that despite efforts towards harmonisation, there will not be a single database but rather a standardised way that manufacturers need to comply with for their databases.

[204] See: https://catena-x.net/en/, last accessed 4.9.2022

significantly to ensure provision of required information at fleet and vehicle level. This will be more of an effort the first time the strategy is submitted but will also need to be updated bi-annually, meaning an additional effort, where at present the strategies are understood not to be updated so often.

In terms of the information that the strategy is to include, type approval authorities that shall review the strategies as part of the type approval process will obtain a better overview as to how vehicles are assembled to ensure dismantlability. This will feed into the review of type approval submissions in relation to data provided for components that are dismantled form the vehicle.

3.1.4.1.4 Scenario Design 3: Better Compliance + Circularity strategy+ minimum levels of recycled content

In addition to the measures addressed under scenario Design 2, OEMs will be obliged to provide a declaration, i.e., report on the rate of use of recycled content from all content used of a specific material. Under the current assessment, this will require the declaration of the rate of recycled plastic from all plastic used in a vehicle submitted to type approval. Depending on other measures to be implemented, should a minimum target be introduced as to the minimum recycled content rate, the declaration would also be considered for the general compliance of the vehicle with design requirements and for its 3R type approval.

3.1.4.2 Results of qualitative analysis

Scenario Design 1 is aimed at increasing the effectiveness of the type-approval process in ensuring that the 3R Targets are achievable by vehicles placed on the market and that sufficient data is available to ATFs to allow components to be dismantled that have been intended for such operations in their design. Additionally, the measures are designed to ensure that reuse is covered more adequately by the 3R Type-approval, removing obstacles to reuse for components.

The data that is to be provided by OEMs is already known and some of it is provided to existing platforms like IDIS or RMI individual manufacture platforms. However, in the baseline:

- information made available on parts with depollution or dismantling obligations can still lack detail of importance for dismantling and is presented in a less harmonised way which discourages ATFs from using such data,
- information made available on parts with a reuse potential is provided in the RMI individual platforms at a cost that decreases per use, discouraging ATFs that only use data occasionally, i.e., in particular smaller ATFs that treat vehicles of multiple brands, form using such data and thus also from dismantling components for reuse,
- information needed to ensure reuse of digitally locked components, is usually provided by OEMS on individual platforms at a cost that decreases per use, again meaning that ATFs that treat multiple brands will face high costs per use and in particular the smaller ones will be discouraged from dismantling components with digital locks and preparing them for reuse,
- information on the interchangeability of components between models and brands is understood not to be available to ATFs, though OEM suppliers will have data on the interchangeability of their supplied components.

Under all design scenarios OEMs would be required to provide such data in a more harmonised way, either for free (dismantling data for components with obligations) or at a consistent and fair price (digital keys, interchangeability data). Though it would be most efficient for all such data to be provided to ATFs on a single platform, it is not expected that the legislation would be prescriptive as to the type of platform, but rather only as to the level of harmonisation and cost categories (no cost or low cost). It is thus expected that OEMs would either continue to use IDIS and RMI for the data for which each platform is used today or would develop a digital product passport for vehicles (possibly adapting existing initiatives like Catena-x for this purpose).

- In the case that IDIS will continue to be used for dismantling data, it is expected that additional harmonisation will be needed, resulting in an administrative burden. Nonetheless, harmonisation of IDIS data is understood to be an activity in which the platform is constantly engaged and thus costs for such activities would be expected to be of an acceptable range. Using the platform for data on digital keys and interchangeable components would be convenient for ATFs, but would probably require developing new IT architecture, increasing the total burdens.
- In the case that RMI is used for some or all data, it would, probably be necessary to legally require the introduction of specific user costs for ATFs to ensure that the cost shall not discourage access to such information as required by Article 63 of Regulation (EU) 2018/858)[205]. Though this may result in an administrative burden, it is not expected to be high as the IT architecture would probably remain similar, however OEMs may see some losses in terms of the fees that they currently receive form ATFs through the system (range of related revenues is unknown). As RMI data shall remain available on OEM individual platforms, it is not clear if this would not on its own already discourage ATFs (in particular independent and smaller ones) from use of such data.
- Data on the interchangeability of components is understood currently not being available. Should OEMs be obliged to provide such data, it may be provided on either IDIS or RMI platforms or through a digital product passport. In any case provision would require developing related IT architecture, creating development costs, but would be expected to support more reuse of components with high interchangeability.
- Improving accessibility of data on content of hazardous substances could be addressed through adaptations to the SCIP or to GADSL and IMDS or through development of the DPP as currently contemplated under the ESPR. This is explained in more detail under Section 3.1.4.9 below.
- Should a digital product passport be applied, this would be expected to have the highest costs, as the platform does not yet exist. Nonetheless, the fact that the automotive sector has already embarked on such initiatives suggests that a benefit of a mutual digital data base for the sector exists. Should such a system develop naturally, is assumed to indicate that the benefits are higher than the expected costs. Should the legislation require such a development, costs could be higher and would probably also be accelerated in time.

In any case, under all design scenarios, the accessibility of data is expected to be higher than in the baseline and in so far to increase the rate of reuse in components where this is hindered at present due to lacking data on dismantling, on digital keys or on interchangeability. Data on dismantling could also have a positive impact on the rate of recycling, where, when performed prior to shredding operations, this results in higher quality or quantity of recycling.

[205] Currently Article 63(1) of Regulation (EU) 2018/858) allows the OEM to “charge reasonable and proportionate fees for access to vehicle repair and maintenance information […] Those fees shall not discourage access to such information by failing to take into account the extent to which the independent operator uses it”. However, paragraph 2 of the same article allows the OEM to “make available vehicle repair and maintenance information, including transactional services such as reprogramming or technical assistance, on an hourly, daily, monthly, and yearly basis, with fees for access to such information varying in accordance with the respective periods of time for which access is granted”. Thus the current cost scheme is not expected to change for ATFs without intervention and would be expected to continue to discourage use, in particular for small and independent ATFs.

This could be the case for components and materials for which dismantling obligations do not exist but also for components with a reuse potential, as some of those to be dismantled will be damaged during removal or will not be purchased for reuse and will, thus, subsequently be sent to separate recycling.

Under the design scenarios it is further envisioned that MS and the EC shall perform market surveillance and vehicle dismantling tests. Though this comes with some administrative costs, it is expected to increase the knowledge of type approval authorities and of authorities as to the correlation of the 3R type approval calculation with the actual 3R targets achieved at EoL. This should over time lead to more vehicles which can fulfil the targets being placed on the market.

It is also envisioned under all design scenarios that OEMs will be required to perform dismantling tests of prototype vehicles as part of the 3R type approval. This should lead also to an increase in the share of vehicles placed on the market that can fulfil the targets but would also allow fee modulation in cases of vehicle models where e.g., vehicle design does not sufficiently facilitate dismantling of components with obligations. Though in the first years this may be a burden to OEMs, it can also be expected to reduce the number of 3R directive market surveillance violations that would results in sectioning of OEMs. In other words, the benefits in the long run would probably justify the costs of implementation.

Under **Scenario Design 2**, OEMs will be requiring submitting a circularity strategy and to update it on a bi-annual basis. The strategy will include data on the circularity performance of OEMS at vehicle fleet and at the level of some individual models. The data is not expected to change the compliance of OEMs with legal requirements but could lead some OEMs to advance a little bit voluntarily. In so far, the strategies could help type approval authorities to better understand the efforts made by OEMS to increase circularity through design and what this may mean for the type approval process. OEMs will have costs for developing the strategies but also for their implementation in areas that go beyond the legal obligations. It is however not clear to what degree design changes would actually go beyond legal obligations in a way that differs from the baseline (i.e., frontrunners would be expected to perform similarly).

Scenario Design 3 is considered for the most part as a measure that ensures compliance in the case of a target for recycled content. Where the declaration is required by OEMs without a target, a small increase in the use of recycled content may be expected to allow “declaring on positive results”. However, this would most likely only be a small difference to the baseline and would probably rely more on recycling from other sectors than on recycling of materials from vehicles. Once the declaration is coupled with a target for recycled content (as proposed for e.g., plastic), the main benefit of this option is for compliance verification, whereas it is the measure introducing the targets which would be expected to generate the increase in the use of recycled content in general and more specifically from vehicle origin.

3.1.4.2.1 Environmental impacts

Under **all design scenarios**, the prescribed measures do not address environmental aspects directly, but rather how the 3R type approval process is carried out, how it is enforced in terms of market surveillance and what type of information needs to be provided by OEMs as part of the process. Nonetheless, these aspects can be expected to affect the composition of vehicles, their dismantling and thus also the level of the 3Rs at EoL, leading indirectly to environmental impacts:

In relation to the general reusability and recyclability of vehicles placed on the market following the 3R type approval, it is expected that under the design scenarios, the level of reuse and recycling will increase from around 70% to at least 74% (based on the monitoring with the calculation point concept). This is not just related to the 3R revision but also to the application of additional measures, however, the former may increase the total achievable rates a little further, as market entrance of vehicles that cannot fulfil targets will be more limited.

The reuse and recycling rates could increase further with time due to the dismantling tests that OEMs will need to perform and submit documentation for: this information will allow both OEMs and type approval authorities to develop a better understanding of what practices facilitate dismantling, reuse and recycling to a higher degree. This could be reflected both in OEMs choice of practices in vehicle types submitted for approval and in decisions of authorities as to approval of vehicle types for market access.

In addition, it is expected that the use of non-recyclables in large amounts in vehicles will be less common in vehicles that do not show a higher environmental performance during the use phase that sets-off negative impacts on recyclability. Though it could be that vehicles using non-recyclables will have a lower fulfilment of the 3R targets, this would be expected to be set-off through benefits to have incurred from the use of respective materials in the use phase, i.e., a net benefit in total.

The availability of information on dismantling and on digital keys and interchangeable components will likely increase the rate of components dismantled for reuse and/or recycling. This is expected to particularly be the case:

- For components for which OEMs have developed quick dismantling methods but where information does not sufficiently reach ATFs under the baseline. EGARA (2021) for example reported on a vehicle model in which the OEM invested in a method for quick release of the copper wire harness, however as the information did not reach ATFs, the practice was abandoned instead of being applied by additional OEMs and increasing the complete dismantling of such components. Similar cases are expected to be relevant for other material components.
- For components where digital keys prohibit the reuse in vehicles, a more harmonised and less expensive accessibility is likely to increase the rate of dismantling and sales for reuse. As such components are EEC, this will have a positive effect on the reliance of the vehicle sector on primary precious metals and CRMs and will also have a positive effect on the level of copper impurities in steel scrap. Similarly, information on dismantling of components with a potential for reuse can be expected to increase the dismantling and sales for reuse of other components, also affecting the reliance on resources needed to manufacture new components for replacement.

Under the design scenarios, the increase in the rate of reuse of certain components will translate into a decrease in the amount of resources needed for manufacturing new ones.
Under the design scenarios, MS could be expected to perform more market surveillance activities looking at the enforcement of the legislation. The same is true for the EC performing dismantling tests. Where non-compliant vehicles are to be identified, this could result in a premature recall and scrapping of such vehicles, meaning that the resources used to manufacture such vehicles will have not reached the full potential of the vehicle service life. This impact will be less severe, as materials could be recycled, however the environmental burden of recycling scrapped vehicles into new materials cannot be ignored.

Under **scenario design 2**, as manufacturers using large amounts of non-recyclables will be obligated to show how they will promote recycling of such materials within 7 years of the initial type approval, it will additionally be expected that the recyclability of non-recyclables is increasingly possible at EoL or that the OEM collects such materials to ensure their waste management independently.

Furthermore, under this scenario, the reporting on practices that support circularity to type approval authorities could increase the knowhow of staff over time, again resulting in vehicles that have a higher compliance with design requirements and with the 3R targets being placed on the market mor often.

Under **Scenario design 3**, the declaration obligation may have some benefit in terms of increasing the level of recycled content marginally (see results of the plastic analysis at material level under section 3.1.9 for more details) when no target exists. However, once a target is enforced it is assumed that the target is the driving force behind environmental benefits and not the declaration. This measure is thus mainly considered a supporting measure to allow ensuring compliance with future recycling content targets, having a benefit in terms of ensuring enforcement.

3.1.4.2.2 Economic impacts

For all design scenarios, economic impacts can be expected for OEMs, 3R Type approval authorities and for ATFs.

The revisions to the type approval calculation under the **design scenarios**, could be considered to make the process somewhat more complex for OEMs and for 3R type approval authorities, however the calculation generally follows the existing one, with the main burden being expected to result in a one-time transitional costs for adjusting the software so that when a material is given with a TRL lower than 9 or in the case of materials with low recycling efficiency (rubber), that such materials are accounted for only partially (or not at all) in the calculation of the 3Rs. Though this will have an impact, it is assumed to be negligible in relation to other costs, in particular as the automotive already has a document specifying the recyclability level of different material typed which is updated from time to time and is used by the various OEMs.

Under the **design scenarios**, the increase in the rate of reuse of certain components will mean that suppliers of replacement components see a loss of business, while ATFs and remanufacturers will see an increase in business. This is considered to be more of a distributional impact. In parallel, vehicle owners shall profit from the increased supply of reused parts (assuming that demand will increase), as these are less costly, meaning that repairs will be less expensive.
Market surveillance authorities performing activities in relation to type approvals or EC dismantling activities would have a burden in terms of the time needed for surveillance activities and the costs that e.g., surveillance of a single vehicle would incur. For example, if the authority would need to pay for the vehicle to be surveyed this could easily translate to a few tens of thousands of € per year for authorities dismantling whole vehicles (assumed 30,000 € on average) or a fraction thereof (assumed 1,000 € per average component) for authorities dismantling specific components. Assuming that each MS performs at least one activity related to 3R type approval annually, and assuming that 20% of activities are at vehicle level would mean that annually close to 185 thousand € would be spent only on the vehicles or components to be surveyed. Additional costs may incur for equipment used for surveillance as well as for the time that employees will spend on such activities (see below under administrative burden).
Vehicle recalls resulting from market surveillance or EC dismantling tests are also expected to have a significant economic cost for OEMs. Market surveillance sanctions could lead to fines of up to 30,000 € per vehicle. If to assume that a vehicle has been placed on the market in the EU at a volume of 10,000 vehicles in the year following its type approval, at the end of which a non-compliance is revealed, this could lead to sanctions at a value of 300 million € just for the one case. This is furthermore considered an underestimation, as additional costs would incur due to vehicle owners needing to be compensated for their damages and due to

the “losses” related to the upscaling of production of a vehicle type that will no longer be manufactured.

Regarding provision of data, it is difficult to assess what costs this will result in for OEMS. Whether (sometimes existing) platforms are used, or a digital product passport (DPP) could affect the costs for OEMS: a DPP would need to be developed as an IT solution and can be considered to be more complex and costly in its entirety than a web-platform, particularly as some of these are already established (IDIS; RMIS, GADSL And IMDS) and could be improved instead of developed anew. Nonetheless, it is also observed that the vehicle sector is already considering the development of a digital product passport for vehicles, meaning that this is also assumed to have certain benefits. Whether this would also be the case for provision of data to ATFs through a DPP is not clear. If the decision between the options is left open to OEMs, impacts can be considered to be acceptable even if different in range. Where the regulator decides to require a certain solution over alternatives, in particular a DPP solution, it should be kept in mind that this shall probably increase economic impacts on OEMs.

As for the impact of different methods of provision of data on ATFS, here, there is also a lack of quantified data as to the actual benefits. Data proposed to be made available (in general or in a more harmonised way) is data for which stakeholders have explained that there is a lack in data (EGARA 2021; EuRIC 2021) or that use of data results in costs for ATFs that discourage ATFs from reuse of respective components. Generally, it can be understood that for ATFs it would be an advantage to have all data in one place as, it is explained to be a burden if an ATF needs to open multiple PDFs to reach data of interest. INDRA (2021) explain that IDIS is too general, “you know the information only per model but the model can have different options which are not detailed” and recommend the use of a RFID, QR code for access to data. “Dismantlers should not be asked to search in a database for 20 min on different websites but can scan the code of the car / component that he has in front of him in the dismantling line”.

It is thus also assumed that needing to install multiple platforms of individual ATFs will discourage ATFs from use of such data, as it requires not just installation but familiarity with the structure of multiple sites that are not used often enough for this to develop. If all data is located under one platform and harmonised, this could be assumed to have a benefit for ATFs, however they should be included in the process of development of the IT architecture of such platforms to increase their efficient use. A digital product passport may have an advantage, as it would be assumed to work with a QR code or RFID, allowing the use by the operator “at the vehicle”, however such systems are yet to be developed to clarify their actual efficiency of use. ATFs, who over time should have an increased availability of data would be expected to see an increase in activity for parts that could be reused or recycled separately due to the newly available data. Though this may increase costs of dismantling it would also be expected to increase revenues where the data is applied.

Administrative costs for 3R Type approval authorities shall need to assume the additional task of ensuring that required information has been submitted (or linked) with the 3R Type-approval application. This will increase the costs of the process but is likely to only affect some authorities as not all MS perform 3R Type Approvals. One Type approval authority estimated that it needs less than < 0.25 years full time job equivalents (FTE) per each 3R type approval performed, however it is not clear if the days needed are closer to 3 months work or to a few days. A type approval service provider that supports another authority in checking submissions of 2 OEMs estimated 10 days of work per annum, without specifying the number of approvals that this covers. Assuming 10 working days for a single type approval thus seems to be an over estimation. If the need to check the provision of data would increase this by 50%, this would still only be 5 additional day per annum. It is understood that only a handful of MS perform 3R type approvals, but even if half would be involved in such tasks, this would still only result in less than 70 working days in the EU in terms of the administrative cost, amounting to less than 15,000 € per annum.

As data is lacking to allow a more accurate quantification, it has been assumed that the administrative costs for MS performing market surveillance activities will require 3 days for testing a vehicle and 1 day for testing an average component. Again assuming one activity per MS and, 20% of which are at vehicle level, would amount in less than 40 days of work in the EU in terms of administrative costs. Cost for vehicles/components have also been included in the sum. This amounts to ca. 190 thousand € per annum across the EU.

In addition, the Commission will be tasked with performing and reviewing dismantling tests, creating costs for the purchase of vehicles for dismantling as well as costs for the actual dismantling exercise, the review of its results and communication to 3R Type approval authorities. Cost for 5 vehicles have also been included in the sum. This amounts to ca. 160 thousand € per annum.

OEMs are also expected to have additional costs for dismantling tests of (prototype) vehicles prior to submission of type approvals. Assuming that the OEM would need to cover expenses of 5 days for a shredder activities and 10 days for type approval service provider activities for each vehicle tested, assuming 5 vehicles tested per year per OEM (at a cost of 30,000 € for the vehicle itself) and assuming 10 OEMs, this would amount to around half a million € per annum.

In total, this amounts to around 820 thousand €per annum for thus scenario.

Scenario Design 2

Under **scenario design 2**, manufacturers using large amounts of non-recyclables will be obligated to show how they will promote recycling of such materials within 7 years of the initial type approval. Though it is not sure that this method of treatment would be more environmental than the method applied by ATFs, however the burden for ATFs would be significantly smaller, leaving more of a financial margin to treat other materials at a higher level. For OEMs this may mean higher costs for treatment of such materials, however as OEMs are expected to have benefits from the use of such materials, such costs would be expected to either be acceptable or to create a disincentive from using such materials where recyclability cannot be ensured over time.

Costs are expected mainly for OEMs, who need to prepare and submit the strategy and to update it on a bi-annual basis. Though OEMs already have an obligation to prepare and submit a strategy, this is understood to be more general and is not updated very often. The new obligation would require preparing a more detailed strategy and also clarifying at vehicle level to some degree how it is implemented over time. This is assumed to be a more significant effort, however there is no data as to how much time OEMs would spend on developing the strategy and how much would be spent in its implementation. Though the cost could be expected to be significant, it is considered to support design improvements that would make vehicles more circular.

Even though type approval authorities would need to review such strategies, they are already expected to do so in relation to the strategy that OEMs are expected to submit, and costs would not be expected to differ significantly.

Scenario Design 3

Costs are mainly expected for OEMs and shall depend on the effort of certifying the amount of recycled content used per vehicle. JRC has made estimations of providing such declarations and explained that these are negligible in comparison to the effort of increasing the amount of recycled content actually applied. This is explained to some degree in the section assessing impact for plastics and in the JRC report (see (Maury et al. 2022)).

3.1.4.2.3 Social impacts

Where there shall be more work, an increase in employment could be expected, however the range of additional jobs is difficult for quantification.

For measures addressed under **Scenario Design 1 and relevant for all scenarios** increases in jobs can be estimated in relation to the expected administrative burden. This amounts to around 900 working days per annum in total and makes up for around 4.5 jobs with less than 1 job being associated with authority activities.

In addition, new employment can be expected to develop at OEMs in relation to actual design changes to be initiated to ensure compliance of vehicles to be type approved. As the range of design changes could vary between vehicles it is not possible to estimate the range of this impact.

In addition, additional jobs would also be assumed to be created at ATFs where, more components could be dismantled and sold for reuse due to the additional availability of data. However here too, there is no data to allow a quantification, also as this would depend on the quality of data made available and on the platform chosen.

In **Scenario Design 2**, OEMs can be expected to have costs for preparing their strategies but also for their implementation, thus driving a small increase in employment. Though type approval authorities will experience some additional work for the review of strategies this is expected to be covered by existing employees.

In **Scenario Design 3**, OEMs can be expected to have costs for performing dismantling tests. These would be performed by type approval authorities and by shredders, making up for almost 4 jobs annually as explained above.

3.1.4.3 Results of quantitative analysis

Data is not available to allow a quantitative analysis of most aspects.

3.1.4.4 Comparison of scenarios

Impacts		Scenario design 1 Type approval	Additional impacts under Scenario design 2 circularity strategy	Additional impacts under Scenario design 3 Declaration on recycled content
Economic	on ATFs	Some costs for additional dismantling but assumed to be set-off by benefits for selling components for reuse and scrap for recycling Between + and ++	Indirect benefits from OEMs strategies in the long term, as vehicles become more circular +	Benefits related to increase in recycled content but not to declaration n.a
	on Shredders	Possible decrease in shredder inputs where more dismantling takes place -	Unclear impact, depending on how vehicles become more circular	Benefits related to increase in recycled content but not to declaration n.a

Impacts		Scenario design 1 Type approval	Additional impacts under Scenario design 2 circularity strategy	Additional impacts under Scenario design 3 Declaration on recycled content
	On recyclers	Possible increase in revenues where dismantling for separate recycling increases Between 0 to +	Unclear impact, depending on how vehicles become more circular	Benefits related to increase in recycled content but not to declaration n.a
	on SME	Inefficient provision of information assumed to have a larger impact on small and independent ATFs who would be discouraged from using data.		
	OEMs	Costs for calculation revision assumed to be low and mainly transitional Between 0 and - Admin costs of about half a million € for implementing dismantling tests Costs from provision of data unknown, possibly higher if DPP is required Between - and ---	Administrative costs for developing and revising strategy and for implementation in the mid-long term Between - and --	Administrative costs for declaring rate of recycled content, possibly negligible: Between 0 and -
Environmental	Circularity	Small increase in the share of vehicle that comply with the 3R, raising the reuse and recycling level by around 4% Between + and ++ Decrease in the use of resources for manufacture of new parts due to increased reuse Between + and ++	Small increase in circularity in the long run Between 0 and +	Declaration not expected to have a significant impact
Social	Employment	Increase in type approval service provider and ATF/shredder employment of around 4 jobs for dismantling tests + Increase in Type approval authority and EC employment,	Increase in employment at OEMs for developing and implementing circularity strategy Between + and ++ Existing type approval authorities assumed to be able to cover additional work n.a	Increase in employment negligible

Impacts		Scenario design 1 Type approval	Additional impacts under Scenario design 2 circularity strategy	Additional impacts under Scenario design 3 Declaration on recycled content
		estimated at less than one job Between 0 and + Increase in ATF employment due to additional dismantling – level unknown Between + and ++		
	Proportionality	Proportional to ensure that vehicles placed on the market achieve 3R targets and that data is sufficiently available to ATFs ++	Proportional to increase circularity in the long run +	Unclear if proportional, but considered supporting measure Between – and +,
	Cost effectiveness	Low costs but low benefits	Costs will increase proportionally to benefits (probably low)	Negligible costs and benefits but considered supporting measure
	Coherence	Possibly not coherent with Regulation UN ECE 133, could affect movements of vehicles between EU and non-EU countries -	General coherence with the CEAP, promoting waste treatment of a higher hierarchy and circularity) +	n.a – supporting measure

EPR considerations:

As information on the dismantling time of various components will be submitted together with the 3R Type-approval application (or linked thereto), it shall be able to feed into the EPR and any necessity to develop fee modulations. Such data will be more accurate if OEMs required to perform dismantling tests, data of which is also to feed into fee modulation.

3.1.4.5 Preferred Scenarios for inclusion in final policy options

It is proposed to look consider the measures addressed under **scenario design 1** and **2** in combination and to further combine scenario 3 in all policy options in which recycled content targets are envisioned.

- 3R Type-approval information requirements and dismantling tests + OEM obligation to submit and implement circularity strategy.
- 3R Type-approval information requirements and dismantling tests + OEM obligation to submit and implement circularity strategy + recycled content declaration.

3.1.4.6 Reporting and monitoring requirements

All of the measures addressed in this section have a reporting element by requiring OEMs to report on certain aspects (scenario design 2 and 3) or through the dismantling tests of vehicles that is considered to enable monitoring of the 3R Type-Approval.

3.1.4.7 Analysis for non-recyclables

Six measures were shortlisted for non-recyclable materials or those with not yet established recycling capacities in the EU, including the following measures:

Title	Chapter
2.1.d: Provisions for improving the relation between the 3R Type- approval process and ELV waste management performance with a view to having non-recyclables better reflected in the type-approval calculation	2.1.5.1.4
2.1.e: Option for OEMs to submit life cycle analysis data as part of the 3R Type-approval process to justify the use of non-recyclables	2.1.5.1.5
2.3.a: Align definition of 'recycling' with the WFD to prohibit backfilling of non-recyclables	2.1.5.3.1
2.3b: Making it mandatory to remove parts made of non-recyclables before shredding to encourage their recycling or to prevent contamination of other fractions	2.1.5.3.2
2.3.d: Regulate shredder/post shredder facilities to ensure higher quality of recycling	2.1.5.3.4
2.3.e: Ban disposal or landfilling of waste from ELVs	2.1.5.3.5

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

- The first two measures (2.1d) will be considered jointly. In the first measure, one of the main changes proposed for the calculation method applied in the 3R Type-approval process relates to the technology readiness level (TRL) of the recycling of a specific material. This is mainly targeted at reflecting non-recyclable materials more precisely in the calculation. When such materials are used in large volumes, this aims at considering whether it is reasonable to assume that the 3R Targets will be complied with or, if this is not the case, considering the rejection of the request. The second measure (2.1.e) adds-on to this approach, allowing OEMs the option of justifying lacking compliance when the use of such materials leads to a significant benefit in the use phase (e.g., emission reduction). This measure is meaningless when not implemented together with the type-approval calculation changes. An additional strength of this measure is that it ensures that the non-recyclable material will be identified as such in the type approval process and in related information for dismantlers that is to be made available as part of the process. OEMs would also be required to recommend how to treat the material at EoL should the recycling still not be established.
- Measure 2.3.b prescribes an obligation to dismantle non-recyclables from the vehicle prior to shredding. This is expected to either push the market to find solutions for the recycling of such materials or to at least allow obliging OEMS that make use of such materials to take responsibility for its treatment in line with the EPR principles. As a minimum obligatory dismantling would ensure that contamination of other fractions is prevented, i.e., when non-recyclables are sent to the shredder and following treatment together with other materials.

Measures 2.3.a and 2.3.e, could both affect the recycling of non-recyclables insofar that they create limitations for material fractions that cannot be treated without downcycling or without disposal. Which of these measures is more suitable to address non-recyclables, depends on the material at hand:

- Measure 2.3.a refers to an alignment of the definition of recycling with the WFD, in practice prohibiting that backfilling is counted towards the recycling target. At present, backfilling is practiced with the mineral fraction that is generated by shredders. Measure 2.3.a is thus only considered suitable for materials that land in the mineral fraction after treatment of the SHF.

- Measure 2.3.e proposes among others a ban on disposal for shredder-light fraction that is not sent for PST and for PST output fractions with a specific weight of > 1.3 g/cm^3. Banning the disposal of SLF and sending it to PST to allow removing the fraction with a specific weight of > 1.3 g/cm^3 is targeted at removing the fraction contaminated with decaBDE and substances that increase the specific density of plastic materials. As the analysis looks at Carbon Fibre Reinforced Plastics (CFRP) to demonstrate possible impacts of measures, it cannot be excluded that decaBDE or similar substances were not used CFRP components in vehicles put on the market prior to the ban in 2018. This measure is thus considered to be more suitable in this case and will be analysed, whereas measure 2.3.a will be discarded.
- Measure 2.3.d is aimed at limiting the quantity of recyclables (mainly metals) in shredder residues. As the non-recyclables identified under Section 2.1.2.5.10 are not of metallic nature and as metals used in high volumes are generally recyclable, this measure is not expected to have an effect on the content of non-recyclables. It is thus discarded.

For the sake of simplicity, the following sections refer to the example of CFRP to demonstrate the costs and benefits of the various scenarios. For this reason, CFRP is referred to as a material and in the names of the scenarios and not under the term “non-recyclables”.

3.1.4.7.1 Scenarios for quantitative analysis

3.1.4.7.1.1 Baseline

As described by Marklines (2015), an increasing number of European automakers has added CFRP to some vehicle models in an effort to reduce weight and thus also emissions during use. BMW has used CFRP for the body of some of its vehicles like the i3 and the i8, and other manufacturers like Mercedes-Benz and Audi were also reported to be considering the use of such materials. EGARA (2021) mentions additional non-recyclable materials like composite plastics, and reinforced plastics, and explained that that these are currently neither used in many vehicles nor in large amounts, but that an increase in use is expected.

According to (DexCraft 2015), a carbon fibre supplier, as a material, carbon fibre offers stiffness and strength at low density, which is lighter than aluminium and steel, and provides many practical benefits. Assuming the same weight, carbon fibre offers 2 to 5 times more rigidity (depending on the fibre used) than aluminium and steel, and even higher values when the component in question will only be stressed along one plane (i.e., one-direction carbon fibre). If a component has a weight limit in design, and is thus limited to a thickness of 1.5 mm when using steel or 4 mm when using aluminium, the use of carbon fibre will allow increasing the thickness to up to 7 mm. The additional thickness however then also translates into higher stiffness, as where the thickness increases x 2 it provides an increased rigidity of 2^3.

Table 3-1 Analysis of aluminium, steel and two-direction carbon fibre regarding stiffness against weight and strength against weight

	Aluminium	Steel	Two-direction carbon fibre – common modulus	Two-direction carbon fibre – improved modulus	Two-direction carbon fibre – highest modulus
Stiffness against weight (Specific Modulus) Unit: 10^{6} m^2s^{-2}	26	25	56	83	120
Resistance to damage (Specific Strength) Unit kN·m/kg	214	254	392	211	126

Source: (DexCraft 2015)

Since we can assume that reducing vehicle weight will play a larger role in the future, the use of non-recyclables will probably continue to increase, whether through use of CFRP or new materials to be developed for this purpose. Where the volumes of use will increase significantly, recycling could develop, but where it does not, this shall affect the ability of such vehicles to achieve the 3R Targets and shall reduce the general circularity of vehicles, in particular when such materials replace larger amounts of conventional ones like steel.

3.1.4.7.1.2 Scenario CFRP 1: Type-approval revisions

The 3R Type-approval process will be changed. Aside from excluding materials with a TRL of 4 from the accounting of the recyclability rate, those with non-established recycling will be penalised in the calculation as they will not be accounted for to 100 % (see details in measure description, Section 2.1.5.1.4). To allow exclusions for vehicles where the use of non-recyclable material (TRL of 4 and below) results in an environmental benefit during the use phase, the manufacturer will have the option of submitting life cycle analysis data to show that the use of the material in question provides benefits during the use phase that set off the negative impacts of not recycling at EoL.

3.1.4.7.1.3 Scenario CFRP 2: Obligatory dismantling of non-recyclables

The removal of non-recyclable materials used in a vehicle shall be made obligatory. Relevant material parts and components with a total weight above 5 kg shall need to be removed and recycled separately. This weight threshold is suggested to ensure removal of all larger components, but with an understanding that removal of smaller ones could be very time consuming, affecting the economic feasibility of this practice.

3.1.4.7.1.4 Scenario CFRP 3: Ban on disposal

A ban will be introduced on the disposal of the shredder-light fraction that is not sent to PST and PST output fractions with a specific weight of > 1.3 g/cm^3.

3.1.4.7.2 Results of qualitative analysis

With regard to vehicles that use large amounts of non-recyclables, **Scenario CFRP 1** will allow to make a distinction between cases where this does not lead to a significant environmental contribution to the use phase and cases in which this occurs. Evidence used for justification is to be provided in reference to the single vehicle, i.e. comparing data on emissions and environmental performance at the level of the single vehicle. Comparisons at fleet level could be submitted to further support the request, however as future PoM levels are not always known during the initial type approval of a vehicle, the single vehicle level is proposed to ensure that in all type approvals, the data is reviewed in a comparable fashion.

- In the former case, such vehicles would be denied market access if they cannot show that the targets are met. This is expected to push manufacturers towards using less non-recyclables, to ensure that the targets are met. Alternatively, it could also lead to investments of manufacturers in the establishment of recycling capacities for materials that are expected to have a higher potential for benefits during the use phase.
- In the latter case, the 3R Type approval could be granted as the environmental benefits during use set off the costs during EoL of the volume that cannot be recycled. This said, it is possible that in some cases OEMs may decide not to submit LCA data if the additional administrative effort is perceived as too burdensome or if there is uncertainty as to whether the case would be considered justified.

It is considered that this scenario will lead to an increase in administrative costs for OEMs, as they will need to provide more data to the 3R Type-approval submission. The range of costs would depend on whether LCA data is provided or only the additional data compiled for the non-recyclable material. Theoretically, the scenario could also lead to revenue losses, where the 3R Type approval of a vehicle is denied, requiring the model design to be revised or resulting in the design being abandoned (loss of the investment costs of developing the model). However it is expected that OEMs would ensure that their designed vehicles level of use of non-recyclables is too low to hinder achieving the 3R targets, or that they would ensure that when large volumes are applied, that this has justification that can be shown through evidence. There is a risk that the measures would affect innovation, though this could develop in two directions. In some cases, OEMs would avoid development of new materials, anticipating that this could jeopardise type-approvals and subsequently their product portfolio. In others this could push more OEMs to using the same innovative materials and cooperating with waste operators to ensure the timely development of recycling capacities. It is generally considered that OEMs will learn to work with the system, so that after a certain period from implementation there will be more certainty on which cases can be type-approved and which cannot. Thus, in the mid- to long-term, the scenario would be expected to contribute to more circularity when new materials are introduced into the design of vehicles.

Scenario CFRP 2 leaves all options open as to the use of non-recyclables, however, it requires their removal and separate recycling at EoL. For some materials, it could be that recycling will have developed at this stage and for some possibly not. In the latter case, waste management operators could be faced with large storage costs of materials for which there is no recycling, or with high investment costs of developing new recycling techniques and capacities. In some cases, such collected fractions may end up being shredded after all. A few past examples show that this can have different consequences.

EGARA (2021) give an example of a bearings manufacturer that used vehicle hulks after the dismantling stage to produce bearings. “Normally it’s impossible to make cars again out of car scrap because of contamination with copper”. However, after removal of the copper, the manufacturer managed to produce steel bearings, despite the upholstery (including plastics) being left in the hulk and the result was just as good. They could use the recycled steel for bearings production, but less carbon in the melting and forging process needed to be added”. In such cases, a high-quality recycling of the non-recyclables is not pursued, but at least non-recyclables of plastic or hydrocarbon composition could be used, e.g., in steel manufacturing instead of adding carbon to the process. A second example refers to the vehicle dashboard due to its electronic components rather than to a non-recyclable material. “There was the case that it was obligatory in Denmark to take the dashboards out of the vehicle (instrument panels), so they were removed and piled up, but there was no specific recycling for it at the time – in the end it went to the shredder”. On the instrument panels “10 years ago it was too hard to recycle. Now Stena (Swedish recycling company) recycles it, so maybe it has changed". To summarise this scenario could promote the development of some recycling techniques, thus increasing circularity, but where this does not happen (or in cases where it takes too long), obligatory dismantling could have a high financial toll for ATFs, not always ensuring that the targeted material is indeed recycled.

The effectivity of **Scenario CFRP 3** depends on the density and weight of the material in question. Carbon fibre composites have a density of 1.55 g/cm^3 (epoxy resin 30 %, carbon fibre 70 %)[206] which would mean that they would be affected by the ban in this case. CFRP would need to be removed from the SLF, ensuring that it is not landfilled, however, this does not ensure that it will be recycled at high quality. It could be that such materials are used for backfilling or as construction filling materials or as explained above, in some cases they could be fed to smelting processes to replace the addition of carbon-based fuels. As the material will have been shredded and possibly also grinded, high-quality recycling could also be hindered in some cases due to contamination with other materials.

3.1.4.7.3 Results of quantitative analysis

The BMW i3 is taken as an example to demonstrate some of the impacts at vehicle level. The total weight of the BMW i3 is 1345 kg when unladen[207]. According to by Marklines (2015), 68.5 kg (5 % of total weight) of the body weight is composed of CFRP, comparing this with the weight of the body if it had to be composed of steel and concluding that the CFRP and other light-weight materials used in the body could be reduced by 90 kg of this component and the total vehicle weight.

According to Dupont[208], reducing an automobile's weight by a mere 50 kg (110 lbs) reduces up to 5$CO_2$of CO_2/km and increases fuel economy by up to 2 %. This translates into a 90 kg CO_2 eq. per year or 900 kg CO_2 eq. for a lifetime of 10 years (both considered to be conservative assumptions).

IDIS dismantling data[209] which is provided by the OEM specifies 152 kg (11 % of total weight) of CFRP for the body. Taking into consideration that the 3R Targets allow 10 % of material to be recovered and leaving 5 % to be disposed, means that this material does not leave much room for other materials that are not considered to be recycled, particularly not if the content is indeed above 10 %. This vehicle contains a Li-Ion traction battery (235 kg according to IDIS). Based on the material recovery targets being considered for such batteries under the new Batteries Regulation (65 % for 2025 and 70 % by 2030), this would also leave between 5-6% of non-recycled material that needs to fit under the targets. Under the current Batteries Directive (2006/66/EC), the Li-Ion battery only needs to be recycled to 50 %, resulting in almost 9 % of non-recycled material. Based on the IDIS data, by 2030, if the recycling of CFRP does not change, all other materials in the vehicle would need to be recycled to achieve the targets, though it is expected that not all materials in the vehicle are currently recycled (e.g., not all plastics are recycled). First models of the BMW i3 were placed on the market in 2013 and BMW announced that it would be discontinued in 2022[210], meaning that some vehicles are already reaching end of life now and that in 2035 ELVs would still be expected at ATFs. Based on the above data, it is concluded that in the **baseline**, it is not clear how the

[206] http://www.dexcraft.com/articles/carbon-fiber-composites/aluminium-vs-carbon-fiber-comparison-of-materials/, last viewed 24.6.2022

[207] Data for BMW i3 120 Ah: https://ev-database.org/car/1145/BMW-i3-120-Ah, last viewed 24.6.2022

[208] Dupont website on "Light-weighting" https://www.dupont.de/knowledge/lightweighting.html, last viewed 24.6.2022

[209] IDIS data for BMW i3: https://data.idis2.com/IDIS_data/faces/contents/vehicle/vehicleMain.xhtml, last viewed 24.6.2022

[210] See: https://www.bmwblog.com/2022/01/28/bmw-explains-why-i3-discontinued/, last viewed 20.8.2022

vehicle would comply with the RRR targets, and it is probable that it will still have difficulties reaching the targets in 2030. And yet the BMWi3 was type-approved, so that it can be assumed that under the baseline, the TRL level considered for CFRP (and possibly also for other materials) was 4 or above, as otherwise the vehicle type-approval should not have been approved.

Under **Scenario CFRP 1**, the vehicle could have only been type-approved if submitted LCA data would show that the CFRP resulted in fuel benefits. Looking at the above data, this translates to a use related reduction of 900 kg CO_2 eq. emissions setting off the related “cost” of not recycling the CFRP. If the CFRP is not recycled into a material with equivalent use, the environmental cost can be compared with that of manufacturing new CFRP. The carbon footprint of manufacturing wing rib made of CFRP thermoset by the technique of in-autoclave single-line-injection (SLI) is around 109 kg CO_2 equivalent for each kg of CFRP (Al-Lami et al. 2018). It is not clear whether this result can be applied to the case of CFRP in the vehicle, however, assuming this value would mean that the 68.5 kg of CFRP needed for use in a new vehicle as there is no recycling result in over 61 thoCO_2nd CO_2 eq. Assuming that at least some of the amount could be sent to recovery would result in a lower amount, however whether such data would support the type approval of the vehicle can be questioned.

Whereas the assumption in the baseline is that the vehicle is placed on the market, (also assumed for Scenario CFRP 2 and 3 which only apply requirements on the treatment of the CFRP) it is not clear whether this would be the case under Scenario CFRP 1. Here, two cases can be distinguished:

- Case A: Vehicle placed on the market, no special treatment requirements (i.e., evidence supports type approval), or
- Case B: Vehicle placed on the market following design revision and change to other materials.

3.1.4.7.3.1 Environmental impacts

Under **scenario CFRP 1B**, it can be assumed that design revisions would result in the use of heavier materials like steel (for structural reasons) or aluminium (if it can provide the structural requirements). Looking at the Marklines (2015) data-based estimation, this could increase the vehicle emissions by up to 900 kg CO_2 eq. over the lifetime of the vehicle. In parallel, the shift to materials which are recyclable would be expected to offset this impact, at least partially, through recycling credits obtained from the recovery of metals.

Under all other scenarios, the vehicle is not changed, but the scenarios may affect how the material is treated at EoL.

Under **scenario CFRP 1A**, there are no requirements for the CFRP treatment, and it is assumed to be the same as in the **baseline** (see below).

In **scenario CFRP 2**, the CFRP must be removed. Where the CFRP will be collected separately, it could be that it is sent for use in energy recovery or that it is grinded with other fractions and used as a filling material (construction, back-filling). This option may have the fate of **scenario CFRP 1A** and the **baseline** (see below). A further option is that the CFRP will be sent to recycling[211]. This would also be the case where the OEM is required to take care of the material treatment. One obstacle for this up till now has been that recycling is only economically feasible when large amounts are collected and separated for recycling.

[211] According to Sukanto el al. (2020), recycling of CFRP is currently limited as capacities are very small in relation to the amounts manufactured. In addition, CFRP cannot be recycled at present back to the same quality, however it has been shown that it can be used in the form of short fibres in composite materials under medium and low loads.

Scenario CFRP 2 will not necessarily solve this in the short term, as first vehicles using CFRP only came on the market about 10 years ago, and the economies of scale may still not be sufficient to ensure that separate collection and recycling will become economically viable in the next few years. However, the use of CFRP could increase, in which case collected amounts may be sufficient to establish its recycling further. Already in 2014, there were prospects for reclaiming CFRP from end-of-life sources (aircraft and, eventually, ELVs) and repurposing it for use in automotive composite applications used in the interior (Gardiner G. 2014) so that the recycling limitation is not necessarily a technical one.

In all these cases (aside from CFRP 1B), as long as 95 % of the vehicle is recovered (as a material or energy), at least some of the CFRP could still be landfilled. Whether this will create pressure to recycle CFRP or rather to recycle other fractions (other plastics or glass) is not clear.

Under **scenario CFRP 3**, landfilling is excluded and a treatment at a higher hierarchy will need to be applied. Here too, energy recovery or use as a filling material could still be applied as long as the targets are fulfilled. For the baseline and scenarios CFRP 1A, CFRP 2 and CFRP 3, it is assumed that at least in the short term, i.e., as long as CFRP capacities are not more established throughout the EU, there will be little changes in comparison to the current situation.

3.1.4.7.3.2 Economic impacts

From an economic perspective, scenarios in which CFRP will be collected and sent to recycling can be assumed to result in higher treatment costs that will affect ATFs (dismantling and transport costs), shredders or PST operators (separation and transport costs). This is probably the case for **scenario CFRP 2** (in the moderate to long term). Though there could be recycling of this type under the **baseline**, **scenario CFRP 1A** and **scenario CFRP 3** if there is a risk of not meeting the 3R targets, it would probably only be applied in facilities that treat larger volumes of CFRP- containing vehicles and that are located relatively near to a CFRP reprocessing facility. It is not clear how common such facilities are at present and thus a change in this direction would mainly be expected in the long term if at all.

Under **scenario CFRP 1A**, OEMs would submit LCA data to justify the use of CFRP. These could be prepared inhouse or contracted to LCA practitioners. The cost per vehicle model is be assumed to be in the order –f 50 - 100 thousand Euro and is also assumed to cover the effort for preparing the data for submission to the type approval process.

S**cenario CFRP 1B** is expected to have an impact on consumers that would purchase the same vehicle despite the change in the vehicle weight. Such consumers would incur additional costs for fuel consumption throughout the vehicle life (2 % more according to Dupont[212]). The change in the design of the vehicle will result in some costs for redesign for OEMs and can also be expected to result in slight benefits for waste operators resulting from an increased use in recyclable material. The actor depends on the type of operator that removes the additional metal and sells it to recyclers, collecting related revenue. The additional dismantling or removal costs are assumed to be negligible as various metals are already removed through the ELV treatment and sent to separate recycling (for the ATF depending on profitability).

[212] See footnote 208.

3.1.4.7.3.3 Social impacts

Scenario CFRP 2 could promote the development of recycling capacities, at least for materials that are more commonly used. This would lead to an increase in employment.

Under **scenario CFRP 1A**, a low increase in employment can also be related to the need to perform LCA analysis studies as part of the 3R Type approval for vehicles with non-recyclables.

Scenario CFRP 1B may also result in an increase in employment related to the necessity to redesign vehicles, however, this would only affect some models and would probably decrease as OEMs get used to the new 3R Type-approval requirements.

3.1.4.7.4 Comparison of scenarios for CFRP /non-recyclables

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-2 below to allow an easier comparison. All impacts are considered to be low, as CFRP is not used in most vehicles at present and, even with an increase, it is not the only option for light-weighting (e.g., aluminium is lightweight and recyclable). Nonetheless, the idea behind the measures is to address high volume use of non-recyclable materials in a way that shall ensure the conditions under which such materials can be used or, alternatively how they are to be treated at EoL and who is to carry the burden in such cases.

Table 3-2 Summarising table for the comparison of the non-recyclables' scenarios

Impacts		Scenario CFRP 1 Type approval	Scenario CFRP 2	Scenario CFRP 3
Economic	on ATFs	CFRP1B: Increase in revenues from sales of recyclables. + CFRP1A: -/-	Increase in costs for dismantling and storage of CFRP - Possible set-off when/where CFRP can be recycled, moderate- to long-term Between 0 to +	-/-
	on Shredders	Shredders/PST operators may need to develop some form of treatment to ensure targets are complied with, expected in the long term if at all Between 0 to +	-/-	-/-
	On recyclers	Possible investments in CFRP recycling capacities (one time investment) expected in the long term. However, then set off by revenues between 0 and +	-/-	Possible investments in CFRP recycling capacities (one time investment) expected in the long term. However, then set off by revenues Between 0 and +

Impacts		Scenario CFRP 1 Type approval	Scenario CFRP 2	Scenario CFRP 3
	on SME	For ATF SME, the dismantling obligation (scenario CFRP 2) will likely result in higher costs. SMEs are understood to be common among waste operators, so any costs for these (ATF, shredder, PST, recycler) could have a heavier burden for SMEs.		
	OEMs	Design costs where vehicle does not pass type approval	Costs for ensuring treatment / take-back of non-recyclables if required by EPR (see below)	Costs for ensuring treatment / take-back of non-recyclables if required by EPR (see below)
	Consumers	CFRP1B: 2 % increase in fuel costs of some vehicles. -	-/-	-/-
	Administrative costs Burden	Increased costs for OEMs where LCA data submitted to type-approval process and for authorities for reviewing such data	-/-	-/-
	2ndary resources	Increase in SRM where non-recyclable replaced by recyclables +	Increase in SRM in moderate- to long term where recycling technologies develop +	Changes considered negligible
Environmental	CO_2 eq. emissions	CFRP1B: Increase over vehicle lifetime (~900 kg CO_2 eq./vehicle) - CFRP1A: no change expected but benefit of non-recyclable in use phase ensured	-/-	-/-
	Recycling credits	CFRP1B: Increase in credits due to shift to recyclables. + CFRP1A: similar to baseline Negligible	In the mid- to long-term, recycling will lead to increase in credits and circularity +	Similar to baseline Negligible
Social	Employment	CFRP 1A Increase in employment for performing LCA	Increase in employment for dismantling and new recycling capacities	Possible increase in employment for new

Impacts		Scenario CFRP 1 Type approval	Scenario CFRP 2	Scenario CFRP 3
		+ CFRP 1B Increase in employment for redesign +	+	PST capacities (expected in long term) Between 0 and +
	Proportionality	Proportional to ensure that vehicles placed on the market achieve 3R Targets +	Proportional as highest potential to encourage recycling of non-recyclables / use of recyclables ++	Assumed proportional to avoid disposal of non-recyclables +
	Cost effectiveness	Low costs but low benefits +	Higher effectiveness - High costs but higher benefits ++	Low costs but low benefits +
	Coherence	Not coherent with Regulation UN ECE 133, could affect movements of vehicles between EU and non-EU countries -	General coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity) +	General coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and avoiding disposal) +
Stakeholder acceptance		Various stakeholders have raised the problems related to the use of non-recyclable materials and how this could affect the ability to achieve targets. Nonetheless, when asked if such materials should be prohibited, stakeholders state that this would have a negative impact on innovation. Waste operators generally have low acceptance to any change in the waste management as they fear it will increase their costs.		
			Lower acceptance due to costs of dismantling with unclear compensations and unclear availability of material outlets	Lower acceptance due to costs of PST with unclear availability of material outlets

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. are rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

Looking at the different scenarios and the impacts detailed in the earlier sections, a few conclusions can be made:

- **Scenario CFRP 1** is considered to have a high relevance for ensuring that vehicles placed on the market comply with the 3R Targets and respectively that the 3R Directive is effective in this regard. It could affect the choice of materials for vehicles, however, at least promoting more use of the same materials in the long term, which in turn will promote recyclability. The cost of justifying a non-recyclable is low in relation to the removal of obstacles to market entry (though at present it is not clear whether type approval authorities actually deny market entry in such cases). The 3R Calculation itself will require some additional detail for non-recyclables, but the format for the calculation will remain the same, and the data is assumed to be available to OEMs and thus only slightly increases administrative burden of the process. The need to justify the use of non-recyclables based on environmental performance is expected to provide Type approval authorities a clear, black and white method for deciding on the granting of type approval in respective cases and to ensure the effectiveness of the 3R Directive in such cases. Though this scenario is not coherent with the international Regulation UN ECE 133, the EC or MS could initiate an update of the Regulation or could decide to withdraw for this international regulation. It is not clear how this would affect the movement of vehicles from outside the EU inside (i.e., nor how often such vehicles are imported). Regarding exports, it is understood that the proposed changes would still fulfil the requirements of the UN ECE 133, but also fulfil requirements with higher ambition. Thus, it would be assumed that exports would not necessarily be impacted. This scenario has a positive effect also on measures that promote the recycling of metals in cases where non-recyclables will be substituted by those in redesign (e.g., steel, aluminium, etc.).
- **Scenario CFRP 2** is the only one that is expected to potentially increase the recyclability of (some) non-recyclables, however, the costs for ATFs could be substantial (at least at the single vehicle level), particularly as long as recycling for such materials is not established. It is recommended to ensure that this scenario is also addressed under the future EPR, to ensure that ATFs are not the only ones to carry the costs related to non-recyclables. Currently, the use of large amounts of non-recyclables is still limited in the vehicle fleet, however, should this change without changes in the recyclability of such materials, the affect in terms of costs on ATFs will increase, possibly hitting the small facilities harder than the larger ones.
- Though **scenario CFRP 3** will prevent disposal of non-recyclables, its potential for benefit is only set in the long term and does not necessarily guarantee a higher quality of treatment for non-recyclables.
- A combination of scenarios can be expected to have a higher positive impact on the use of non-recyclables in vehicles. In particular, the combination of scenario CFRP 1 and 2 would also allow requiring the provision of data for non-recyclables to support dismantling, while also increasing the awareness to the size of the non-recyclable problem. For this latter aspect, it is noted that the requirement to provide separate data on recyclability/recoverability in the 3R type-approval calculation and to provide data on dismantlability should be linked to a threshold level of the total weight of non-recyclables (e.g., 10 kg). If the threshold is too low, the administrative burden will increase due to the need to report on each element (for example for use of e.g., sealing materials and glues which are used in very small quantities. Reference to a component threshold could result in manufacture of smaller components to circumvent the limitations for non-recyclables. In addition, a weight threshold could be considered for components for which separate data is to be provided (e.g., 1 kg) otherwise sufficing to e.g., specify the total weight of CFRP components. This would also keep the administrative burden low.

EPR considerations:

The dismantling of CFRP and other non-recyclables will increase costs for ATFs, at least as long as the recycling is not established. This is not just related to the dismantling itself but also to storage and, where/when capacities are available, to transport. It is to be seen whether the recycling is economically feasible. If not, compensation could be needed, with the related value needing to be investigated in the future. Possibly of more importance to the development of vehicle EPR is the case of materials that cannot be recycled at the time of dismantling. Here it could be considered to compensate e.g., ATFs for storage costs, or to allow ATFs (or shredder/PST operators) that separate the non-recyclable fraction to require the OEM to collect and treat the material independently and at no cost to the ATF.

3.1.4.7.5 Preferred Scenarios for inclusion in final policy options

It is proposed to look at the three following measures for comparison under the various policy options:

- Revision of the 3R Type-approval rules regarding the calculation method for showing that the 3R Targets are complied with (including provision of data on dismantling of non-recyclables above a minimum total weight),
- Revision of the 3R Type approval rules (including provision of data on dismantling of non-recyclables above a minimum total weight) in combination with an obligatory dismantling of non-recyclables and requirements for separate treatment.

3.1.4.7.6 Reporting and monitoring requirements

There is currently no monitoring of the 3R Type approval process. Instead of monitoring, this study considers introducing annual dismantling and shredder tests of 5 single (newly Type-approved) vehicles with the aim of monitoring the “distance” between the calculations of the 3R in type-approval applications and between the actual rate of reuse, recycling and recovery at EoL. Revision of the 3R-Type approval rules addressed under the analysis for non-recyclables would not need further individual monitoring on an annual basis (also seeing as not all MS are active in checking 3R Type-approval submissions). However, periodic reporting (e.g., every 5 years) from MS that perform 3R Type-approvals may help in understanding what type of non-recyclables are used in large volumes and could hinder compliance with the 3R Targets.

Reporting on the other measures investigated here should take place as part of the general reporting on materials that are dismantled and sent to separate recycling (by ATFs). The effectivity of a disposal ban could be measured in relation to the general reporting on compliance with the 3R Targets as well as reporting that is under consideration for PST facilities to better understand the available capacities in the EU.

3.1.4.8 Analysis hazardous substances: measure 2.2a

3.1.4.8.1 Baseline

The baseline for comparison is the current split of prohibitions between ELV, restricting the use of four heavy metals, and the REACH Regulation, where other restriction applies to specific products or applications. More specifically:

- ELVD:

  - Article 4 on Prevention of the ELVD specifies that materials and components of vehicles do not contain lead, mercury, cadmium or hexavalent chromium other than in cases listed in Annex II under the conditions, e.g., on maximum concentration values specified therein. It further specifies that the Commission shall on a regular basis, according to technical and scientific progress, amend Annex II.
  - As for further substance restrictions, it can be assumed from Recital 11[213] and Article 4(1)(a)[214] that additional prohibitions could be justified in cases where a decrease or the elimination of substances in ELVs would prevent their release into the environment, facilitate recycling and avoid the disposal of hazardous waste. However, further criteria or guidance on the process for listing are not specified. Therefore, the addition of new substance restrictions under the current ELVD is not anticipated.
  - Exemptions for the four heavy metals are listed in Annex II. The exemptions cover certain materials and components of vehicles if the use of these restricted substances is unavoidable. Those materials and components of vehicles should be designated as such so that they can be stripped before further treatment; they shall be labelled or made identifiable by other appropriate means.
  - The exemption mechanism under ELV is under the scrutiny of the EU COM that shall on a regular basis amend Annex II according to technical and scientific progress.
- Under REACH:
  - Restrictions adopted under REACH envisage the amendment of Annex XVII of REACH when there is an unacceptable risk to human health or the environment, arising from the manufacture, use or placing on the market of a substance, which needs to be addressed on a Union-wide basis as specified in Article 68(1) of REACH. Articles 69 – 73 of REACH define a procedure according to which – starting from a restriction dossier prepared by the European Chemicals Agency (ECHA) at the request of the Commission, or by a Member State – the Agency assesses and issues an opinion on the content and merits of the restriction proposed. If the requirements for a restriction are fulfilled, Article 73 requires the Commission to prepare an amendment of Annex XVII, which is decided upon via the regulatory procedure with scrutiny (comitology). Restrictions are listed in Annex XVII to the Regulation, which lists specific substances or groups of substances and where the text of each entry defines the specific scope of the restriction.
  - Substances of very high concern (SVHCs) included in the Authorisation cannot be placed on the market or used unless the use(s) of that substance on its own or in a mixture has been authorised.

As part of the baseline, it is acknowledged that REACH is under review, however, it is assumed that the revised chemical legislation following REACH when coming into force has mechanisms compared to the current legislation to restrict the application of certain hazardous substances in various products/articles.

[213] (11) It is important that preventive measures are applied from the conception phase of the vehicle onwards and take the form, in particular, of reduction and control of hazardous substances in vehicles, in order to prevent their release into the environment, to facilitate recycling and to avoid the disposal of hazardous waste. In particular, the use of lead, mercury, cadmium and hexavalent chromium should be prohibited. These heavy metals should only be used in certain applications according to a list which will be regularly reviewed. This will help to ensure that certain materials and components do not become shredder residues, and are not incinerated or disposed of in landfills.

[214] Article 4 Prevention:

1. In order to promote the prevention of waste, Member States shall encourage, in particular:

(a) vehicle manufacturers, in liaison with material and equipment manufacturers, to limit the use of hazardous substances in vehicles and to reduce them as far as possible from the conception of the vehicle onwards, so as in particular to prevent their release into the environment, make recycling easier, and avoid the need to dispose of hazardous waste; …

3.1.4.8.2 Policy Options

As mentioned above, the three alternative policy options are:

- POLICY OPTION 1A – RESTRICTIONS AND EXEMPTIONS UNDER REACH
- POLICY OPTION 1B – RESTRICTIONS AND EXEMPTIONS UNDER REVIEWED ELVD
- POLICY OPTION 1C – HYBRID APPROACH

Policy Option 1a – Restrictions and exemptions under REACH

The currently most comparable system with ELVD substance prohibitions for heavy metals is the REACH restriction mechanism where the use or presence of the restricted substance in specific applications is specified.

Under this policy option:

- The existing restrictions of the four heavy metals as well their exemptions are to be transferred to Annex XVII of REACH during the legislative process. The exemptions are taken up as derogations for the new entries of the four heavy metals in Annex XVII. A regular review of the derogations is so far not foreseen under REACH but could result from the ongoing REACH revision.
- Further restrictions are managed exclusively under REACH and by ECHA under the restriction procedure managed by ECHA.[215]
- There are limitations in the current REACH restriction procedure with regards to application for and regular review of derogations.
  - Application for derogation: During the 6 months “call for evidence”, concerned parties provide information that affects the scope of the restriction, e.g., on the need for derogations. This information is reviewed during the opinion making by RAC and SEAC. This process must be made explicit and transparent as process for an exemption application.
  - Regular review of derogations: At the moment, there is no automatic mechanism to review derogations (a change in a restriction entry requires a new restriction).
- In restrictions, spare parts should be addressed when relevant, as the restriction report addresses articles that were placed on the market before entry into force and spare parts produced after that. For both, derogations can be considered.
- Changes have to be made in the ELVD to provide coherence with REACH:
  - Article 4(2) of the ELVD needs to be adapted specifying the coverage of the substance restrictions by REACH.
  - The protection of human health should be added in Article 1 and Article 4; the protection of human health and the environment from the risks that can be posed by chemicals is the objective of REACH.
- Restrictions under REACH are currently not possible solely on the grounds that the substance negatively affects the re-use and recycling of materials in the product in which it is present.[216]

[215] See explanation under the Baseline; besides, the restriction procedure is specified here: https://echa.europa.eu/regulations/reach/restrictions/restriction-procedure

[216] The recent Proposal for a Regulation establishing a framework for setting ecodesign requirements for sustainable products (COM(2022) 142 final) introduces as additional criterion for substances of concern, if a substance “negatively affects the re-use and recycling of materials in the product in which it is present.”

Policy Option 1b – Restrictions and exemptions under reviewed ELV Directive

A revised ELVD where restriction and exemption mechanism would remain in the piece of legislation has to cover the following points:

- Changes have to be made in the ELVD to provide coherence with REACH: The protection of human health should be added in Article 1 and Article 4 (and in the relevant recitals) ("….the protection of human health and the environment from the risks that can be posed by chemical" (REACH wording) or "The use of hazardous substances in [vehicles] should be restricted in order to protect human health and the environment and to reduce the presence of such substances in waste" (wording in the new Battery Proposal a Battery Regulation).
- The procedure to restrict new substances for vehicles are defined comparable to the new Proposal for a Battery Regulation.[217] Recital (17) of the Proposal explains the procedure as follows:
  "The procedure for adopting new and amending current restrictions on hazardous substances in batteries should be fully streamlined with Regulation (EC) No 1907/2006. To ensure effective decision-making, coordination and management of the related technical, scientific and administrative aspects of this Regulation, the European Chemicals Agency set up under Regulation (EC) No 1907/2006 ('the Agency') should carry out specified tasks with regard to the evaluation of risks from substances in the manufacture and use of batteries, as well as those that may occur after their end-of-life as well as the evaluation of the socio-economic elements and the analysis of alternatives, in accordance with relevant guidance by the Agency. Consequently, the Committees for Risk Assessment and Socio-economic Analysis of the Agency should facilitate the carrying out of certain tasks conferred on the Agency by this Regulation" (see detailed requirement in the text box below).
- Comparably, this means that the assessment of the restriction dossier is carried out by ECHA, which would submit an opinion to DG ENV. Subsequent decision-making would be carried out by the Commission in consultation with a specific expert group under the waste legislation. The Commission would then adopt delegated acts: The restrictions are listed in Annex II of the reviewed ELVD via delegated acts.
- As the regular review of the Annex is foreseen under ELVD, a methodology needs to be defined. It seems consistent that the review is managed by ECHA based on the REACH restriction procedure. Another possibility for the review of derogations could imply that a simplified procedure could be envisaged (e.g., opinion prepared by ECHA experts without the involvement of the committees instead of a full restriction procedure involving the committees RAC and SEAC).

Policy Option 1c – Hybrid approach

The following option describes a hybrid approach where the substance restriction process is addressed under REACH but the exemption mechanism, as currently not comparably covered by REACH in term of regular amendments, remains under the ELVD.

Elements in this policy option are:

- The restrictions of new substances in vehicles are managed under REACH and are listed in Annex XVII of REACH.

[217] COM(2020) 798 final

- Existing restrictions of the four heavy metals and their exemptions remain in ELV. Their review and maintenance would still be done via delegated acts under the ELVD, with a view to their progressive elimination.
- The review of these exemptions would be supported by ECHA, inspired by the REACH restriction assessment process, where an opinion would be delivered by ECHA to DG ENV B3 for then amending annex II via delegated acts.
- The particularly important derogation on lead in lead-acid starter batteries to be addressed by the Batteries Regulation.
- Changes have to be made in the ELVD to provide coherence with REACH:
    - Article 4(2) of the ELVD needs to be adapted specifying the coverage of the substance restriction by REACH.
    - The protection of human health should be added in Article 1 and Article 4; the protection of human health and the environment from the risks that can be posed by chemicals is the objective of REACH.

To summarize, under the hybrid approach, besides the provisions regarding the four heavy metals policy option, 1a applies.

3.1.4.8.3 Analysis

Economic impacts

Policy Option 1a – Restrictions and exemptions under REACH

As most stakeholders in the automotive value chain have to follow the REACH regulation anyway, a benefit in terms of less administrative burden is expected from needing to follow one legislation instead of two. However, the extent of this benefit cannot be determined.

Generally, authorities are expected to save costs as there would not be the need to ensure coherence of REACH and ELV. It also applies to EU authorities, e.g., Commission and ECHA, that administrative costs incurred from running one system as compared to two are expected to be lower. Furthermore, as REACH is a regulation, the administrative burden for Member States can be expected to be lower because there is no need for a transposition to national law of changes regarding the exemptions from the prohibitions.

Transition costs to REACH as a new format and to ECHA as executing agency are not expected, as it would build on the preparation and running of restriction proposals that are already performed under REACH.

Policy Option 1b - Restrictions and exemptions under reviewed ELV Directive

- Transition costs to REACH as a new format and ECHA as executing agency are expected. The Proposal for a Regulation concerning batteries and waste batteries mentions that "the ECHA will also support the Commission in managing battery substances and their regulatory restriction as part of the existing REACH activities. This requires a total of two, new full-time-equivalent (FTE) temporary-agent staff (AD 5-7) at the ECHA (average cost EUR 144 000/year over 7 years and beyond). In addition, one FTE contract agent (CA FG III, average cost EUR 69 000/year over 3 years) will be necessary to increase the knowledge base, and to facilitate an informed priority setting and work plan. This work plan should be based on a study to build the ECHA's current knowledge on how the battery industry manages its hazardous chemicals to identify relevant substances for regulatory risk management in the future." [218]
- As for MS, the impact assessment for the Proposal for a Regulation concerning batteries and waste batteries[219] concluded that "Member States will have greater clarity and lower administrative burden by dealing with the technical and socio-economic assessment of the proposals for restrictions under one single common assessment framework, provided by ECHA according to the methodologies developed for chemical risk management under REACH. This is very much in line with the "one-substance, one assessment" approach put forward in the upcoming Chemical Strategy for Sustainability.
  Industry will benefit from the high standards and procedural guarantees in carrying-out chemical risk assessments given by the REACH restriction processed managed by ECHA."

Policy Option 1c – Hybrid Approach

Stakeholders would have to follow two legislations, however, as the known restrictions and exemptions are kept without any changes under ELVD, no increase of administrative burden is expected.

As for future substance restrictions, the considerations of policy option 1 a applies.

Social impacts

Policy Option 1a – – Restrictions and exemptions under REACH

There is an expected social benefit because reference to human health protection is added to the ELVD and will be considered for future restriction of substances in vehicles. A quantitative assessment of the possible reduction in the use of substances in vehicles due to human health concerns is not possible.

Policy Option 1b - Restrictions and exemptions under reviewed ELV Directive

Same considerations as for policy option 1a.

Policy Option 1c – Hybrid Approach

The same considerations as for policy option 1a applies.

[218] COM(2020) 798 final

[219] SWD(2020) 335 final PART 3/3

Environmental impacts

Policy Option 1a – Restrictions and exemptions under REACH

Equally, benefits for environmental health are expected if the future restriction of substances in vehicles is clearly located to REACH and the restriction procedure ensuring that further restrictions are set up. Such restrictions could then be translated in reduced emissions of hazardous substances during service life and subsequently in waste management. The environmental benefits of future restriction of substances in vehicles will be case and substance specific.

Policy Option 1b - Restrictions and exemptions under reviewed ELV Directive

Same considerations as for policy option 1a.

Policy Option 1c – Hybrid Approach

For the provisions on the four heavy metals, it can be concluded the environmental benefits have been achieved: An ex-post analysis on the four heavy metals shows environmental benefits of past restrictions: lifecycle emission reductions between 2000 – 2005 for Pb were estimated at 99,6%, for Cd at 96% and for CrVI at 99,99%.[220]

The applications of heavy metals for which exemptions are in place, these can be considered as being already narrowed down and provided with an expiry date. Remaining exemptions without an expiry date are the alloy exemptions 1(a), 2(c)(i), 2(c)(ii) and 3 and special exemptions for lead in solders such as 8e and lead in glass or ceramic materials (exemption 10(a) and 10(b)).

For future substance restrictions under REACH, the environmental impacts depend on the (range of) applications in which substances to be restricted in the future are applied, as well as on the difficulty or ease of their substitution.

Effectiveness, efficiency and coherence

Policy Option 1a – Restrictions and exemptions under REACH

A transfer of substance restriction under REACH would make use of the comprehensive and robust restriction procedure, which relies on the expertise of ECHA, according to a defined structure. Stakeholder participation via consultation is built into the process and managed by the Agency.

With regards to efficiency, the exemption mechanisms must be raised as a point that is so far not in place under REACH: An explicit and transparent process to apply for derogations/exemptions for a specific use of a restricted substances as well as the mechanism for a regular review of these derogations/exemptions is so far not in place under the REACH restriction procedure. As this is understood to have a focus in the REACH revision and the restriction procedure might be merged with the authorisation procedure, an explicit and transparent derogation/exemption mechanism with regular review and following clear criteria might be installed. However, at this point this cannot be concluded with certainty.

Coherence is understood to be established as all provisions regarding substances are covered by the REACH regulation.

[220] Oeko-Institut 2010 on behalf of ACEA

Policy Option 1b - Restrictions and exemptions under reviewed ELV Directive

The new Proposal for a Battery Regulation[221] is still under negotiation. It is understood that there are concerns that the proposal duplicates REACH provisions instead of simply referring to them. Against the background of the REACH revision, the provisions on the proposal might be outdated before they are approved in case that the REACH restriction procedure is changed. This affects the option in terms of effectiveness and coherence.

The impact assessment for the Proposal for a Regulation concerning batteries and waste batteries[222] describes an increased efficiency because

- a restriction proposal can also be initiated by Member States,
- it takes advantage of the expertise of ECHA and of its established Scientific Committee and public consultation procedures, to deal with the assessment of the risks and socio-economic impacts of potential restrictions of substances, as this seems the most efficient approach currently available, also providing a unity of action with REACH as regards the methodologies and bodies entrusted with these tasks,
- a specific focus of policy analysis envisaged in decision-making under the Batteries Regulation is possible, not further saturating the subsequent decision-making process under REACH.

It is important to note that battery-related derogations/exemptions from the restriction of substances did not need many reviews or changes over time. In contrast, vehicles are more complex in design, the development of the ELVD annex for exemptions suggests that changes will be needed more often to ensure adaption to scientific and technical progress and to ensure a gradual elimination of restricted substances. It has to be made clear in the revised ELVD if, for example, Member States are also allowed to initiate the review of a restriction proposal or if a methodology for a regular review is to be introduced. However, it is not yet possible to fully assess the legal feasibility of both options and to determine to which preference shall be given.

Policy Option 1c – Hybrid Approach

In the interviews conducted in the course of this impact assessment, stakeholders often mentioned the option that the current restrictions of the four heavy metals as well as their exemptions can remain under ELVD, as this could be seen as a discontinued model with only a few remaining exemptions.

As the future and additional substance restrictions would be work described in policy option 1b, the considerations on effectiveness and efficiency also apply here.

3.1.4.8.4 Summary and conclusion

Under all policy options, the restriction procedure under REACH is the assessment procedure to which reference shall be made. Therefore, the policy options are largely equivalent. However, the possibility under policy option 1b and 1c is to preserve the specificity and policy focus that results from keeping decision-making under a separate instrument (the ELVD). This advantage was a rationale for the new Proposal for the Battery Regulation to introduce this system. However, it should be noted that this proposal is still negotiated, so that this system serving as a template is so far not finally approved.

[221] COM(2020) 798 final

[222] SWD(2020) 335 final PART 3/3

Besides, under these policy options, the concern of a duplication of REACH provisions that might be revised should be avoided. Otherwise, this policy options bear the risk of being incoherent.

A crucial point to decide in favour of one of the policy options concerns the exemption mechanism and the regular review derogations/exemptions for a specific use of the restricted substances. However, under all three policy options, uncertainty remains if such a regular review of the derogations/exemptions can be installed as a formalized and explicit process.

If the REACH revision results in an amendment of the restriction procedure that foresees the review of derogations of restrictions after a default period, or a period individually determined for the derogation, this would support the choice of policy option 1a.

3.1.4.9 Analysis hazardous substances: measure 2.2.b

3.1.4.9.1 Baseline

The following points describe the current baseline:

- The SCIP database is in place and manufacturers submit data; so far, recyclers practically cannot use the information. However, there is an impact assessment for the WFD currently ongoing and the outcome in relation to SCIP is pending.
- No major changes are expected as to how manufactures submit data to GADSL/IMDS.
- REACH will be revised, but the information requirements on SVHC in products/articles are not expected to change.
- The ESPR is still under negotiation with unpredictable outcome regarding the final provisions on reporting on substances of concern in products when ESPR enters into force.

3.1.4.9.2 Policy Options

For this measure, no policy options are considered. The measure can be implemented in different schemes, the schemes of SCIP and Product Passport being subject to different legislations. While the schemes are described and compared with each other, much uncertainty is expected as the related legislations are under discussion for revision and amendments (REACH) and further development (ESPR).

3.1.4.9.3 Analysis

The following analysis describes the potential impacts of the measure 2 “improved communication on hazardous substances” for the three information schemes:

- Via the SCIP database as a centralised European Database which would need further development and adaptations in order to provide relevant dismantling information to the waste treatment facility.
- Via an industry-driven system based on GADSL/IMDS, for example, which would also need adaptations to provide the relevant dismantling information to the waste treatment facility.
- Via a Digital Product Passport (DPP) which is most likely based on a decentralised IT architecture, as defined in the Proposal for a Regulation establishing a framework for setting Ecodesign requirements for Sustainable Products (ESPR).

Economic impacts

The measure would impose additional administrative burden on industry due to the increased information to be reported, compared to the current baseline, and defined by the SVHC reporting obligations to the SCIP database. For an improved communication proposed in this measure, the SCIP database would need further development of the database. This would impose burdens for public administrations, particularly the European Commission and ECHA in terms of IT development and infrastructure as well as management and maintenance.

Experience in the setting of the SCIP database[223] indicates potential one-off adaptation costs running into the several million Euros over several years, and a permanent increase in the fixed maintenance and the operational costs of the database.

The stakeholder feedback indicates that the GADSL/IMDS data format would need adaptations that result in administrative and economic burden for industry with regard to enabling treatment facilities to use the relevant information. It is expected that this would require significant investment for adapting IT systems etc. Stakeholders from industry roughly estimated that, since the establishment of GADSL/IMDS 25 years ago, an investment of "dozens of millions of €" has been made,[224] which, however, served to meeting the requirements of various legislations and contributed to maintenance which is a common industry activity on which a magnitude of time and costs are spent.

Stakeholders have expressed views on the SCIP as well as on an extension of the GADSL and IMDS:

- For the SCIP database, individual stakeholders noted in the interviews that the notifications in SCIP are not scrutinized and thus questioned the reliability of the entries.[225] Besides, the SCIP platform for hazardous substances currently does not serve waste management purposes because it does not match with the needs of the recycling industry.[226]
- Half of the answers of stakeholders to interactive questions asked during the stakeholder meeting indicated that OEMs document data on the content of GADSL substances in vehicles and components through the parts list of the vehicle (i.e., linked to the VIN).[227] The BMW Group explains that the "*information on the content of GADSL substances in vehicles and components is linked to part numbers, not to vehicles; a linkage to the VIN number is seen as an unreasonable effort, due to millions of potential variations (and due to the fact, the vehicle owner may have changed parts, which cannot be considered)*". The Renault Group also explains that "*it is possible to extract indirectly a maximizing list of GADSL substances for a given vehicle i.e., a list of substances, corresponding to an "envelope vehicle" that would contain the parts of all possible versions of a model (i.e., not the exact list of substances actually contained in a given vehicle/VIN).*" Thus, according to the stakeholders, the current form of the GADSL/IMDS would need adaptation to meet the requirements of the proposed measure.

[223] Citation from John Garcia in impact assessment of the PPWD.

[224] Interview Stellantis/Opel

[225] EUROMETEAUX interview

[226] ACEA interview.

[227] On the Slido question "**Is it correct to assume that OEMs document data on the content of GADSL substances in vehicles and components through the parts list of the vehicle (i.e., linked to the VIN)?":** 13 individuals answered this question. Only a single answer was possible. Almost half of the participants think the assumption is correct. The rest did not have an opinion (I don't know").

Although an estimation on the DPP as further information scheme cannot be made, the impact assessment of the ESPR stated that substantial efforts and investment are also needed to put such a system in place.

Social impacts

No specific social impacts are expected to be linked to this measure, apart from the fact that stakeholders will have to dedicate additional resources to the notification.

If the objective of the measure was reached, additional jobs in the recycling sector could potentially be assumed. Additionally, the provision of data on legacy substances – which is deemed to be possible – would in some cases make it easier to remove these substances from the material cycle, leading among others to health benefits.

Environmental impacts

According to stakeholders, SCIP in its current form is not expected to contribute to the environmental benefits, as it is not practical for waste management operators to retrieve information on the localisation of hazardous substances. A potential improvement in environmental performance of waste management facilities is one aim of the measure to achieve better sorting and lower losses of material quantity or material quality. In cases where depollution is possible, impacts could be quantified in tonnes of avoided emissions.

Effectiveness, efficiency and coherence

The effectiveness of this measure would also depend on the extent of hazardous substances that is covered by the database. As e.g., the existing SCIP database only covers substances of very high concern identified under REACH, whereas GADSL and IMDS cover more substance groups and individual substances, the latter should be considered more effective. The ESPR defines substances of concern in a way that also allows restricting a substance when it “negatively affects the re-use and recycling of materials in the product in which it is present”. Although this is not further specified, it can be assumed that a wider extent of substances might be addressed under ESPR as compared to GADSL/IMDS. Thus, regarding coherence, the three information schemes refer to different policy requirements; whereas SCIP is based on the notification requirement of REACH Article 33, GADSL/IMDIS includes this, and further voluntary reporting and the DPP rely on Ecodesign.

The efficiency of the information schemes cannot be compared here, as the ESPR and especially the DPP has not been developed yet: Article 10 of the Commission’s proposal for a regulation on eco-design for sustainable products envisages the adoption of an implementing act establishing the detailed technical rules for the design and operation of the product passport. The impact assessment of the ESPR states on the DPP: “Given the developments pending in this area, it is not possible, and premature, to assess the impacts that relying on such a system could have.”

3.1.4.9.4 Summary and conclusion

Under all options for practical implementation and against the background of the dynamic around the ESPR and DPP, we consider this measure as being premature at this point of time. Instead, it should be re-examined at a later stage in the context of a vehicle product passport, where the objective of e.g., a full material and component declaration is addressed in a broader context of data flow and data access. Thus, making a statement about the potential administrative burden or environmental savings as a result of this measure would be highly speculative at this point of time.

3.1.5 Analysis for steel

3.1.5.1 Qualitative analysis for steel

Six measures were shortlisted for steel including the following measures:

No JH	Title	Chapter
2.1B	2.3.e) Establish provisions to support the market of used spare parts composed of steel	2.1.5.3.5
2.1B	2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing of steel components	2.1.5.3.6
2.3A1	2.4.b) Making it mandatory to remove certain copper parts before shredding to encourage high quality steel/aluminium and high quantity copper recycling	2.1.5.4.2
2.3C	2.4.c) Set material-specific recycling targets for steel	2.1.5.4.3
Possible alternative	2.4.d) Regulate shredder/post shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process	2.1.5.4.4

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

- Measure (2.2.f) about the monitoring of components for reuse/remanufacturing would require provisions aimed to increase the demand of such components containing steel (e.g., bumpers, and fenders).
- The removal from the vehicles of components with a high content of steel and sending them to separate recycling would limit the ‘poor quality’ of obtained recycled steel, i.e., where the removed components is composed of a steel alloy with low levels of impurities. However, (FEAD 2022) expects that separate recycling of steel parts (prior to shredder) would have a small impact on the quality of secondary steel. Hence, mandatory removal of steel parts is thus discarded at this stage but could be reconsidered in the future if the implementation of other measures does not lead to a sufficient improvement in circularity.
- A number of studies show copper contamination in end-of-life scrap posing a future metallurgical problem in the global steel recycling (more details in section 2.1.2.5.1). Also, EUROFER refers to copper as an impurity in steel which can affect the portfolio of applications in which secondary steel can be applied. The removal of electronic components and cables (wire harness) prior to shredding is raised as one option to limit such impurities. Thus, mandatory removal of certain copper parts before shredding to encourage high-quality steel recycling is considered. This measure is linked to analysis of copper (section 3.1.6). This measure shall encourage high-quality steel recycling as well as higher copper recycling. However, mandatory removal of parts can promote reuse as well when removed part will not be recycled but instead reused.
- Regulation of shredder/post-shredder facilities and especially the standardisation of deliverables from these facilities could lead to the improvement of existing technologies or the promotion of the dismantling of reusable components prior to shredding. Additionally, setting standards on the Cu-concentration in steel scrap would support high-quality steel recycling. Thus, this measure is considered in further analysis.
- A separate recycling target for steel, since the recycling rate of this material is currently rather high, up to 90 % is discarded from further analysis. Also, according to (EUROFER 2021a), “the only compulsory target shall always refer to the weight of the entire vehicle. The information about the recycling of specific fractions or materials recovered from ELVs shall be complementary information to better check the legislation's functioning and support the automotive industry in improving the design of their vehicles.”

3.1.5.2 Scenarios for quantitative analysis

3.1.5.2.1 Baseline Steel

Throughout the EU, the commonly applied methods to treat steel from ELVs are shredder operations, usually combined with some type of post-shredder treatment operations. Steel scrap obtained from shredder/PST facilities is generally used by steelmakers to make construction products, such as reinforcing bars, which do not require high-quality steel (e.g., purity). Only a limited part of steel originating from ELVs can be recovered in the production of new vehicles.
According to the various stakeholders, the recycling rate of steel from the ELVs is rather high, 90 %.
On this basis, it is assumed that under the baseline, steel shall continue to be treated mainly in shredder/PST facilities, achieving a similar level of recycling.

3.1.5.2.2 Scenario Steel 1: Monitoring of components composed of steel for reuse/remanufacturing

Under this scenario the monitoring of components composed of steel for reuse/remanufacturing shall be introduced. For this purpose, a list of components recommended for reuse/remanufacturing (Annex to ELVD) would be defined. The preliminary list prepared in this report contains also elements made of steel, e.g., engines, bumpers. This list should be revised from time to time to consider the current market situation of components for reuse and remanufacturing.
The list's review should also consider the new technological solutions that promote remanufacturing as a way of processing components from ELVs. An example is the remanufacturing process that converts waste sheet steel (WSS) from the exterior components of ELVs into value-added mesh steel sheet (MSS) as a sustainable end-of-life strategy as an alternative to recycling the recovered steel by smelting (Abdullah 2021).

This scenario also considers implementation of harmonised monitoring of components that have been removed for reuse/remanufacturing to understand the actual volume of reuse in different MS and will enable the comparability of monitoring data. Obtained information will allow a better understanding of the potential for reuse and how it is influenced by measures that affect market demand. It will also help in the future in the revision of the list of removed spare parts as well as to potentially set out the targets. The reporting obligation would be limited to the components listed in the Annex to ELVD ("list of components recommended for reuse/remanufacturing"). However, separate reporting on components sold for reuse/remanufacturing could also be required though it may create a burden for ATFs if it cannot be linked to an existing list of sales.

3.1.5.2.3 Scenario Steel 2: Market support of used spare parts composed of steel

Under this scenario the market demand for spare parts should be regulated by requiring car repair shops to provide customers with an offer to repair a vehicle with used/remanufactured components alongside offers for repair with new components. Insurance companies will also be obliged to offer car owners discounted policies if they agree that repairs are performed with reused/remanufactured parts when these are available. Furthermore, a ban on the online sales of illegally operating facilities would be introduced.

Use of spare parts is market driven, and increasing demand is assumed to provide more flexibility to ATFs to decide on components to be dismantled as opposed to measures for increasing supply which could result in a high burden for storage without significant impact on the actual reuse/remanufacturing of components. Obligations for insurance companies may only be implementable through national legislation. Strengthening the market demand for reused components will increase the profitability of dismantling relevant components. Provisions on online sales will reduce sales of used components from illegally operating facilities, increasing profitability of legally operating ones. Again, these provisions may only be implementable through national legislation.

3.1.5.2.4 Scenario Steel 3: Mandatory removal of certain copper parts before shredding to encourage high quality steel/aluminium recycling and high quantity copper recycling

A dismantling obligation for copper-bearing components is already provided by the ELVD, but only if the copper is not segregated in the shredding process.

The copper contained in vehicles is about 60% in the cable harness and in engines, e.g., ventilation and heating (Argonne 2021). While a separation of the large electric motors is effectively possible after shredding, the separation of increasingly fine and more widely distributed cable strands can only be realised with considerable effort.

For instance, the Japanese ELV system contains provisions that dismantlers when they want to send ELV directly to the electric furnaces without shredding process, are allowed to do it, under the condition that copper contents are reduced to max 0.3%. In consequence they have to remove the wire harness from ELVs. Like this, Japanese dismantlers remove them by operating heavy machinery.[228]

(Russo et al. 2002) carried out several trials to analyse the influence of the dismantling parameter on scrap quality, with special focus on tramp elements, like copper. The results show that removal of the engine has a direct effect of removing 62 % of the copper present in the car, thus the total copper removal from car to shredder scrap is thus 90 %, to be compared to only 71.5 % without prior dismantling. The study proved that engine removal leads to the possibility of producing shredded scrap with a copper level of around 0.1 % (without dismantling of the engine it would be on the level of 0.28 %).

Copper content in steel scrap destined for recycling is considered an impurity of steel and may affect the portfolio of applications in which secondary steel can be applied (EUROFER 27.10.21).

Thus, removal of electronic components and cables (wire harness) prior to shredding is an option to limit such impurities and is a part of this scenario.

3.1.5.2.5 Scenario Steel 4: Regulate shredder/post-shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process

The intention of this scenario is to ensure high recovery of metals from the shredder/PST residues. It aims also to obtain high-quality recycling output from these treatment plants. To

[228] https://www.gov.scot/binaries/content/documents/govscot/publications/progress-report/2013/12/remanufacture-refurbishment-reuse-recycling-vehicles-trends-opportunities/documents/00440543-pdf/00440543-pdf/govscot%3Adocument/00440543.pdf

obtain the goal, a legally binding maximum metal content for shredder residues[229] should be set up at an ambitious level in order to recover as many metals as possible as secondary raw materials and it should be oriented towards the best available technical practices. The removal of metal from the shredder light fraction at least to below 1 % metal content by means of post-shredder separation (Tabel et al. 2011) is considered to be feasible for this purpose.

On the other side copper content in steel scrap destined for recycling is considered an impurity of steel and may affect the portfolio of applications in which secondary steel can be applied (EUROFER 27.10.21).

The full implementation of this scenario would require setting up a maximum copper content in steel scrap[230] (output from shredders/PST) that is sourced from recycling, possibly by means of a European standard, e.g., currently under development is “European standardisation deliverables on Road vehicles – Post-shredding recycling – design-for-recycling guidelines for plastic products”[231].

For more information, please refer to the information on copper in the current situation chapter and measure description (2.1.2.5.2 and 2.1.5.4.2).

3.1.5.3 Results of qualitative analysis

Scenario **Steel 1** and **Steel 2** are intended to increase the reuse/remanufacturing level of components in ELVs incl. those containing steel. Scenario Steel 1 in a way intends to increase the attention of ATF to component reusability as well as supporting the policy maker in understanding the situation of the market of components, potentially dismantled and reused. On the other hand, scenario Steel 2, includes legally binding obligations for both ATFs and insurance companies, and it is expected that level of dismantling will increase more under scenario Steel 2 than under Steel 1 due to the expected increase in demand for reused parts.

However, implementation of the scenario Steel 2 requires legal adjustments mainly at national level, which may affect its implementability by all Member States. Both scenarios would require development of administrative support in terms of i.e., monitoring/reporting. For dismantled (relatively) pure steel sheets (with no copper contamination), both scenarios are expected to potentially increase the level of high-quality recycling. Where it is not possible to reuse/remanufacture components that have already been dismantled, they can be sent to separate recycling, avoiding shredder process.

Scenario **Steel 3** refers to dismantle copper-bearing components prior shredding. This would require additional steps before shredding and will lead to additional costs for ATFs. Dismantling could be done manually or automatically, for parts that are easily accessible. The copper contained in vehicles is about 60% in the cable harness and in engines, e.g., ventilation and heating. As already highlighted before, Cu-contamination in steel scrap limits the applicability of this scrap.

In addition to increased steel scrap quality, dismantled components might be shifted for reuse/remanufacturing, as well as more copper (or other materials) would be available for (high-quality) recycling. Scenario **Steel 4** aims to obtain: 1) a higher quantity of metals (ferrous and non-ferrous) for recycling, 2) a high-quality steel scrap for recycling.

[229] destined for backfilling/ landfill construction, energy recovery/ incineration or final disposal/landfill sites

[230] More on possible max value under description of measure.

[231] file:///C:/Users/I65A1~1.KOS/AppData/Local/Temp/Draft%20standardisation%20request%20as%20regards%20medical%20devices%20and%20in%20vitro%20diagnostic%20medical%20devices.pdf

The introduction of this provision would require regular checks of the obtained outcomes/residues from shredder. The monitoring under this scenario would require development of a harmonised testing approach. This can be done twofold: either by shredder or by recycler. The testing of the steel scrap samples is less precise as chemical analysis of smelted input material to EAF. However, material put into EAF normally comes from different sources, what might challenge to assess the composition of each input material separately (this issue requires further investigation).

Reporting on the steel scrap quality would also involve development of a reporting scheme that to submit by facilities (shredders/recycler) the monitoring results to the authority to be responsible for controlling.

There are two possible actions once the results of monitoring are not satisfactory:

1) the authorities could develop local/regional/national strategies to improve the situation, by, e.g., introduction of mandatory dismantling of parts that contain copper before shredding (if not implemented yet).

2) modulation on price for steel scrap for recycling.

3.1.5.4 Results of quantitative analysis

The calculation of potential environmental impact is based on the model (described in detail in Annex I 6.9). The following tables show assumed treatment routes for the steel fraction that would potentially be available in the collected ELVs in 2035. For instance, a different share is assumed to be dismantled in each scenario. In scenario Steel 3 and 4 the share of components for reuse/remanufacturing is the same, however in scenario 3 and 4 less of dismantled steel is sent to shredder and thereafter to the recycler (it is assumed that provision on mandatory removal and PST/shredder regulation will support separate recycling). Additionally, in scenario Steel 3 and 4, a higher share of dismantled steel is sent to the recycler directly (skipping the shredding process) in contrary to other scenarios. High dismantling is assumed in order to see how the environmental benefits could change when it is required to dismantle more components prior shredding or when Cu-content threshold is put on steel scrap in order to obtain the outputs from shredder/PST facilities in sufficient quality.

The following table specifies the rates that have been assumed for each scenario as dismantled, reused, recycled pre- or post-shredder, recovered, or lost; and with which quantitative impacts have been calculated.

Table 3-3 Routes of treatment for steel under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	10%	15%	18%	18%	18%
Dismantled -> recycled (no shredding)	2%	4%	7%	13%	18%
Dismantled -> shredded -> recycled	2%	4%	7%	4%	4%
Shredded -> recycled	75%	65%	57%	54%	50%
Losses/process inefficiencies	12%	11%	10%	10%	10%

Source: Oeko-Institut: own assumptions

Based on this description and the shares specified in Table 3-3, in the baseline and in each scenario, the amounts that would be reused/remanufactured as well as recycled pre- and post-shredder were calculated (Figure 3-2). The total mass of steel in EoL vehicles is assumed to be about 6 130 Mt in 2035.

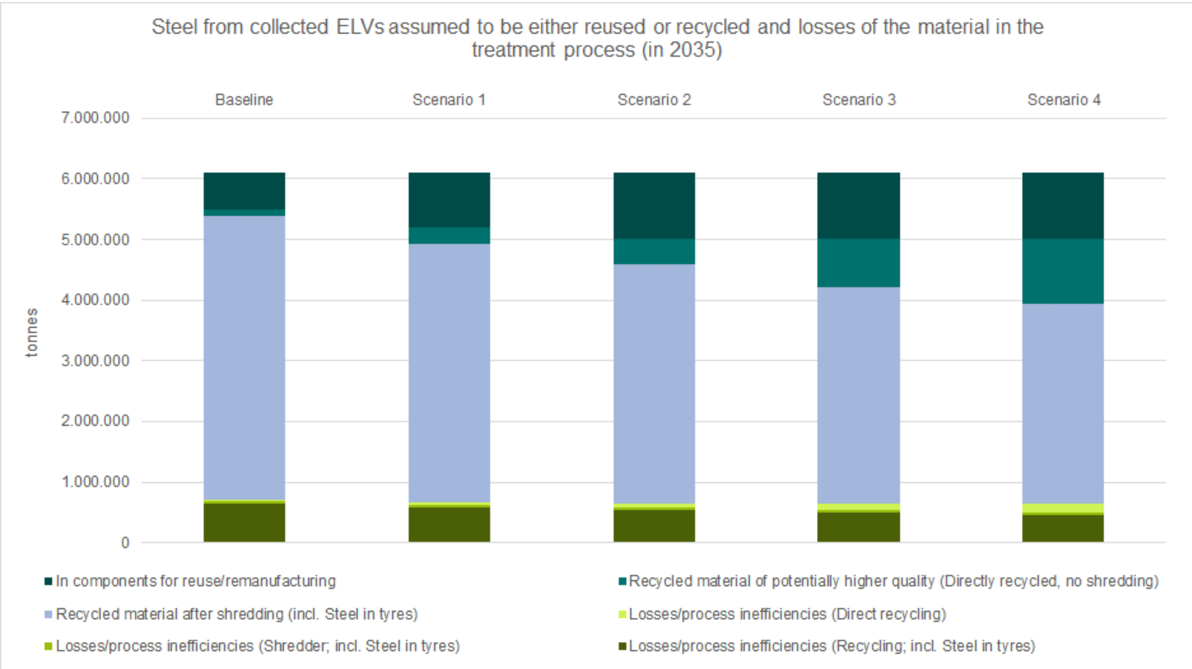
Table 3-4 Tonnes of steel from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035)

Total of the material in EoL vehicles (without battery) [tonnes]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total of the material in EoL vehicles (without battery)	6,113,500	6,113,500	6,113,500	6,113,500	6,113,500
In components for reuse/remanufacturing	611,300	917,000	1,100,400	1,100,400	1,100,400
Recycled material of potentially higher quality (Directly recycled, no shredding)	107,600	269,000	430,400	807,000	1,076,000
Recycled material after shredding (incl. Steel in tyres)	4,686,900	4,260,800	3,941,300	3,568,500	3,302,100
Losses/process inefficiencies (Direct recycling)	14,700	36,700	58,700	110,000	146,700
Losses/process inefficiencies (Shredder; incl. Steel in tyres)	53,800	48,900	45,200	41,000	37,900
Losses/process inefficiencies (Recycling; incl. Steel in tyres)	639,100	581,000	537,400	486,600	450,300

Table 3-5 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		161,400	322,800	699,400	968,400
Recycled material after shredding (incl. Steel in tyres)		-426,100	-745,600	-1,118,400	-1,384,800
TOTAL		**-264,700**	**-422,800**	**-419,000**	**-416,400**

Figure 3-2 Tonnes of steel from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035)



Source: Own illustration

3.1.5.4.1 Environmental impacts

To calculate potential environmental impact for each scenario, the masses of steel (Figure 3-2) were multiplied by the respective environmental impacts in terms of global warming potential (GWP). For recycled steel a corresponding credit is given, for the losses an environmental burden is calculated which results from the disposal of these losses. The results are shown below for all steel from ELVs collected in the year 2035 (Figure 3-3).

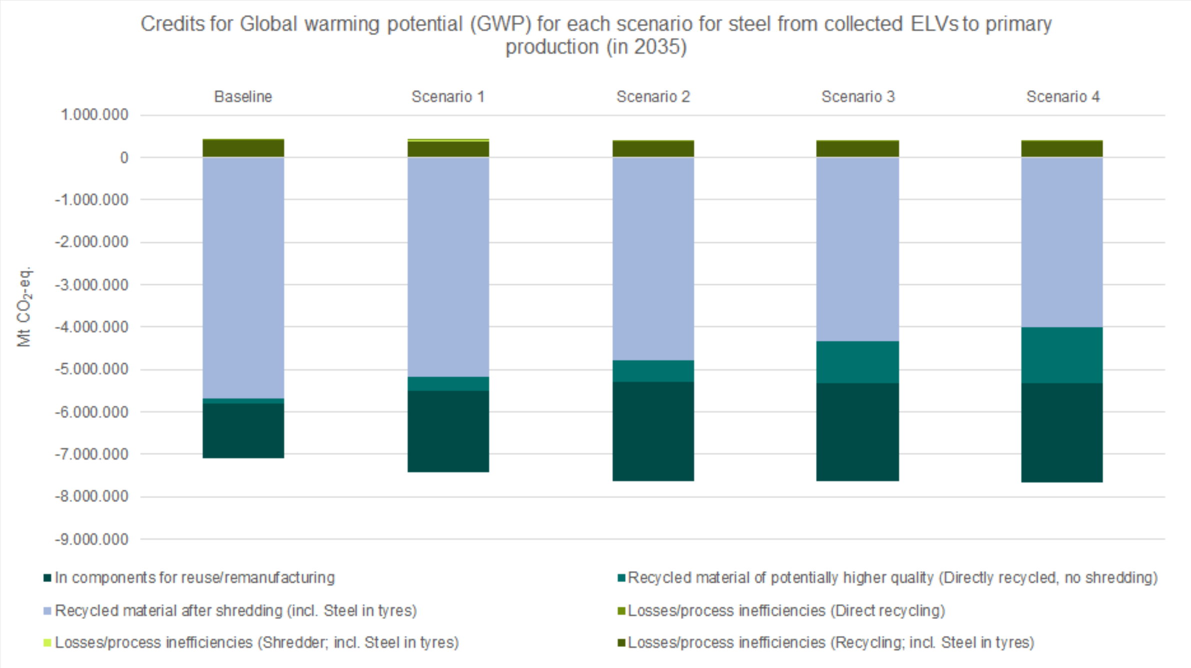
Table 3-6 Credits for Global warming potential (GWP) for each scenario for steel in collected ELVs in 2035 to primary production (Mt CO2eq)

Environmental impact in GWP [Mt CO2-eq.] ["-" environmental credits, "+" environmental burdens]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
In components for reuse/remanufacturing	-1,295,300	-1,943,000	-2,331,600	-2,331,600	-2,331,600
Recycled material of potentially higher quality (Directly recycled, no shredding)	-131,700	-329,100	-526,600	-987,400	-1,316,600
Recycled material after shredding (incl. Steel in tyres)	-5,677,700	-5,161,600	-4,774,500	-4,322,800	-4,000,200
Losses/process inefficiencies (Direct recycling)	33,800	30,700	28,400	25,700	23,800
Losses/process inefficiencies (Shredder; incl. Steel in tyres)	7,600	7,600	7,600	7,600	7,600
Losses/process inefficiencies (Recycling; incl. Steel in tyres)	410,700	388,000	374,500	374,800	375,000
TOTAL	**-6,653,000**	**-7,007,000**	**-7,222,000**	**-7,234,000**	**-7,242,000**

Table 3-7 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in Mt CO2-eq. comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		-197,400	-394,900	-855,700	-1,184,900
Recycled material after shredding (incl. Steel in tyres)		516,100	903,200	1,354,900	1,677,500
TOTAL for recycling (excl. reuse and burdens due to losses/process inefficiencies)		**318,700**	**508,300**	**499,200**	**492,600**
TOTAL of the whole process steps (e.g. reuse, recycling, etc.)		**-354,000**	**-569,000**	**-581,000**	**-589,000**

Figure 3-3 Credits for Global warming potential (GWP) for each scenario for steel in collected ELVs in 2035 to primary production (Mt CO_2eq)



Source: Own illustration

The figure above shows an LCA comparison of the dismantling and recycling route with the shredder route showing that the shredder has major environmental impacts, while dismantling has a minor environmental benefit. Additionally, there is only a slight environmental profit when the parts are sent directly to recycler after dismantling (avoiding shredding process). However, scenario 4 assumes regulation on the shredder/PST, thus in this scenario the whole treated steel for recycling is of high-quality. This scenario assumes removal of copper from the steel scrap in the shredder facilities. Additionally, the threshold on max Cu-content in the steel scrap for recycling might be obtain also by dismantling, thus the removal of ELVs parts containing copper is higher than in scenario 3 (Table 3-3). The amount of removed copper is illustrated in the scenario Copper 4 for copper in the following chapter. In the calculations it was assumed that original Cu-content in the steel scrap is 0.4 % which is then reduced to 0.1 %[232]. For the removal an additional energy demand of 50 kWh electricity per ton steel scrap is used (Daehn 2019).

Steel scrap under scenario 4 is assumed to be of high-quality. This would mean that potentially, mining and processing of primary iron ore could be avoided, i.e., through avoided production of high-quality primary steel or when needed for dilution of steel scrap to obtain the required quality of the relevant steel alloy. However, this potential is not expected to occur as long as there is not a surplus of steel scrap (there is not demand on cast steel that exists in the stock). Currently, it is not the case, thus in the global scale (2.1.2.5.1) there is still demand for cast steel from ELVs for instance in the construction field.

[232] Calculation was done based on available data, however original Cu-content in steel scrap is in the range of 0.2 to 0.7 %.

3.1.5.4.2 Economic impacts

Investment costs

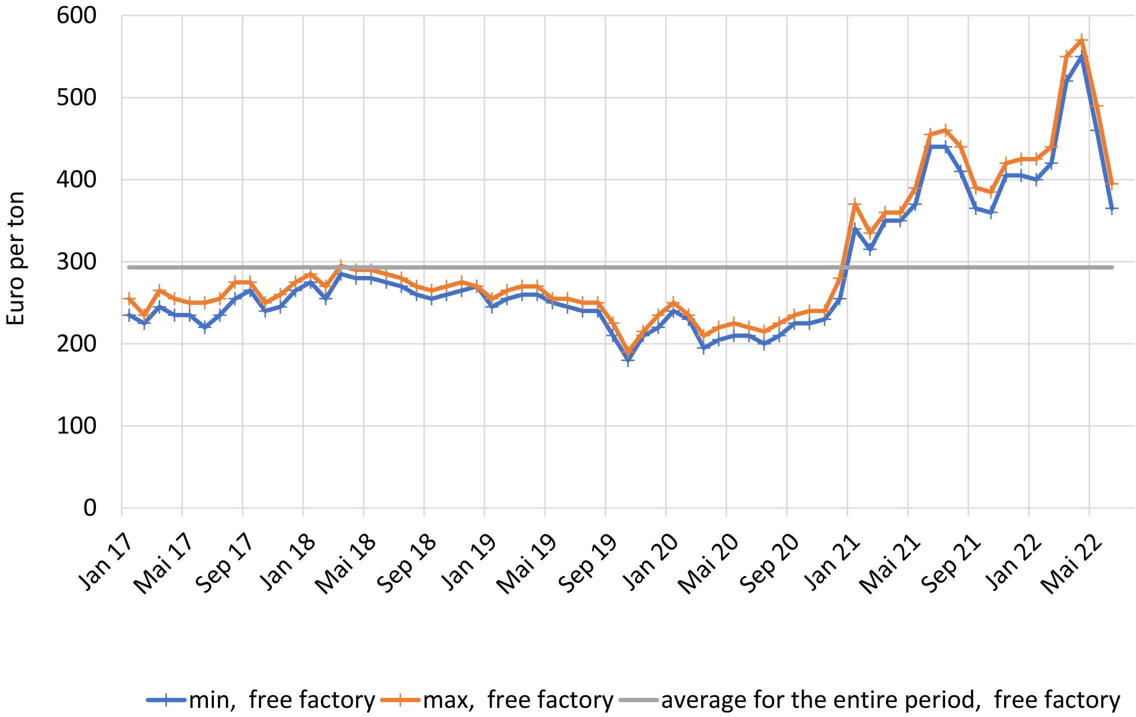
Investment costs are considered to arise in each scenario as well as in the baseline. In Scenario **Steel 1** and **Steel 2** are expected to occur bit higher costs than in baseline. Implementation of Scenario **Steel 3** would potentially require investment in dismantling machines and tools by ATFs for removal of mandatory parts. These costs would in similar hight also appear in Scenario **Steel 4** together with additional costs for shredder/PST to improve their efficiency in removing copper from steel scrap and metals in the residues from PST. Assuming transition time in introduction of the provision on the quality of outcomes/residues from shredders/PSTs the investments costs would be shifted in time. This additional time would be required for further development of methods for removal of copper, which are in practice under certain conditions and could be expanded or need to be scale-up since are proven only at laboratory scale (please refer to 2.1.2.5.1, 2.1.2.5.2, and 2.1.5.4.4). The share on the investment costs either for increased dismantling or higher develop shredder technologies, might differ among MS, since the provision introduced together with Scenario Steel 4 would not prescribe how defined thresholds need to be achieved. Some countries might develop strategy to dismantle more parts that contain copper before shredding and improve hand picking after shredding instead of investing in e.g., sorting machines. This approach might increase labour costs. (Daehn et al. 2017a) illustrates effectiveness (copper concentration achievable) to qualitative energy/cost for various technologies to separate copper (Figure 2-24).

The main stakeholder of EoL automotive sector are ATFs, shredder and PST facilities, recyclers, and garages (repair shops that have no official approval to dismantle ELVs). As it is introduced in several parts of this report (e.g. 2.3.2.3 and 3.2.5), more challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, in the end might require more effort at ATFs. Shredder and PST facilities in practice are always profitable that in case of high investments costs or low revenues for sold outcomes of their treatment process, would compensate their costs by decreasing price for input material. In that case, economical effort is put on ATFs, which might not be covered by revenues, and would cause decrease of their profits. This in consequence might lead reduction of the competitiveness of ATFs with the illegal sector.

The operation costs for shredding/PST are not accessible und unclear and, according to (EGARA 2022a), “financial results are… not detailed enough”, and it is not sufficiently clear that PST will actually reach a sufficient quality at lower cost than dismantling. Nevertheless, based on the input from stakeholders during the workshop in March 2022, the facilities operators compensate their costs through the prices they charge from their customers. When steel scrap prices decline, the price that ATFs receive from shredders/recyclers for input material for downstream processes, declines as well. Insofar it might be concluded those shredders (in general) are profitable, since, in the event of their operation cost being comparatively high due to lower revenues, they forward the excess costs up the value chain in the form of lower compensation for the ATFs delivering the ELVs. The figure below (Figure 3-4) illustrates the development of the prices for steel shredder scrap (E40) over the past years.

Dismantling costs depend on several aspects, e.g., access complexity to the component for removal, required additional machines, tools to remove it. For example, the removal of bumpers with a metal bar used to attach a bumper to a car, can costs between 1,400 to 2,300 Euros per tonne[233] (IRT M2P 2021).

Figure 3-4 Min / max prices for shredder steel, free factory (Germany)



Source: www.euwid-recycling.com

Further costs and revenues

Aside from the difference in costs of steel processing from ELVs, a further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the "metal components" arising from depollution and dismantling in Table 1. However, this data is voluntary and mandator is only a sum of all depolluted and dismantled materials, incl. "metal components". Introduction of scenario **Steel 1** (and especially the monitoring aspect) will require adjustment of the reporting format as well as changing the reporting from voluntary to mandatory. This adjustment is assumed to result in additional economical costs for public administration as well as for ATF that report on removed parts/components (please refer to Table 3-2 on economic impacts of measures addressing the treatment of vehicles at EoL).

These additional costs will be related to the additional time for collecting all data for ATFs thus more cells to fill in, as precise reporting of the total weight of reused parts/components is to be required for each component in the reporting table. Optimally, if ATFs would also report on the material composition of the dismantled parts/components, but this would require more thorough information for the producers, e.g., in IDIS. More time will also be needed for the institution that collects, summarises, and validates data before its official publication. It is to assume that the expected additional administrative cost of reporting would be similar significantly higher for scenario **Steel 2** in comparison to Steel 1. Some cases repair shops

[233] This includes the following costs: collection and transport, depollution, specific investments, labor costs for dismantling, carcass depreciation, transportation to the recycler.

(including ATFs) already apply reused parts, anyway the obligation under Steel 2 would lead to an increase in such activities. Further costs under this scenario are related to implementation of enforcement against illegal sales of reused components, thus MS would need to inspect online sale platforms to ensure no illegal activities.

Steel 3 considers mandatory dismantling, what can affect investment costs (introduced above under investment costs) but also labour costs. The average costs of labour work as well as the number of dismantled parts/components ahead shredding differ among MS, thus the possible increase of additional costs for MS might differ, while introducing mandatory dismantling. Administrative costs for reporting on dismantled parts are assumed to be higher than in Scenario Steel 1 despite already existing scheme on reporting. It is assumed that for ATFs it would be an additional effort due to higher number of dismantled parts/components as well as due to need to provide more data on weight and kind of dismantled parts/components. In case when Scenario Steel 1 and Steel 3 would be implemented together, the administrative costs for reporting would not sum up[234], because while reporting on dismantled part/components, ATFs would highlight for which purpose it is dismantled (reuse/remanufacturing, recycling). However, the level of detail of reporting on dismantled parts would increase.

Additional costs will also exist due to requirement on reporting on the quality of shredders/PSTs deliverables (scenario **Steel 4**). These costs will appear for facilities' operators (shredder or/and recycler depending on the agreed measurement point) as well as for public authorities, however it is expected that these costs will be higher for facilities. As described above, public offices will need to collect data, validate it, and assess the situation (locally, regionally, or nationally) and to eventually establish an improvement strategy when it is necessary.

The administrative costs for each steel scenario are highlighted in section 3.1.11 on the analysis of measures addressing the treatment of vehicles at EoL.

Figure below shows possible high of revenues for steel scrap for analysed scenarios (2035) and status-quo (2020). These values do not consider revenues for dismantled components for reuse/remanufacturing as well as costs for this process.

Table 3-8 Revenues for steel scrap of potentially higher quality and obtained after shredding in mln Euro. Below also a change in mln Euro of these revenues comparing to the baseline.

Total of the revenues for recycled material [mln Euro]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)	20	50	81	151	201
Recycled material after shredding (incl. Steel in tyres)	877	797	737	668	618
TOTAL	**897**	**847**	**818**	**819**	**819**

Table 3-9 Change in mio Euro of these revenues comparing to the baseline ["-" decrease, "+" increase]

Change in mio Euro of revenues comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		30	61	131	181
Recycled material after shredding (incl. Steel in tyres)		-80	-140	-209	-259
TOTAL		**-50**	**-79**	**-78**	**-78**

[234] Relevant for components for reuse/remanufacturing arise on the list for monitoring.

Source: own calculations, the price does not consider the steel scrap quality, which might be higher due to dismantling of some parts and sending them directly to recycler (no shredding). For the price current prices were taken. Lowest raw represents a total and percentage of revenue's decrease/increase in each scenario 1 to 4 in comparison to baseline (decrease in revenue is due to, e.g., higher reuse/remanufacturing or direct recycling of components dismantled by ATFs).

The calculation of ATFs dismantling costs in steel scenario is based on the time required to remove an engine. When we refer to dismantling of an engine, it means that the engine is removed in its entirety and is either reused or shredded and in some cases sent directly to the steel smelter. When we refer to deep dismantling, it means that the engine is removed and then dismantled into separate material parts – this of course needs more time.

In the calculations dismantling time of engine to the steel and aluminium scenarios are allocated 50:50 and time for deep dismantling of engines is allocated 33:33:33 to Fe:Cu:Al scenarios. Additionally, the percentage of dismantled and deep-dismantled engines variate among scenarios and depends also on the vehicle's type. Allocation () of calculated dismantling time to three materials allows avoiding double counting. Also, dismantling times vary for components removed for reuse (20 min) and for recycling (10 min).

Table 3-10 Allocation of calculated dismantling time to three materials (steel, copper, and aluminium) to avoid double counting.

	Dismantling (removal)		Deep-Dismantling	
Scenario	ICE and Hybrid	EV and Plug-in	ICE and Hybrid	EV and Plug-in
Steel	50%	50%	33%	33%
Copper	0%	0%	33%	33%
Aluminium	50%	50%	33%	33%

Following table summarises assumptions to calculate dismantling time for engines for all scenarios. These assumptions are valid for all three materials.

Table 3-11 Assumptions to calculate dismantling time for engines for all scenarios of steel, copper, and aluminium

		Dismantling (removal)			Deep-Dismantling		
		Time (min)	ICE and Hybrid	EV and Plug-in	Time (min)	ICE and Hybrid	EV and Plug-in
Status-quo		20	30%	5%	0	0	0
Baseline		20	32%	5%	0	0	0
Scenario 1	reuse	20	33%	6%	0	0	0
Scenario 2	reuse	20	42%	7%	0	0	0
Scenario 3	mandatory removal for recycling	10	70%	95%	10	70%	95%
	mandatory removal for reuse	20	30%	5%	0	0	0
Scenario 4	PST output quality, for recycling	10	40%	95%	10	40%	95%
	PST output quality, for reuse	20	30%	5%	0	0	0

As example, Scenario 3 sets an obligation to remove engines, thus it is assumed that all engines are dismantled (among them 30% for reuse and 70% for recycling). In Scenario 4, less engines from ICE and hybrid will be removed (in total 70%), however for EV and plug-in the percentage remains the same as in Scenario 3, due to higher content of copper in the engines from these types of vehicles.

The average cost per hour is 51 Euros (base on the information from EGARA).

Following table show the total costs in million Euro for baseline and additional dismantling costs (as compared to the baseline, also in mln Euro)

Table 3-12 Total costs for baseline and additional dismantling costs (as compared to the baseline) in mln Euro

	Total costs, in million Euro	Additional dismantling costs (as compared to the baseline, in million Euro)			
Material	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Steel	21	1	7	48	31

3.1.5.4.3 Social impacts

Figure 3-2 illustrates shift (from baseline to Scenario Steel 4) into higher amount of steel in reuse/remanufactured components containing steel and steel from dismantled parts send directly to recycler. Increase in reuse/remanufacturing and dismantling would potentially increase the dismantling cost, incl. need for more employee to remove[235] more parts/components from the ELVs.

Based on one example the possible social impact is calculated. Calculations are based on the assumptions applied to estimate economical costs for ATFs (previous sub-chapter). The following tables shows the number of additional job positions in the ATFs as compared to the baseline.

Table 3-13 Number of additional job positions in the ATFs as compared to the baseline

	Additional positions (number) as compared to the baseline			
Material	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Steel	12	86	582	383

Additionally, employee will be needed for the operation of new machines in shredder/PST and additional employees for hand picking/sorting in shredder facility. In Europe there are about 300 shredders/PST. It is expected that relevant investments would do done by facilities from middle up to big size, thus not in all existing facilities. There is not precise data on shredder/PST and also on the fact if shredder have a PST in house, therefore rough assumptions are done: 60% of existing plants are middle or bigger size, for the new technological solutions there will be need for 2 employees that could operate new machines. It would mean that for Scenario Steel 4 (for which bigger investments are planned) would be required to hire additional 360 employees.

3.1.5.5 Comparison of scenarios for steel

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-14 below to allow an easier comparison. The scope of the analysis is EoL of steel from collected ELVs, however some of the outcomes either overlap with the outcomes of the analysis of other materials or are representative for other material(s) as well. Thus, the finding listed below should not be sum up with other summarising tables for the separately analysed materials. The overall analysis on the collected ELV level is performed in section 3.1.11 below.

[235] Especially for these parts/components, which cannot be removed by machines and in MS where labour costs are still not so high.

Table 3-14 Summarising table for the comparison of the steel scenarios (the assessed impacts are based on the total of ELVs collected in 2035)

Impacts		Scenario Steel 1	Scenario Steel 2	Scenario Steel 3	Scenario Steel 4
Economic	on ATFs	1 mln € costs due to additional dismantling[236] (comparing to the baseline) Additional revenues for dismantled parts/comp. for separate recycling (+30 mln €) -	6 mln € costs due to additional dismantling [236] comparing to the baseline) Additional revenues for dismantled parts/comp. for separate recycling (+61 mln €) --	43 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for separate recycling (+131 mln €) --- / +	28 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for separate recycling (+181 mln €) --- / +
	on shredders	Loss of shredding material (loss of revenue) Decrease in revenues for steel scrap (-80 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for steel scrap (-140 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for steel scrap (-209 mln €) --	Loss of shredding material (loss of revenue) Additional investment costs in separation technologies and hand picking However, the secondary steel is of high-quality and potentially of higher price (higher revenues)[237] --- / +++
	on recyclers	Small decrease in business, due to loss of steel scrap (-50 mln €) However, increase in higher quality material (dismantled prior shredding) 0	Small decrease in business, due to loss of steel scrap (-79 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of steel scrap (-78 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of steel scrap (-78 mln €) However, huge increase in higher quality material (dismantled prior shredding), thus potentially lower processing costs to obtain

[236] Value represents the additional costs for manual dismantling (labour costs), there might occur also additional investment costs in the machines for automatic dismantling (especially relevant for scenario Steel 3 and 4).

[237] Assuming the price for high-quality secondary steel the same as for the cast steel, there will occur decrease in revenues for steel scrap (-227 mln Euro)

Impacts		Scenario Steel 1	Scenario Steel 2	Scenario Steel 3	Scenario Steel 4
					steel of high quality ++
	on SME	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities.			
	Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal			
	Administrative costs burden	Moderate increase in administrative burden for reporting for regulators and waste management --	Moderate increase in administrative burden for reporting for regulators and waste management --	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---
	2ndary resources	Decrease in availability of secondary steel (-50 mln €) due to increase in reuse -	Decrease in availability of secondary steel (-79 mln €) due to increase in reuse -	Decrease in availability of secondary steel (-78 mln €) due to increase in reuse -	Decrease in availability of secondary steel (-78 mln €) due to increase in reuse However, the secondary steel is of high-quality ++
Environmental	Environmental impacts: LCA credits from reuse/rem. and recycling[238]	Increase in credits: ~354 Mt CO_2-eq. +	Increase in credits: ~569 Mt CO_2-eq. ++	Increase in credits: ~581 Mt CO_2-eq. ++	Increase in credits: ~589 Mt CO_2-eq. ++
Social	Employment[239]	Increase in jobs in ATF (~12) +	Increase in jobs in ATF (~86) ++	Increase in jobs in ATF (~582) ++	Increase in jobs in ATF (~383) Increase in jobs in shredder facilities (~360) +++
	Proportionality	All scenarios are considered proportional for achieving the objectives that the EU Treaties intends to implement			
	Cost effectiveness	Low costs but low benefits +	Similar effectiveness to scenario 3 and 4 in GWP and amount of recycled steel, while lower costs. However, the quality of recycled	Higher costs than scenario Steel 2 to result in the similar amount of secondary steel as scenario Steel 2. However, the quality of recycled steel is higher.	Very high costs in comparison to scenario Steel 2 and 3. Highest revenues for ATFs for sold recyclable material. However, the obtained secondary steel

[238] As a difference to baseline scenario

[239] Increase in comparison to baseline scenario. The calculations done based on dismantling time of engine/gearbox, so the values presented here in reality might be even higher while considering more parts/components for dismantling.

Impacts		Scenario Steel 1	Scenario Steel 2	Scenario Steel 3	Scenario Steel 4
			material is lower. ++	++	is of high quality. ++
	Coherence	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting maximal recycling. ++	Coherence with waste legislation and the CEAP, promoting maximal high-quality recycling. +++

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

Please see EPR section in analysis at EEC level in section 3.1.10.1.4 for possible costs of dismantling EEC containing copper and in section 3.1.12 on possible costs of PST at vehicle level.

3.1.6 Analysis for copper

3.1.6.1 Qualitative analysis for copper

Measures were shortlisted for copper including the following measures:

Title	Chapter
2.3.e) Establish provisions to support the market of used spare parts composed of copper	2.1.5.3.5
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing of copper components	2.1.5.3.6
2.4.b) Making it mandatory to remove certain copper parts before shredding to encourage high quality steel/aluminium and high quantity copper recycling	2.1.5.4.2
2.4.c) Set material-specific recycling targets for copper	2.1.5.4.3
2.4.d) Regulate shredder/post shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process	2.1.5.4.4

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

- Monitoring of components for reuse/remanufacturing is a supporting measure (2.2.f) that will need to accompany provisions designed to increase the demand of components for reuse/remanufacturing (2.2.e) that contain copper, e.g., EV motor. EV motors contain also high shares of aluminium and, since the reuse/remanufacturing of aluminium components is analysed under the next section, these two measures will be discarded from the further analysis here.

- Regulation of shredder/post-shredder facilities and especially the standardisation of deliverables from these facilities could lead to the improvement of existing technologies or the promotion of the dismantling of reusable copper (containing) components[240] prior to shredding.
- A mandatory removal of certain components aims to limit 'poor-quality' material recovery operations through removing from vehicles components with a high content of copper and sending them to separate recycling. Dismantling of parts composed of copper and sending them to recycling is a pre-condition for the recycling of higher amounts of copper as well as obtaining the ELV steel scrap of lower Cu-contamination. Treatment of copper components together with the rest of the hulk in the shredder limits the number of coppers recycled but also limits the applicability of recycled steel (for more details please refer to the chapter 2.1.2.5.1).
- Setting a separate reuse and recycling target for copper would also aim at increasing reuse/remanufacturing, also contributing to increasing the quantity of copper for recycling. However, reporting on this target would create significant administrative burden. The most challenging would be obtaining the weight of the specific material in the components for reuse/manufacturing. Additionally, tracking of materials from the ELVs in the shredder process is hampered since ELVs that are processed in these facilities are often mixed with other items. Setting only the material-specific recycling target (excluding the components for reuse/remanufacturing from it) would act contra-productive for promoting reuse/remanufacturing. Also identifying a meaningful level of these targets would be extremely challenging. Hence, a separate target for copper is discarded at this stage but could be reconsidered in the future if the implementation of other measures does not lead to a sufficient improvement in circularity.

3.1.6.2 Scenarios for quantitative analysis

3.1.6.2.1 Baseline Copper

EU wide the commonly applied methods to treat copper from ELVs, similarly to steel, are shredder operations, usually combined with some type of post-shredder treatment operations. After the scrap is shredded into first-size pieces, it is separated by a magnet into a ferrous and a non-ferrous stream. The efficiency of this process might be limited, since some ferrous pieces are still connected to non-ferrous pieces, causing a certain degree of impurity in each stream. One example are copper wires from electric motors that remain attached to ferrous components in their stream. Partly the remaining wires might be removed manually. The rest remains in the ferrous scrap and causes its impurity. Shredding companies are aware of their customers' requirements and can adjust their processes accordingly. Nevertheless, in the heavies' fraction of non-ferrous stream, which accounts for 20-25 % of the non-ferrous output, contains about 1-15 % copper.[241]

On this basis, it is assumed that under the baseline, copper shall continue to be treated mainly in shredder/PST, with the chance that the quality of obtained deliverables will improve together with development of new technologies. Dismantling of specific components for recycling may potentially increase, however, similarly to treatment in shredder/PST, the economic viability is questionable. As said above, its profitability might depend on additional fundings.

[240] Wheels, transmissions, and engines (EV, ICEV).

[241] https://www.cargroup.org/wp-content/uploads/2017/02/Copper-in-End_of_Life-Vehicle-Recycling.pdf

3.1.6.2.2 Scenario Copper 1: Monitoring of components composed of copper for reuse/remanufacturing

Under this scenario the monitoring of components for reuse/remanufacturing shall be introduced. For this purpose, a list of components recommended for reuse/remanufacturing (Annex to ELVD) would be defined. The preliminary list prepared in this report contains also elements made of copper, e.g., engines. This list should be revised from time to time to consider the current market situation of components for reuse and for remanufacturing.

This scenario also considers implementation of harmonised monitoring of components that have been removed for reuse/remanufacturing to understand the actual volume of reuse in different MS and will enable the comparability of monitoring data. Obtained information will allow a better understanding of the potential for reuse and how it is influenced by measures that affect market demand. It will also help in the future in the revision of the list of removed spare parts as well as to potentially set out the targets. The reporting obligation would be limited to the components listed in the Annex to ELVD (“list of components recommended for reuse/remanufacturing”). However, separate reporting on components sold for reuse/remanufacturing could also be required though it may create a burden for ATFs if it cannot be linked to an existing list of sales.

3.1.6.2.3 Scenario Copper 2: Market support of used spare parts composed of Copper

Under this scenario the market demand for spare parts should be regulated by requiring car repair shops to provide customers with an offer to repair a vehicle with used/remanufactured components alongside offers for repair with new components. Insurance companies will also be obliged to offer car owners discounted policies if they agree that repairs are performed with reused/remanufactured parts when these are available. Furthermore, a ban of the online sales of illegally operating facilities could be introduced.

Use of spare parts is market driven, and increasing demand is assumed to provide more flexibility to ATFs to decide on components to be dismantled as opposed to measures for increasing supply which could result in a high burden for storage without significant impact on the actual reuse/remanufacturing of components. Obligations for insurance companies may only be implementable through national legislation. Strengthening the market demand for reused components will increase the profitability of dismantling relevant components. Provisions on online sales will reduce sales of used components from illegally operating facilities, increasing profitability of legally operating ones. Again, these provisions may only be implementable through national legislation.

3.1.6.2.4 Scenario Copper 3: Mandatory removal of certain copper parts before shredding to encourage high quality steel/aluminium recycling and high quantity copper recycling

A dismantling obligation for copper-bearing components is already provided by the ELVD, but only if the copper is not segregated in the shredding process.

The copper contained in vehicles is about 60 % in the cable harness and in engines, e.g., ventilation and heating (Argonne 2021). While a separation of the large electric motors is effectively possible after shredding, the separation of increasingly fine and more widely distributed cable strands can only be realised with considerable effort.

For instance, the Japanese ELV system contains provisions that dismantlers when they want to send and ELV directly to the electric furnaces without shredding process, are allowed to do it, under the condition that copper contents are reduced into max 0.3%. In consequence they have to remove the wire harness from ELVs. Like this Japanese dismantler remove them by operation heavy machinery.[242]

(Russo et al. 2002) curried out several trials to analyse influence of the dismantling parameter on scrap quality, with special focus on tramp elements, like copper. The results show that removal of the engine has direct effect of removing 62 % of the copper present in the car, thus the total copper removal from car to shredder scrap is thus 90 %, to be compared to only 71.5 % without prior dismantling. The study proved, that engine removal leads to the possibility of producing shredded scrap with a copper level of around 0.1 % (without dismantling of the engine it would be on the level of 0.28 %).

Copper content in steel scrap destined for recycling, is considered an impurity of steel and may affect the portfolio of applications in which secondary steel can be applied (EUROFER 27.10.21).

Thus, removal of electronic components and cables (wire harness) prior to shredding is an option to limit such impurities and is a part of this scenario.

3.1.6.2.5 Scenario Copper 4: Regulate shredder/post-shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process

The intention of this scenario is to ensure high recovery of metals from the shredder/PST residues. It aims also to obtain high-quality recycling output from these treatment plants. To obtain the goal, a legally binding maximum metal content for shredder residues[243] should be set up at ambitious level in order to recover as many metals as possible as secondary raw materials and should be oriented at the best available technical practices. The removal of metal from the shredder light fraction at least to below 1 % metal content by means of post-shredder separation (Tabel et al. 2011) is considered to be feasible for this purpose.

On the other side copper content in steel scrap destined for recycling, is considered an impurity of steel and may affect the portfolio of applications in which secondary steel can be applied (EUROFER 27.10.21).

The full implementation of this scenario would require setting up a maximum copper content in steel scrap[244] (output from shredders/PST) that is sourced from recycling, possibly by means of a European standard, e.g., currently under development is "European standardisation deliverables on Road vehicles – Post-shredding recycling – design-for-recycling guidelines for plastic products" .

For more information, please refer to the information on copper in the current situation chapter and measure description (2.1.2.5.2 and 2.1.5.4.2).

[242] https://www.gov.scot/binaries/content/documents/govscot/publications/progress-report/2013/12/remanufacture-refurbishment-reuse-recycling-vehicles-trends-opportunities/documents/00440543-pdf/00440543-pdf/govscot%3Adocument/00440543.pdf

[243] destined for backfilling/ landfill construction, energy recovery/ incineration or final disposal/landfill sites

[244] More on possible max value under description of measure.

3.1.6.3 Results of qualitative analysis

Scenario **Copper 1** and **Copper 2** are intended to increase the reuse/remanufacturing level of components in ELVs incl. those containing copper. Scenario Copper 1 in a way intends to increase the attention of ATF to component reusability as well as supporting the policy maker in understanding the situation of the market of components, potentially dismantled and reused. On the other hand, scenario Copper 2, includes legally binding obligations for both ATFs and insurance companies, and it is expected that level of dismantling will increase more under scenario Copper 2 than under Copper 1 due to the expected increase in demand for reused parts.

However, implementation of the scenario Copper 2 requires legal adjustments mainly at national level, which may affect its implementability by all Member States. Both scenarios would require development of administrative support in terms of i.e., monitoring/reporting. For dismantled (relatively) pure steel sheets (with no copper contamination), both scenarios are expected to potentially increase the level of high-quality recycling. Where it is not possible to reuse/remanufacture components that have already been dismantled, they can be sent to separate recycling, avoiding shredder process.

Scenario **Copper 3** aims to dismantle copper-bearing components prior shredding. This would require additional step before shredding and will lead to additional costs for ATFs. Dismantling could be done manually or automatically, for parts that are easily accessible. The copper contained in vehicles is about 60% in the cable harness and in engines, e.g., ventilation and heating. As already highlighted before, Cu-contamination in steel scrap, limits the applicability of this scrap.

In addition to increased steel scrap quality, dismantled components might be shifted for reuse/remanufacturing, as well as more copper (or other materials) would be available for (high-quality) recycling.

Scenario **Copper 4** aims to obtain: 1) a higher quantity of metals (ferrous and non-ferrous) for recycling, 2) a high-quality steel scrap for recycling.

Introduction of this provision would require regular checks of the obtained outcomes/residues from shredder. The monitoring under this scenario would require development of a harmonised testing approach. This can be done twofold: either by shredder or by recycler. The testing of the steel scrap samples is less precise as chemical analysis of smelted input material to EAF. However, material put into EAF normally is coming from different sources, what might of challenge to assess the composition of each input material separately (this issue require further investigation).

Reporting on the steel scrap quality would also involve development of a reporting scheme that to submit by facilities (shredders/recycler) the monitoring results to the authority to be responsible for controlling.

There are two possible actions once the results of monitoring are not satisfactory:

1) the authorities could develop local/regional/national strategies to improve the situation, by, e.g., introduction of mandatory disposal of parts that contain copper before shredding (if not implemented yet).
2) modulation on price for steel scrap for recycling.

3.1.6.4 Results of quantitative analysis

The wire harness is one of the larger components with a large share of copper in the vehicle. Engines, which contain copper and in EV its use in it is even double so high as in ICEV, are understood to commonly be removed for reuse, though this also depends on the model. The reuse potential for EV engines may currently be similar to that of combustion engines but is expected to increase as it is often said that service life of an EV engine is significantly longer than that of the vehicle. In future such components could be reused in new vehicles (assumed to be relevant already in 2035 due to expected increase of EV sales).

For the purpose of the impact analysis, the total amount of copper in collected ELVs is considered, however some calculations are done for the wire harness and engines due to high copper content. The scope of the analysis is to consider in the copper analysis also the amount of copper that can be gain thanks to its reduction in steel fraction[245] (Scenario Copper 4). Based on ADEME data from 2017, the average weight of wire harness is 10 kg, with 90% of the composition being copper and the rest plastic. It is assumed that the plastic is not recycled among others due to probably contents of flame retardants.

The following table specifies the rates that have been assumed for each scenario as dismantled, reused, recycled pre- or post-shredder, recovered, or lost; and with which quantitative impacts have been calculated. For instance, a different share is assumed to be dismantled in each scenario. In scenario Copper 3 and 4 the share of components for reuse/remanufacturing is the same, however in scenario Copper 3 and 4 a higher share of dismantled steel is sent to the recycler directly (skipping the shredding process) in contrary to other scenarios. However, higher share is assumed in Scenario Copper 3, thus mandatory removal. It is also assumed that no dismantled parts that contain copper would be send to the shredder. High dismantling is assumed in order to see how the environmental benefits could change when it is required to dismantle more components prior shredding or when Cu-content threshold is put on steel scrap in order to obtain the outputs from shredder/PST facilities in sufficient quality.

Scenario Copper 4 introduces threshold on Cu-content in steel scrap (outcome from shredding), thus additional copper removed from this fraction was calculated. It was assumed that original Cu-content is 0.4 %, which is reduced to 0.1 %. The obtained copper can be recycled, thus its recycled values is calculated and included to the following table and two figures (kg and GWP). The amount of steel scrap is assumed to be the same as in Scenario Steel 4.

Table 3-15 Routes of treatment for copper under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	1%	5%	7%	8%	8%
Dismantled -> recycled (no shredding)	5%	15%	15%	46%	31%
Dismantled -> shredded -> recycled	0%	0%	0%	0%	0%
Shredded -> recycled	60%	49%	47%	21%	30%
Losses/process inefficiencies	34%	31%	30%	25%	26%
Recycled removed copper from steel scrap	0%	0%	0%	0%	5%

Source: Oeko-Institut: own assumptions

[245] Increased amount of copper recycled intend to improve quality of steel scrap and thus its applicability

Based on this description and the shares specified Table 3-15 in the baseline and in each scenario, the amounts that would be reused/remanufactured as well as recycled pre- and post-shredder were calculated (Table 3-16). The total mass of copper in EoL vehicles is assumed to be about 1 66 Mt in 2035.

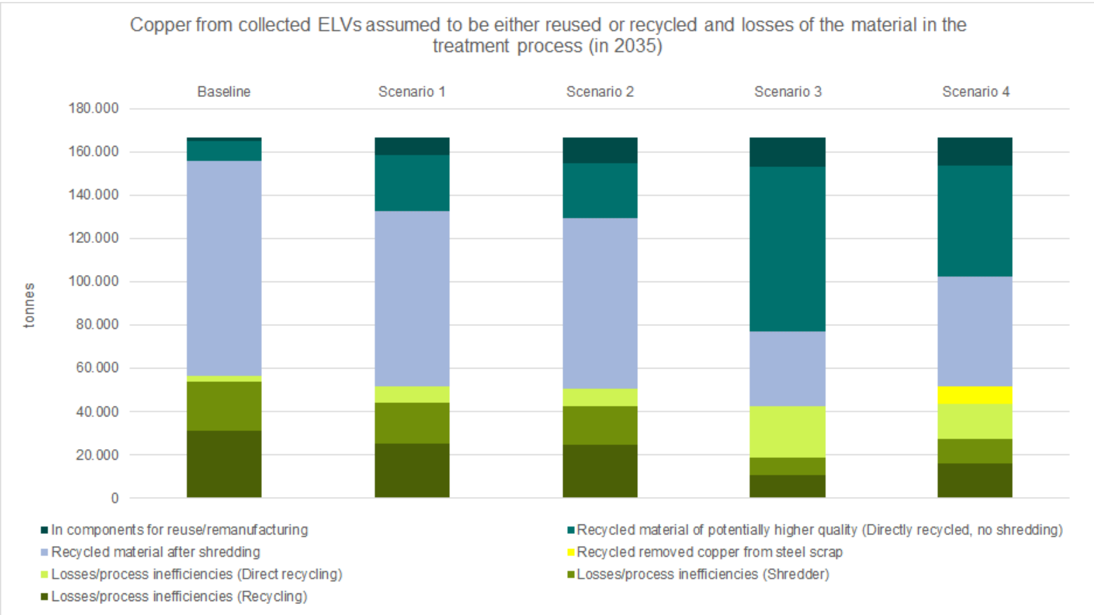
Table 3-16 Tonnes of copper from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035)

Total of the material in EoL vehicles (without battery) [tonnes]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total of the material in EoL vehicles (without battery)	166,700	166,700	166,700	166,700	166,700
In components for reuse/remanufacturing	1,700	8,300	11,700	13,300	13,300
Recycled material of potentially higher quality (Directly recycled, no shredding)	8,900	25,400	25,400	76,300	50,900
Recycled material after shredding	99,400	81,100	78,900	34,600	50,800
Recycled removed copper from steel scrap	0	0	0	0	8,500
Losses/process inefficiencies (Direct recycling)	2,800	7,900	7,900	23,700	15,800
Losses/process inefficiencies (Shredder)	23,000	18,700	18,200	8,000	11,700
Losses/process inefficiencies (Recycling)	30,900	25,200	24,500	10,700	15,800

Table 3-17 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		16,500	16,500	67,400	42,000
Recycled material after shredding		-18,300	-20,500	-64,800	-40,100
TOTAL		**-2,000**	**-4,000**	**3,000**	**2,000**

Figure 3-5 Tonnes of copper from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035) (kg)



Source: Own illustration

3.1.6.4.1 Environmental impacts

Based on this description and the shares specified in Table 3-15, in the baseline and in each scenario, the amounts that would be recycled pre- and post-shredder are calculated. The obtained results are masses of copper multiplied by the respective environmental impacts in terms of Global warming potential (GWP). This is shown below for all copper from collected ELVs in the year 2035 (Table 3-18).

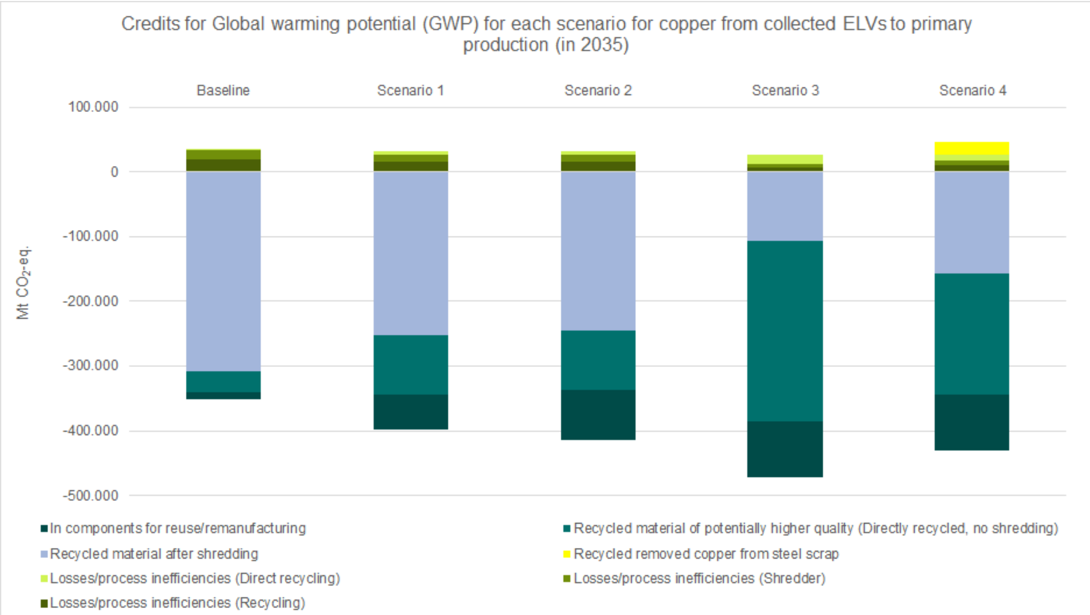
Table 3-18 Credits for Global warming potential (GWP) for each scenario for copper in collected ELVs in 2035 to primary production (Mt CO2eq)

Environmental impact in GWP (without battery) [Mt CO2-eq.] ["-" environmental credits, "+" environmental burdens]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
In components for reuse/remanufacturing	-10,800	-54,200	-75,900	-86,700	-86,700
Recycled material of potentially higher quality (Directly recycled, no shredding)	-32,500	-92,800	-92,800	-278,400	-185,600
Recycled material after shredding	-308,400	-251,500	-244,700	-107,300	-157,600
Recycled removed copper from steel scrap	0	0	0	0	19,100
Losses/process inefficiencies (Direct recycling)	1,700	5,000	5,000	14,900	9,900
Losses/process inefficiencies (Shredder)	14,400	11,800	11,500	5,000	7,400
Losses/process inefficiencies (Recycling)	19,400	15,800	15,400	6,700	9,900
TOTAL	**-316,000**	**-366,000**	**-382,000**	**-446,000**	**-384,000**

Table 3-19 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in Mt CO2-eq. comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		-60,300	-60,300	-245,900	-153,100
Recycled material after shredding (incl. Steel in tyres)		56,900	63,700	201,100	150,800
TOTAL for recycling (excl. reuse and burdens due to losses/process inefficiencies)		-3,400	3,400	-44,800	-2,300
TOTAL of the whole process steps (e.g. reuse, recycling, etc.)		**-50,000**	**-66,000**	**-130,000**	**-68,000**

Figure 3-6 Credits for Global warming potential (GWP) for scenarios for copper in collected ELVs in 2035 to primary production (kg CO_2eq)



Source: Own illustration

The figure above shows an LCA comparison of the recycling route with the shredder route, where it is concluded that the environmental benefits are higher thanks to recycling route avoiding shredder. Less environmental benefits can be gain when the copper is sent to the shredder and recycled afterwards. It is due to the high losses of copper in the shredder process. In the calculations of copper removed from the steel scrap (Scenario Copper 4), it was assumed that original Cu-content in the steel scrap is 0.4 % which is then reduced to 0.1 %[246]. For the removal an additional energy demand of 50 kWh electricity per ton steel scrap is used (Daehn 2019). The energy input requested for sorting is environmental burden, which is higher than credits from removed from steel scrap copper, thus the additional effort is illustrated as environmental burden.

3.1.6.4.2 Economic impacts

Investment costs

Investment costs are considered to arise in each scenario as well as in the baseline. In Scenario **Copper 1** and **Copper 2** are expected to occur bit higher costs than in baseline. Implementation of Scenario **Copper 3** would potentially require investment in dismantling machines and tools by ATFs for removal of mandatory parts. These costs would in similar high also appear in Scenario **Copper 4** together with additional costs for shredder/PST to improve their efficiency in removing copper from steel scrap and metals in the residues from PST. Assuming transition time in introduction of the provision on the quality of outcomes/residues from shredders/PSTs the investments costs would be shifted in time. This additional time would be required for further development of methods for removal of copper, which are in practice under certain conditions and could be expanded or may need to be scaled-up where proven only at laboratory scale (please refer to 2.1.2.5.1, 2.1.2.5.2, and 2.1.5.4.4). The share on the investment costs either for increased dismantling or higher

[246] Calculation was done based on available data, however in Cu-content in steel scrap is in range of 0.2 to 0.7 %.

develop shredder technologies, might differ among MS, since the provision introduced together with Scenario Copper 4 would not prescribe how defined thresholds need to be achieved. Some countries might develop strategy to dismantle more parts that contain copper before shredding and improve hand picking after shredding instead of investing in e.g., sorting machines. This approach might increase labour costs. (Daehn et al. 2017a) illustrates effectiveness (copper concentration achievable) to qualitative energy/cost for various technologies to separate copper (Figure 2-24).

The main stakeholders for EoL automotive sector are ATFs, shredder and PST facilities, recyclers, and garage (repair shops that have no official approval to dismantle ELVs). As it is introduced in several parts of this report (e.g. 2.3.2.3 and 3.2.5), more challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, might require at the end more effort at ATFs. Shredder and PST facilities in practice are always profitable. In the case, of high investments costs or low revenues for sold outcomes of their treatment process, would compensate their costs by decreasing price for input material. In that case, economical effort is put on ATFs, which might not be covered by revenues, and would cause decrease of their profits. This in consequence might lead reduction of the competitiveness of ATFs with the illegal sector.

The operation costs for shredding/PST are not accessible und unclear and, according to (EGARA 2022a), “financial results are… not detailed enough”, and it is not sufficiently clear that PST will actually reach a sufficient quality at lower cost than dismantling. Nevertheless, based on the input from stakeholders during the workshop in March 2022, the facilities operators compensate their costs through the prices they charge from their customers. When steel scrap prices decline, the price that ATFs receive from shredders/recyclers for input material for downstream processes, declines as well. Insofar it might be concluded those shredders (in general) are profitable, since, in the event of their operation cost being comparatively high due to lower revenues, they forward the excess costs up the value chain in the form of lower compensation for the ATFs delivering the ELVs.

Further costs and revenues

Aside from the difference in costs of copper processing from ELVs, a further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the “metal components” arising from depollution and dismantling in Table 1. However, this data is voluntary, and mandatory is only a sum of all depolluted and dismantled materials, incl. “metal components”. Introduction of scenario **Copper 1** (and especially the monitoring aspect) will require adjustment of the reporting format as well as changing the reporting from voluntary to mandatory. This adjustment is assumed to result in additional economical costs for public administration as well as for ATF that report on removed parts/components (see Table 3-61 on economic impacts of measures addressing the treatment of vehicles at EoL).

These additional costs will be related to the additional time for collecting all data for ATFs thus more cells to fill in, as precise reporting of the total weight of reused parts/components is to be required for each component in the reporting table. Optimally, if ATFs would also report on the material composition of the dismantled parts/components, but this would require more thorough information for the producers, e.g., in IDIS. More time will also be needed for the institution that collects, summarises, and validates data before its official publication. It is assumed that the expected additional administrative cost of reporting would be similar significantly higher for scenario **Copper 2** in comparison to Copper 1. In some cases repair shops (including ATFs) already apply reused parts, anyway the obligation under Copper 2 would lead to an increase in such activities. Further costs under this scenario are related to implementation of enforcement against illegal sales of reused components, thus MS would need to inspect online sale platforms to ensure no illegal activities.

Copper 3 considers mandatory dismantling, what can affect investment costs (introduced above under investment costs) but also labour costs. The average costs of labour work as well as the number of dismantled parts/components ahead shredding differ among MS, thus the possible increase of additional costs for MS might differ, while introducing mandatory dismantling. Administrative costs for reporting on dismantled parts are assumed to be higher than in Scenario Copper 1 despite already existing scheme on reporting. It is assumed that for ATFs it would be an additional effort due to higher number of dismantled parts/components as well as due to need to provide more data on weight and kind of dismantled parts/components. In case when Scenario Copper 1 and Copper 3 would be implemented together, the administrative costs for reporting would not sum up[247], because while reporting on dismantled part/components, ATFs would highlight for which purpose it is dismantled (reuse/remanufacturing, recycling). However, the level on detail on reporting on dismantled parts would increase.

Additional costs will also exist due to requirement on reporting on the quality of shredders/PSTs deliverables (scenario **Copper 4**). These costs will appear for facilities' operators (shredder or/and recycler depending on the agreed measurement point) as well as for public authorities, however it is expected that these costs will be higher for facilities. As described above, public offices will need to collect data, validate it, and assess the situation (locally, regionally, or nationally) and to eventually establish an improvement strategy when it is necessary. The administrative costs related to the copper scenarios are highlighted in the Table 3-61 presenting the analysis of measures addressing the treatment of vehicles on EoL.

Figure below shows possible high of revenues for copper scrap for analysed scenarios (2035) and status-quo (2020). These values do not consider revenues for dismantled components for reuse/remanufacturing as well as costs for this process.

Table 3-20 Revenues for copper scrap of potentially higher quality and obtained after shredding in mln Euro. Below also a change in mln Euro of these revenues comparing to the baseline.

Total of the revenues for recycled material [mln Euro]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)	56	160	160	480	320
Recycled material after shredding (incl. Steel in tyres)	625	510	496	217	373
TOTAL	**681**	**670**	**656**	**697**	**693**

Table 3-21 Change in mln Euro of these revenues comparing to the baseline ["-" decrease, "+" increase]

Change in mln Euro of revenues comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		104	104	424	264
Recycled material after shredding (incl. Steel in tyres)		-115	-129	-408	-252
TOTAL		**-11**	**-25**	**16**	**12**

Source: own calculations

[247] Relevant for components for reuse/remanufacturing arise on the list for monitoring.

The price does not consider the copper scrap quality, which might be higher due to dismantling of some parts and sending them directly to recycler (no shredding). For the price current prices were taken. Lowest raw represents a total and percentage of revenue's decrease/increase in each scenario 1 to 4 in comparison to baseline (decrease in revenue is due to, e.g., higher reuse/remanufacturing or direct recycling of components dismantled by ATFs).

Detail assumptions for the ATF costs are introduced in chapter for steel. They based on removal of engines including dismantling and deep dismantling. In copper scenario only deep-dismantling of removed engines are assumed. In order to avoid double counting, the 33 % of time (and costs) of this process is allocated to copper scenario. In addition, for copper scenario, time required for dismantling of cables is also considered. The percentage of removed cables remain the same for baseline and scenarios 1 and 2 (10 %). It increases to 100 % in Scenarios 3 and 4. The average cost per hour is 51 Euros (base on the information from EGARA).

Following table show the total costs in million Euro for baseline and additional dismantling costs (as compared to the baseline, also in million Euro)

Table 3-22 Total costs for baseline and additional dismantling costs (as compared to the baseline) in million Euro

	Total costs, in million Euro	Additional dismantling costs (as compared to the baseline, in million Euro)			
Material	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Copper	9	0	0	104	98

3.1.6.4.3 Social impacts

Figure 2-14 illustrates amounts of copper send directly to recycling and amount of copper in reused/remanufactured components and their increases in scenario 1 to 4 in comparison to the baseline scenario. Increase in reuse/remanufacturing and dismantling would potentially increase the dismantling cost, incl. need for more employee to remove[248] more parts/components from the ELVs.

Based on one example the possible social impact is calculated. Calculations are based to the assumptions done to assume economical costs for ATFs (previous sub-chapter). The following tables shows the number of additional job positions in the ATFs as compared to the baseline.

Table 3-23 Number of additional job positions in the ATFs as compared to the baseline

	Additional positions (number) as compared to the baseline			
Material	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Steel	0	0	1,196	1,196

However, it is needed to mention that this analysis does not consider the development of new technologies or a wider application of existing automatic technics to dismantling wires, which on one hand would increase the investment costs but on the other decrease the dismantling time and potentially decrease the number of employees required for dismantling of wires so in consequence decrease the level of salaries. As soon as it will be possible to dismantle components by machine, it is to expect that number of employees will reduce.

[248] Especially for these parts/components, which cannot be removed by machines and in MS where labour costs are still not so high.

Additionally, more employees will be needed for the operation of new machines in shredder/PST and additional employees for hand picking/sorting in shredder facility. In Europe there are about 300 shredders/PST. It is expected that relevant investments would do done by facilities from middle up to big size, thus not in all existing facilities. There is no precise data on shredder/PST and also on the fact if shredder have a PST in house, therefore rough assumptions are done: 60% of existing plants are middle or bigger size, for the new technological solutions there will be need for 2 employees that could operate new machines. It would mean that for Scenario Copper 4 (for which bigger investments are planned) would be required to hire additional 360 employees.

3.1.6.5 Comparison of scenarios for copper

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-24 below to allow an easier comparison. The scope of the analysis is EoL of copper from collected ELVs, however some of the outcomes either overlap with the outcomes of the analysis of other materials or are representative for other material(s) as well. Thus, the finding listed below should not be sum up with other summarising tables for the separately analysed materials. The overall analysis on the collected ELV level is performed in section 3.1.11.

Table 3-24 Summarising table for the comparison of the copper scenarios (the assessed impacts are based on the total of ELVs collected in 2035)

Impacts		Scenario Copper 1	Scenario Copper 2	Scenario Copper 3	Scenario Copper 4
Economic	on ATFs	0 € costs due to additional dismantling[249] (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+104 mln €) - / +	0 € costs due to additional dismantling[249] (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+104 mln €) -- / +	104 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+424 mln €) --- / +++	98 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+264 mln €) -- / ++
	on shredders	Loss of shredding material (loss of revenue) Decrease in revenues for copper scrap (-115 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for copper scrap (-129 mln €) -	Loss of shredding material (loss of revenue) Significant decrease in revenues for copper scrap (-408 mln €) --	Loss of shredding material (loss of revenue) Additional investment costs in separation technologies and hand picking Increase of secondary copper

[249] Value represents the additional costs for manual dismantling (labour costs), there might occur also additional investment costs in the machines for automatic dismantling (especially relevant for scenario Steel 3 and 4).

Impacts		Scenario Copper 1	Scenario Copper 2	Scenario Copper 3	Scenario Copper 4
					However, still decrease in revenues for copper scrap (-252 mln €) ---
	on recyclers	Small decrease in business, due to loss of copper scrap (-11 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of copper scrap (-25 mln €) However, increase in higher quality material (dismantled prior shredding) +	Slightly increase in business, due to increase of copper scrap (+16 mln €) However, increase in higher quality material (dismantled prior shredding) +	Slightly increase in business, due to increase of copper scrap (+12 mln €) However, huge increase in higher quality material (dismantled prior shredding), thus potentially lower processing costs to obtain steel of high quality ++
	on SME	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities.			
	Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal			
	Administrative costs burden	Moderate increase in administrative burden for reporting for regulators and waste management --	Moderate increase in administrative burden for reporting for regulators and waste management --	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---
	2ndary resources	Slightly decrease in availability of secondary copper (-11 mln €) due to increase in reuse -	Decrease in availability of secondary copper (-25 mln €) due to increase in reuse -	Increase in availability of secondary copper (+16 mln €) thanks to higher dismantling +	Increase in availability of secondary copper (+12 mln €) thanks to better sorting ++
Environ mental	Environmental impacts: LCA credits for reuse/rem. and recycling[250]	Increase in credits: ~50 Mt CO_2-eq. +	Increase in credits: ~66 Mt CO_2-eq. ++	Increase in credits: ~130 Mt CO_2-eq. ++	Increase in credits: ~68 Mt CO_2-eq. ++
Social	Employment[251]	Increase in jobs in ATF (0) +	Increase in jobs in ATF (0) ++	Increase in jobs in ATF (~1,196) +++	Increase in jobs in ATF (~1,196)

[250] As a difference to the baseline scenario

[251] Increase in comparison to baseline scenario. The calculations done based on dismantling time of engine/gearbox, so the values presented here in reality might be even higher while considering more parts/components for dismantling.

Impacts		Scenario Copper 1	Scenario Copper 2	Scenario Copper 3	Scenario Copper 4
					Increase in jobs in shredder facilities (~360) ++
	Proportionality	All scenarios are considered proportional for achieving the objectives that the EU Treaties intends to implement			
	Cost effectiveness	Low costs but low benefits +	Similar effectiveness to scenario 1 in GWP and amount of recycled copper, while lower costs. However, the quality of recycled material is lower. ++	Higher costs than scenario 2 thus higher amount of secondary copper as scenario 2. However, the quantity of high-quality recycled copper is the highest among all scenarios. Highest effectiveness in GWP. Highest revenue for ATFs. +++	Very high costs in comparison to scenario 2 and 3. However, the quality of recycled copper is higher. More secondary copper in comparison to other scenarios. Highest revenue for shredders. +++
	Coherence	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting maximal recycling. ++	Coherence with waste legislation and the CEAP, promoting maximal high-quality recycling. +++

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g., ++ to +++ or – to +

n.a.: not applicable

Please see EPR section in analysis at EEC level in section 3.1.10.1.4 for possible costs of dismantling EEC containing copper and in section 3.1.12 on possible costs of PST at vehicle level.

3.1.7 Analysis for aluminium

3.1.7.1 Qualitative analysis for aluminium

Measures were shortlisted for aluminium including the following measures:

Title	Chapter
2.3.e) Establish provisions to support the market of used spare parts composed of aluminium	2.1.5.3.5
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing of aluminium components	2.1.5.3.6
2.4.b) Making it mandatory to remove certain copper parts before shredding to encourage high quality steel/aluminium and high quantity copper recycling as well as mandatory removal of selected parts/components that contain aluminium	2.1.5.4.2
2.4.c) Set material-specific recycling targets for aluminium	2.1.5.4.3
2.4.d) Regulate shredder/post shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process	2.1.5.4.4

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

Monitoring of components for reuse/remanufacturing is a supporting measure (2.3.f) that will need to accompany provisions designed to increase the demand of components for reuse/remanufacturing (2.3.e) that contain aluminium, e.g., bumper carrier frames, engines.

A mandatory removal of certain aluminium components aims to limit ‘poor quality’ material recovery operations through removing components with high contents of aluminium from vehicles and sending them to separate recycling. The aluminium fraction dismantled prior to shredding is a pre-condition to recycling of wrought aluminium separately from cast aluminium. Treatment of aluminium components together with the rest of the hulk in the shredder limits their recycling into cast aluminium only (European Aluminium 2022). In addition, the value of secondary aluminium is linked to the prices for primary aluminium and depends on its quality and can go as high as the value of primary aluminium itself.

Regulation of shredder/post-shredder facilities and especially the standardisation of outputs from these facilities, could lead to the improvement of existing technologies or promote the dismantling of relevant aluminium components prior to shredding.

Setting a separate recycling target for (wrought and cast) aluminium would also aim at gaining high quality aluminium. However, reporting on reuse and recycling/recovery targets would create significant administrative burden. The most challenging would be obtaining the weight of the specific materials (in this case wrought and cast aluminium) in the components for reuse/remanufacturing. Additionally, tracking of materials from the ELVs in the shredder process is hampered since ELVs that are processed in these facilities often are mixed with other items. Setting only the material-specific recycling target (excluding the components for reuse/remanufacturing from it) would act contra-productive for promoting reuse/remanufacturing. Also identifying a meaningful level of these targets would be extremely challenging. Hence, a separate target for copper is discarded at this stage but could be reconsidered in the future if the implementation of other measures does not lead to a sufficient improvement in circularity.

3.1.7.2 Scenarios for quantitative analysis

3.1.7.2.1 Baseline Aluminium

EU wide the commonly applied methods to treat aluminium from ELVs, similarly to steel, are shredder operations, usually combined with some type of post-shredder treatment operations. Recycling results in a fraction (termed zorba), which has a high Al content but is also rich in impurities as it is a mix of different alloys. It can be applied in higher amounts in alloys which are more susceptible to impurities (e.g., casting alloys) but not in alloys where a high purity is required (e.g., wrought alloys). However, for some car parts the recycling practice might differ. According to (European Aluminium 2022) currently ICE engines are often dismantled before the shredding process and are directly sold either for reuse or to aluminium recyclers without further pre-treatment. Aluminium engines are thus often not shredded. The same happens to wheels that are dismantled together with tyres before shredding. The aluminium wheels are directly sold to aluminium recyclers without further pre-treatment. Thus, aluminium wheels are not shredded. The findings of (IRT M2P 2021) show that dismantling of aluminium components from ELVs is profitable only for heavy components (more than 10 kg) and performed within only a few minutes of dismantling. Otherwise, the labour and specific investment costs will exceed the possible revenue from selling of removed components.

Technologies to separate aluminium from other fractions are commonly applied to treat post-consumer scrap. However, technologies to separate different aluminium alloys from each other in post-consumer scrap are not applied at the moment. According to (European Aluminium 2022) a lot of research and testing is ongoing to improve the speed of such technologies and the reliability. These types of technologies however are very expensive for now, thus funding is a key point to have more widespread use of post-shredding technologies and quality control instruments that will contribute to improve the quality of the aluminium fraction.

On this basis, it is assumed that under the baseline, aluminium shall continue to be treated mainly in shredder/PST, with the chance that the quality of obtained deliverables will improve together with development of new technologies. Dismantling of specific components for recycling potentially might increase, however, similarly to treatment in shredder/PST, the economic viability may be questionable. As said above, its profitability may depend on additional financing.

3.1.7.2.2 Scenario Aluminium 1: Monitoring of components composed of aluminium for reuse/remanufacturing

Under this scenario the monitoring of components composed of steel for reuse/remanufacturing shall be introduced. For this purpose, a list of components recommended for reuse/remanufacturing (Annex to ELVD) would be defined. A preliminary list prepared in this report contains also elements made of aluminium, e.g., engines, bumpers carrier frames. This list should be revised from time to time to consider current market situation of components for reuse and for remanufacturing.

This scenario also considers implementation of harmonised monitoring of components removed for reuse/remanufacturing to understand the actual volume of them in different MS and will enable the comparability of monitoring data. Obtained information will allow a better understanding of the potential for reuse and how it is influenced by measures that affect market demand. It will also help in the future in the revision of the list of removed spare parts as well as to potentially set out the targets. The reporting obligation would be limited to the components listed in the Annex to ELVD ("list of components recommended for reuse/remanufacturing"). However, separate reporting on other components sold for reuse/remanufacturing is proposed to be voluntary at this stage as it could create a burden for ATFs if it cannot be linked to an existing list of sales.

3.1.7.2.3 Scenario Aluminium 2: Market support of used spare parts composed of aluminium

Under this scenario the market demand for spare parts should be regulated by requiring car repair shops to provide customers with an offer to repair a vehicle with used/remanufactured components alongside offers for repair with new components. Insurance companies will also be obliged to offer car owners discounted policies if they agree that repairs are performed with reused/remanufactured parts when these are available. Furthermore, a ban of the online sales of illegally operating facilities would be introduced.

Use of spare parts is market driven, thus increasing demand is assumed to provide more flexibility to ATFs to decide on components to be dismantled as opposed to measures for increasing supply which could result in a high burden for storage without significant impact on the actual reuse/remanufacturing of components. Obligations for insurance companies may only be implementable through national legislation. Strengthening the market demand for reused components will increase the profitability of dismantling relevant components. Provisions on online sales will reduce sales of used components from illegally operating facilities, increasing profitability of legally operating ones. Again, these provisions may only be implementable through national legislation.

Scenario Aluminium 3: Mandatory removal of certain copper parts before shredding to encourage high quality steel/aluminium recycling and high quantity copper recycling as well as mandatory removal of selected parts/components that contain aluminium

A dismantling obligation for aluminium-bearing components is already provided by the ELVD, but only if the copper is not segregated in the shredding process.

For aluminium it can be understood that recycling results in a fraction (termed zorba) which has a high Al content but is also rich in impurities as it is a mix of different alloys. It can be applied in higher amounts in alloys which are more susceptible to impurities (e.g., used for casting). However, to enable use in alloys with higher quality specifications, dismantling would need to be improved: aluminium parts would need to be sorted prior to shredding for example into cast alloy parts and wrought alloy parts. Eurometaux (Eurometaux 21 Feb 2021) mentions bumpers, doors, the engine block as parts of relevance for removal prior to shredding. This statement is in line with the Circular Aluminium Action Plan[252].

More about legitimacy of aluminium dismantling is detailed in section 2.1.2.5.3 on "Current situation: aluminium".

Copper content in shredder/PST deliverables is considered an impurity also for fractions rich in aluminium. Similar to steel, Eurometaux state that the dismantling of components with copper prior to shredding would allow secondary aluminium of higher purity. Benefits of copper removal related to EEC from the aluminium/steel fraction are mentioned shortly under the EEC chapter (see section 3.1.10).

[252] engines, heat exchangers, doors, bonnets, fenders, bumpers and gearboxes

3.1.7.2.4 Scenario Aluminium 4: Regulate shredder/post-shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process

The intention of this scenario is to ensure high recovery of metals from the shredder/PST residues. It aims also to obtain high-quality recycling output from these treatment plants. To obtain the goal, a legally binding maximum metal content for shredder residues[253] should be set up at ambitious level in order to recover as many metals as possible as secondary raw materials and should be oriented at the best available technical practices. The removal of metal from the shredder light fraction at least to below 1 % metal content by means of post-shredder separation (Tabel et al. 2011) is considered to be feasible for this purpose.

On the other side copper content in shredder/PST deliverables is considered an impurity also for fraction rich in aluminium. Similar to steel, Eurometaux state that the dismantling of components with copper prior to shredding would allow secondary aluminium of higher purity. Benefits of copper removal related to EEC from the aluminium/steel fraction are mentioned shortly under the EEC chapter (see section 3.1.10).

The full implementation of this scenario would require setting up a maximum copper content in steel scrap[254] (output from shredders/PST) that is sourced from recycling, possibly by means of a European standard, e.g., currently under development is “European standardisation deliverables on Road vehicles – Post-shredding recycling – design-for-recycling guidelines for plastic products”[255].

For more information, please refer to the information on copper in the current situation chapter and measure description (2.1.2.5.2 and 2.1.5.4.2).

3.1.7.3 Results of quantitative analysis

Through scenario **Aluminium 1** and **Aluminium 2** it is intended to increase the reuse/remanufacturing level of components in ELVs incl. those containing aluminium. Aluminium 1 in a way intends to increase the attention of ATF to components reusability as well as support the policy makers in understanding the market situation of components with a potential for reuse, their dismantling and reusability. On the other hand, scenario Aluminium 2, includes legally binding obligations for ATFs and insurance companies, thus, it is expected that the level of dismantling would be higher in scenario Aluminium 2 than in Aluminium 1.

However, implementation of the scenario Aluminium 2 requires legal adjustments mainly at the national level, which may affect their implementability by all Member States. Both scenarios would require development of administrative support in terms of i.e., monitoring/reporting. Where it is not possible to reuse/remanufacture components already dismantled, they can be sent to separate recycling avoiding shredder process.

Scenario **Aluminium 3** aims to dismantle copper- and aluminium-bearing components prior shredding. This would require additional step before shredding and will lead to additional

[253] destined for backfilling/ landfill construction, energy recovery/ incineration or final disposal/landfill sites

[254] More on possible max value under description of measure.

[255] file:///C:/Users/I65A1~1.KOS/AppData/Local/Temp/Draft%20standardisation%20request%20as%20regards%20medical%20devices%20and%20in%20vitro%20diagnostic%20medical%20devices.pdf

costs for ATFs. Dismantling could be done manually or automatically, for parts that are easily accessible.

Aluminium parts would need to be sorted prior to shredding for example into cast alloy parts and wrought alloy parts. Due to mandatory dismantle of parts containing copper, aluminium scrap should be of higher purity additionally. Dismantled components might be shifted for reuse/remanufacturing, as well as more secondary material would be available for (high-quality) recycling.

Scenario **Aluminium 4** aims to obtain: 1) a higher quantity of metals (ferrous and non-ferrous) for recycling, 2) a high-quality steel and aluminium scrap for recycling.

Introduction of this provision would require regular checks of the obtained outcomes/residues from shredder. The monitoring under this scenario would require development of a harmonised testing approach. This can be done twofold: either by shredder or by recycler. The testing of the steel scrap samples is less precise as chemical analysis of smelted input material to EAF. However, material put into EAF normally is coming from different sources, what might of challenge to assess the composition of each input material separately (this issue require further investigation).

Reporting on the aluminium scrap quality would also involve development of a reporting scheme that to submit by facilities (shredders/recycler) the monitoring results to the authority to be responsible for controlling.

There are two possible actions once the results of monitoring are not satisfactory:

1) the authorities could develop local/regional/national strategies to improve the situation, by, e.g., introduction of mandatory disposal of parts that contain copper before shredding (if not implemented yet).

2) modulation on price for steel scrap for recycling.

3.1.7.4 Results of quantitative analysis

For the purpose of analysis, the total aluminium from collected ELVs in 2035 was considered. In all scenarios, it is assumed that some part[256] of aluminium treated in the shredder remains in the[257] steel fraction.

A different share is assumed to be dismantled in each scenario. In Scenario Aluminium 1 and 2 the share for reuse/remanufacturing is lower in comparison to Scenario Aluminium 3 and 4. In the Scenario Aluminium 3 high shares of dismantled aluminium components are sent to the recycler directly (skipping shredding process).

The following table specifies the rates that have been assumed for each scenario as dismantled, reused, recycled pre- or post-shredder, recovered, or lost; and with which quantitative impacts have been calculated.

[256] In the model it is assumed that 50% of calculated material losses in EoL remains in the steel scrap. The other 50% is disposed. More detail about model in Annex I.

[257] This aluminium in the steel fraction has a value since it can act as a reducing agent in steel recycling. Aluminium is then used to produce alloys of iron. For aluminium that ends up in the steel recycling, a corresponding credit for saved coke is applied in the model.

Table 3-25 Routes of treatment for aluminium under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	10%	14%	15%	18%	18%
Dismantled -> recycled (no shredding)	1%	3%	4%	22%	9%
Dismantled -> shredded -> recycled	2%	4%	4%	8%	10%
Shredded -> recycled	69%	61%	60%	33%	45%
Part diverted to steel scrap (energy recovery)	9%	8%	8%	6%	7%
Losses/process inefficiencies	9%	8%	8%	6%	7%

Source: Oeko-Institut: own assumptions

Based on this description and the shares specified in Table 3-26, in the baseline and in each scenario, the amounts that would be reused/remanufactured as well as recycled pre- and post-shredder were calculated (Figure 3-7). The total mass of aluminium in EoL vehicles is assumed to be about 1,240 Mt in 2035.

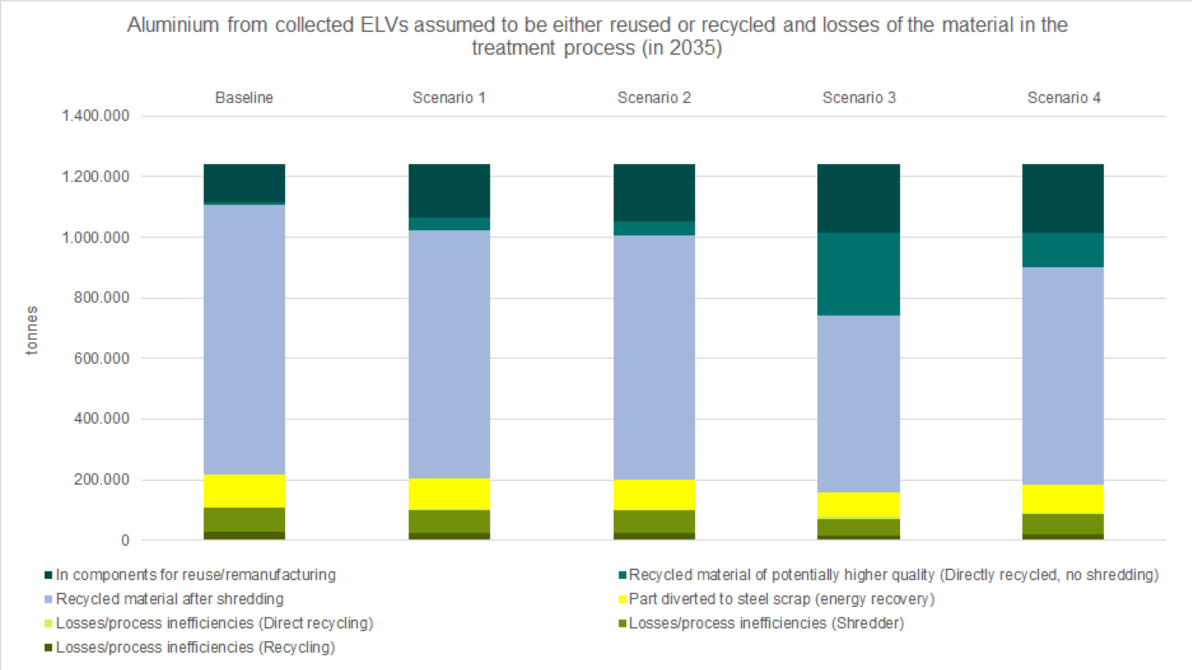
Table 3-26 Tonnes of aluminium from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035)

Total of the material in EoL vehicles (without battery) [tonnes]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Total of the material in EoL vehicles (without battery)	1,240,100	1,240,100	1,240,100	1,240,100	1,240,100
In components for reuse/remanufacturing	124,000	173,600	186,000	223,200	223,200
Recycled material of potentially higher quality (Directly recycled, no shredding)	9,200	41,300	45,800	275,100	114,600
Recycled material after shredding	888,700	821,600	807,700	583,000	719,400
Part diverted to steel scrap (energy recovery)	109,100	101,800	100,300	79,400	91,400
Losses/process inefficiencies (Direct recycling)	300	1,200	1,300	8,000	3,300
Losses/process inefficiencies (Shredder)	83,000	76,700	75,400	54,400	67,200
Losses/process inefficiencies (Recycling)	25,900	23,900	23,500	17,000	20,900

Table 3-27 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		32,100	36,600	265,900	105,400
Recycled material after shredding		-67,100	-81,000	-305,700	-169,300
TOTAL		**-35,000**	**-44,400**	**-39,800**	**-63,900**

Figure 3-7 Tonnes of aluminium from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035) (kg)



Source: Own illustration

3.1.7.4.1 Environmental impacts

Based on this description and the shares specified in Table 3-26, in the baseline and in each scenario, the amounts that would be reused/remanufactured as well as recycled pre- and post-shredder are calculated. The obtained results are masses of aluminium multiplied by the respective environmental impacts in terms of global warming potential. This is shown below for all bumper carrier frames made of aluminium from ELVs collected in the year 2035 (Figure 3-8).

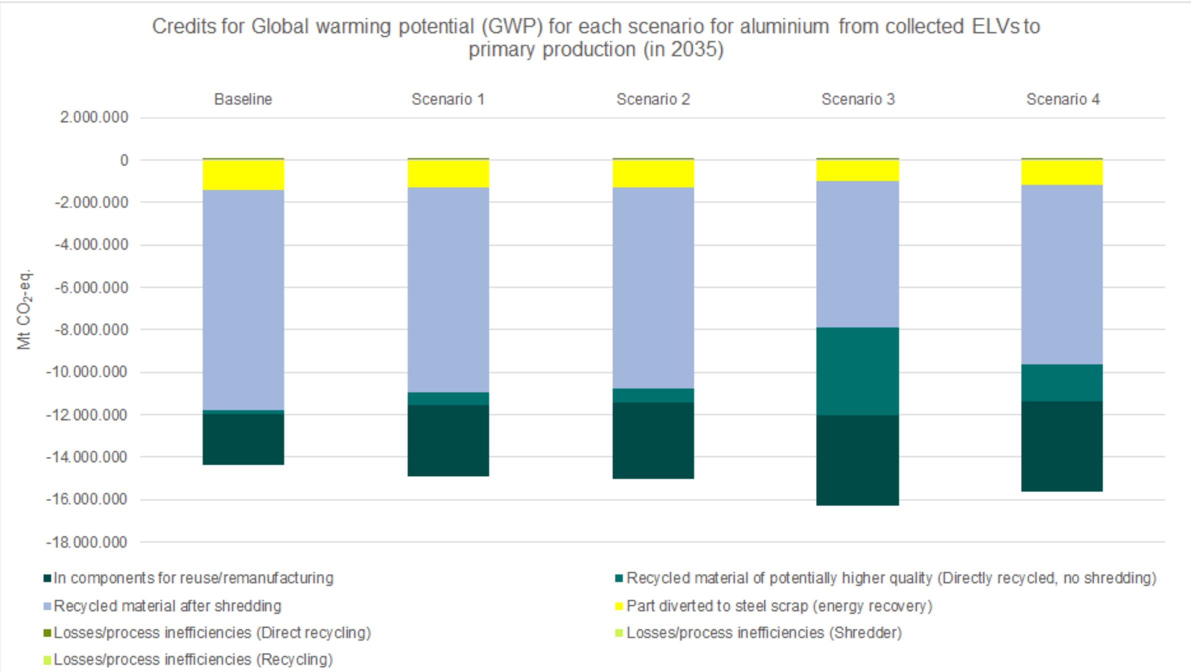
Table 3-28 Credits for Global warming potential (GWP) for each scenario for aluminium in collected ELVs in 2035 to primary production (Mt CO2eq)

Environmental impact in GWP (without battery) [Mt CO2-eq.] ["-" environmental credits, "+" environmental burdens]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
In components for reuse/remanufacturing	-2,389,200	-3,344,800	-3,583,700	-4,300,500	-4,300,500
Recycled material of potentially higher quality (Directly recycled, no shredding)	-138,600	-623,500	-692,800	-4,156,700	-1,732,000
Recycled material after shredding	-10,435,700	-9,647,500	-9,484,800	-6,845,900	-8,447,500
Part diverted to steel scrap (energy recovery)	-1,375,200	-1,284,100	-1,264,500	-1,006,500	-1,154,800
Losses/process inefficiencies (Direct recycling)	200	800	800	5,000	2,100
Losses/process inefficiencies (Shredder)	52,100	48,200	47,400	34,200	42,200
Losses/process inefficiencies (Recycling)	16,200	15,000	14,800	10,700	13,100
TOTAL	**-14,270,000**	**-14,836,000**	**-14,963,000**	**-16,260,000**	**-15,577,000**

Table 3-29 Change in tonnes of materials for recycling comparing to the baseline ["-" decrease, "+" increase] (in 2035)

Change in Mt CO2-eq. comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		-484,900	-554,200	-4,018,100	-1,593,400
Recycled material after shredding (incl. Steel in tyres)		788,200	950,900	3,589,800	1,988,200
TOTAL for recycling (excl. reuse and burdens due to losses/process inefficiencies)		**303,300**	**396,700**	**-428,300**	**394,800**
TOTAL of the whole process steps (e.g. reuse, recycling, etc.)		**-566,000**	**-693,000**	**-1,990,000**	**-1,307,000**

Figure 3-8 Credits for Global warming potential (GWP) for scenarios for aluminium in collected ELVs in 2035 compared to primary production (kg CO_2eq)

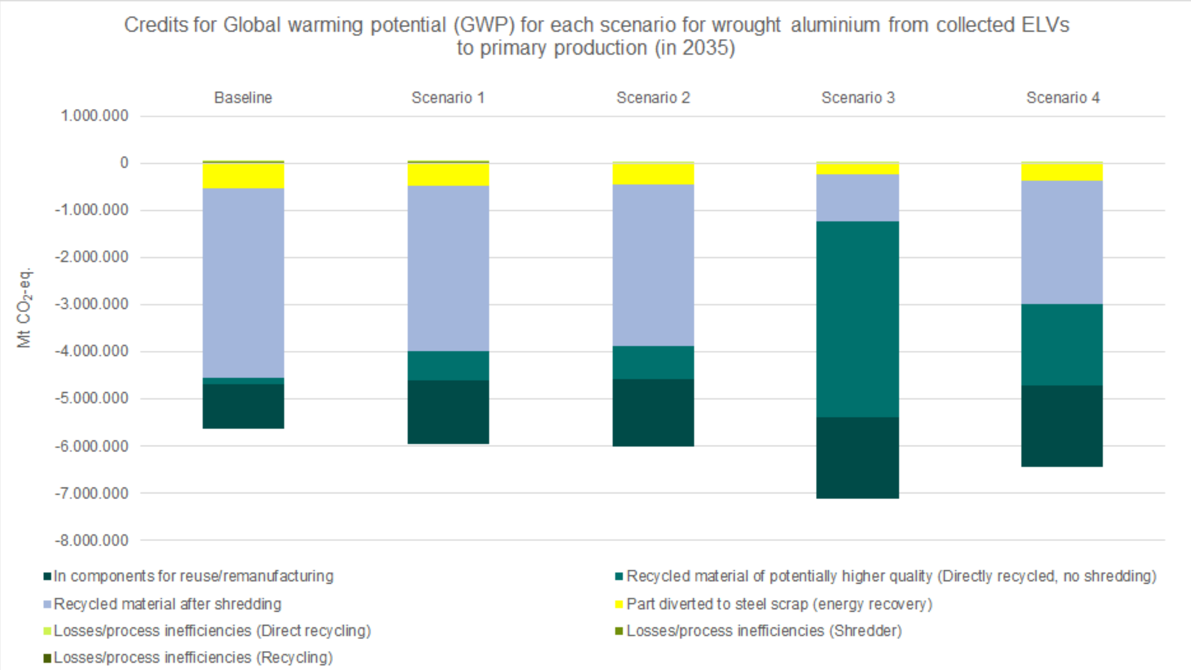


Source: Own illustration

The figure above shows an LCA comparison of the dismantling and recycling route with the shredder route where it is concluded that the shredder and recycling route have major environmental impacts, while dismantling has a minor environmental impact. Although, larger environmental benefits can be seen for dismantled aluminium parts sent to recycling avoiding the shredding process (Scenario Aluminium 3 that assume mandatory dismantling).

The following figures illustrate GWP for wrought aluminium and cast aluminium separately. For the calculation the separate route of treatment for each aluminium type was assumed (Table 3-36 and Table 3-37)[258]. GWP for Scenario Wrought Aluminium 3 (Figure 3-9) visualises rank of dismantling of wrought aluminium and its recycling prior shredding.

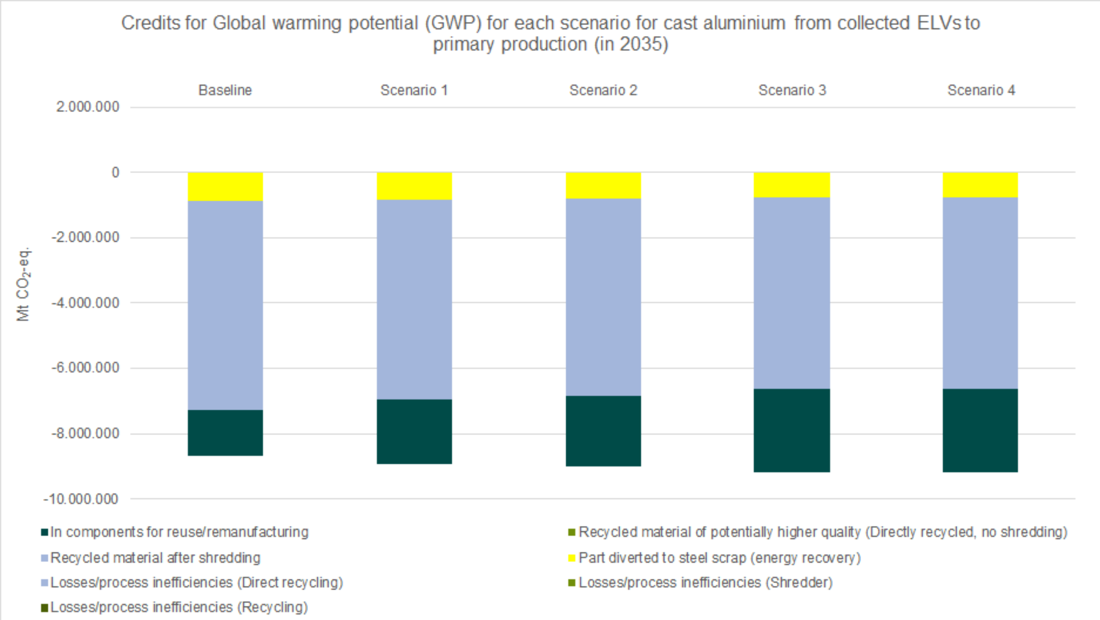
Figure 3-9 Credits for Global warming potential (GWP) for scenarios for wrought aluminium in collected ELVs in 2035 compared to primary production (kg CO2eq)



Source: Own illustration

[258] Based on this estimation the route of treatment of overall aluminium was calculated.

Figure 3-10 Credits for Global warming potential (GWP) for scenarios for cast aluminium in collected ELVs in 2035 compared to primary production (kg CO2eq)



Source: Own illustration

Table 3-30 Routes of treatment for wrought aluminium under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	10%	14%	15%	18%	18%
Dismantled -> recycled (no shredding)	2%	9%	9%	57%	24%
Dismantled -> shredded -> recycled	1%	1%	1%	1%	1%
Shredded -> recycled	70%	61%	59%	17%	45%
Part diverted to steel scrap (energy recovery)	9%	8%	8%	4%	6%
Losses/process inefficiencies	9%	8%	8%	4%	6%

Source: Oeko-Institut: own assumptions

Table 3-31 Routes of treatment for cast aluminium under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	10%	14%	15%	18%	18%
Dismantled -> recycled (no shredding)	0%	0%	0%	0%	0%
Dismantled -> shredded -> recycled	3%	7%	8%	16%	20%
Shredded -> recycled	69%	62%	60%	50%	46%
Part diverted to steel scrap (energy recovery)	9%	8%	8%	8%	8%
Losses/process inefficiencies	9%	8%	8%	8%	8%

Source: Oeko-Institut: own assumptions

3.1.7.4.2 Economic impacts

Investment costs

Investment costs are considered to arise in each scenario as well as in the baseline. In Scenario **Aluminium 1** and **Aluminium 2** are expected to occur bit higher costs than in baseline. Implementation of Scenario **Aluminium 3** would potentially require investment in dismantling machines and tools by ATFs for removal of mandatory parts. These costs would in similar high also appear in Scenario **Aluminium 4** together with additional costs for shredder/PST to improve their efficiency in removing copper from steel/aluminium scrap and metals in the residues from PST. Assuming transition time in introduction of the provision on the quality of outcomes/residues from shredders/PSTs the investments costs would be shifted in time. This additional time would be required for further development of methods for removal of copper, which are in practice under certain conditions and could be expanded or need to be scale-up since are proven only at laboratory scale (please refer to 2.1.2.5.1, 2.1.2.5.2, and 2.1.5.4.4). The share on the investment costs either for increased dismantling or higher develop shredder technologies, might differ among MS, since the provision introduced together with Scenario Aluminium 4 would not prescribe how defined thresholds need to be achieved. Some countries might develop strategy to dismantle more parts that contain copper before shredding and improve hand picking after shredding instead of investing in e.g., sorting machines. This approach might increase labour costs. (Daehn et al. 2017a) illustrates effectiveness (copper concentration achievable) to qualitative energy/cost for various technologies to separate copper (Figure 2-24).

The main stakeholder of EoL automotive sector are ATFs, shredder and PST facilities, recyclers, and garage (repair shops that have no official approval to dismantle ELVs). As it is introduced in several parts of this report (e.g. 2.3.2.3 and 3.2.5), more challenging regulations in the context of the Circular Economy, aiming for a higher quality recycling, might require at the end more effort at ATFs. Shredder and PST facilities in practice are always profitable that in case of high investments costs or low revenues for sold outcomes of their treatment process, would compensate their costs by decreasing price for input material. In that case, economical effort is put on ATFs, which might not be covered by revenues, and would cause decrease of their profits. This in consequence might lead to a reduction of the competitiveness of ATFs with the illegal sector.

The operation costs for shredding/PST are not accessible und unclear and, according to (EGARA 2022a), “financial results are… not detailed enough”, and it is not sufficiently clear that PST will actually reach a sufficient quality at lower cost than dismantling.

Further costs and revenues

Aside from the difference in costs of aluminium processing from ELVs, a further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the “metal components” arising from depollution and dismantling in Table 1. However, this data is voluntary and mandator is only a sum of all depolluted and dismantled materials, incl. “metal components”. Introduction of scenario **Aluminium 1** (and especially the monitoring aspect) will require adjustment of the reporting format as well as changing the reporting from voluntary to mandatory. This adjustment is assumed to result in additional economical costs for public administration as well as for ATF that report on removed parts/components (please refer to the Table 3-61, presenting these costs under economic impacts of measures addressing the treatment of vehicles at EoL).

These additional costs will be related to the additional time for collecting all data for ATFs thus more cells to fill in, as precise reporting of the total weight of reused parts/components is to be required for each component in the reporting table. Optimally, if ATFs would also report on the material composition of the dismantled parts/components, but this would require more thorough information for the producers, e.g., in IDIS. More time will also be needed for the institution that collects, summarises, and validates data before its official publication. It is to assume that the expected additional administrative cost of reporting would be similar significantly higher for scenario **Aluminium 2** in comparison to Aluminium 1. Some cases repair shops (including ATFs) already apply reused parts, anyway the obligation under Aluminium 2 would lead to an increase in such activities. Further costs under this scenario are related to implementation of enforcement against illegal sales of reused components, thus MS would need to inspect online sale platforms to ensure no illegal activities.

Aluminium 3 considers mandatory dismantling, what can affect investment costs (introduced above under investment costs) but also labour costs. The average costs of labour work as well as the number of dismantled parts/components ahead shredding differ among MS, thus the possible increase of additional costs for MS might differ, while introducing mandatory dismantling. Administrative costs for reporting on dismantled parts are assumed to be higher than in Scenario Aluminium 1 despite already existing scheme on reporting. It is assumed that for ATFs it would be an additional effort due to higher number of dismantled parts/components as well as due to need to provide more data on weight and kind of dismantled parts/components. In case when Scenario Aluminium 1 and Aluminium 3 would be implemented together, the administrative costs for reporting would not sum up[259], because while reporting on dismantled part/components, ATFs would highlight for which purpose it is dismantled (reuse/remanufacturing, recycling). However, the level on detail on reporting on dismantled parts would increase.

Additional costs will also exist due to requirement on reporting on the quality of shredders/PSTs deliverables (scenario **Aluminium 4**). These costs will appear for facilities' operators (shredder or/and recycler depending on the agreed measurement point) as well as for public authorities, however it is expected that these costs will be higher for facilities. As described above, public offices will need to collect data, validate it, and assess the situation (locally, regionally, or nationally) and to eventually establish an improvement strategy when it is necessary.

The administrative costs for each aluminium scenario are highlighted in the Table 3-61 presenting the analysis of measures addressing the treatment of vehicles on EoL.

Table and Figure below highlight possible high of revenues for aluminium scrap for analysed scenarios (2035). These values do not consider revenues for dismantled components for reuse/remanufacturing as well as costs for this process.

Table 3-32 Revenues for aluminium scrap of potentially higher quality and obtained after shredding in million Euro. Below also a change in million Euro of these revenues comparing to the baseline.

Total of the revenues for recycled material [mln Euro]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)	11	48	53	319	133
Recycled material after shredding (incl. Steel in tyres)	860	795	781	564	696
TOTAL	**871**	**843**	**834**	**883**	**829**

[259] Relevant for components for reuse/remanufacturing arise on the list for monitoring.

Table 3-33 Change in million Euro of these revenues comparing to the baseline ["-" decrease, "+" increase]

Change in mln Euro of revenues comparing to the baseline ["-" decrease, "+" increase]	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Recycled material of potentially higher quality (Directly recycled, no shredding)		37	42	308	122
Recycled material after shredding (incl. Steel in tyres)		-65	-79	-296	-164
TOTAL		**-28**	**-37**	**12**	**-42**

Source: own calculations, the prices assumed for the calculations distinguish the aluminium scrap quality, thus amounts of aluminium send directly to recycler after dismantling (no shredding) are categorised as secondary wrought aluminium and are higher than the prices for aluminium shredded (categorised as secondary cast aluminium). Current prices were taken for the calculations. Lowest raw represents a total and percentage of revenue's decrease/increase in each scenario 1 to 4 in comparison to baseline (decrease in revenue is due to, e.g., higher reuse/remanufacturing or direct recycling of components dismantled by ATFs). Similarly as for steel scenario, the calculation of economic costs for ATF based on the dismantling and deep dismantling of engines. To avoid double counting, the ATFs costs of dismantling of 50 % engines as well as 33 % of deep-dismantled engines are allocated to aluminium scenario. For more details, please refer to chapter on Economic impacts in steel scenario.

The average cost per hour is 51 Euros (base on the information from EGARA).

Following table show the total costs in million Euro for baseline and additional dismantling costs (as compared to the baseline, also in mln Euro)

Table 3-34 Total costs for baseline and additional dismantling costs (as compared to the baseline) in million Euro

	Total costs, in million Euro	Additional dismantling costs (as compared to the baseline, in million Euro)			
Material	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Copper	21	1	7	48	31

3.1.7.4.3 Social impacts

Based on one example the possible social impact is calculated. Calculations are based to the assumptions done to assume economical costs for ATFs (previous sub-chapter). The following tables shows the number of additional job positions in the ATFs as compared to the baseline.

Table 3-35 Number of additional job positions in the ATFs as compared to the baseline

	Additional positions (number) as compared to the baseline			
Material	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Steel	12	86	582	383

Additionally, employees will be needed for the operation of new machines in shredder/PST and additional employees for hand picking/sorting in shredder facility. In Europe there are about 300 shredders/PST. It is expected that relevant investments would do done by facilities from middle up to big size, thus not in all existing facilities. There is not precise data on shredder/PST and also on the fact if shredder have a PST in house, therefore rough assumptions are done: 60% of existing plants are middle or bigger size, for the new technological solutions there will be need for 2 employees that could operate new machines.

It would mean that for Scenario Steel 4 (for which bigger investments are planned) would be required to hire additional 360 employees.

3.1.7.5 Comparison of scenarios for aluminium

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-36 below to allow an easier comparison. The scope of the analysis is EoL of steel from collected ELVs, however some of the outcomes either overlap with the outcomes of the analysis of other materials or are representative for other material(s) as well. Thus, the finding listed below should not be sum up with other summarising tables for the separately analysed materials. The overall analysis on the collected ELV level is performed in section Table 3-36.

Table 3-36 Summarising table for the comparison of the steel scenarios (the assessed impacts are based on the total of ELVs collected in 2035)

Impacts		Scenario Aluminium 1	Scenario Aluminium 2	Scenario Aluminium 3	Scenario Aluminium 4
Economic	on ATFs	1 mln € costs due to additional dismantling[260] (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+37 mln €) -	7 mln € costs due to additional dismantling[260] (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+428 mln €) --	48 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+309 mln €) --- / +	31 mln € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+122 mln €) --- / +
	on shredders	Loss of shredding material (loss of revenue) Decrease in revenues for material scrap (-65 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for material scrap (-79 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for material scrap (-296 mln €) --	Loss of shredding material (loss of revenue) Additional investment costs in separation technologies and hand picking Decrease in revenues for material scrap (-164 mln €) --- / +++

[260] Value represents the additional costs for manual dismantling (labour costs), there might occur also additional investment costs in the machines for automatic dismantling (especially relevant for scenario 3 and 4).

Impacts		Scenario Aluminium 1	Scenario Aluminium 2	Scenario Aluminium 3	Scenario Aluminium 4
	on recyclers	Small decrease in business, due to loss of material scrap (-28 mln €) However, increase in higher quality material (dismantled prior shredding) 0	Small decrease in business, due to loss of material scrap (-37 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of material scrap (+12 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of material scrap (-42 mln €) However, increase in higher quality material (dismantled prior shredding) ++
	on SME	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities.			
	Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal			
	Administrative costs burden	Moderate increase in administrative burden for reporting for regulators and waste management --	Moderate increase in administrative burden for reporting for regulators and waste management --	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---	High increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies ---
	2ndary resources	Decrease in availability of secondary steel (-28 mln €) due to increase in reuse -	Decrease in availability of secondary steel (-37 mln €) due to increase in reuse -	Decrease in availability of secondary steel (+12 mln €) due to increase in reuse -	Decrease in availability of secondary steel (-42 mln €) due to increase in reuse ++
Environmental	Environmental impacts: LCA credits from reuse/rem. and recycling[261]	Increase in credits: ~566 Mt CO_2-eq. +	Increase in credits : ~ Mt CO_2-eq. ++	Increase in credits: ~2,095 Mt CO_2-eq. ++	Increase in credits : ~1,358 Mt CO_2-eq. ++

[261] As a difference to the baseline scenario

Impacts		Scenario Aluminium 1	Scenario Aluminium 2	Scenario Aluminium 3	Scenario Aluminium 4
Social	Employment [262]	Increase in jobs in ATF (~12) +	Increase in jobs in ATF (~86) ++	Increase in jobs in ATF (~582) ++	Increase in jobs in ATF (~383) Increase in jobs in shredder facilities (~360) +++
	Proportionality	All scenarios are considered proportional for achieving the objectives that the EU Treaties intends to implement			
	Cost effectiveness	Low costs but low benefits +	Similar effectiveness to scenario 1 in GWP and amount of recycled steel, while lower costs. However, the quality of recycled material is lower. ++	High costs however at the same time very high revenue for the secondary wrought aluminium. Highest revenues for ATFs for sold recyclable material. Highest environmental credits due to recyclability of secondary wrought aluminium. +++	Very high costs in comparison to scenario Steel 2 and 3. High environmental credits due to recyclability of secondary wrought aluminium. ++
	Coherence	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity. ++	Coherence with waste legislation and the CEAP, promoting maximal recycling. ++	Coherence with waste legislation and the CEAP, promoting maximal high-quality recycling. +++

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

[262] Increase in comparison to baseline scenario. The calculations done based on dismantling time of engine/gearbox, so the values presented here in reality might be even higher while considering more parts/components for dismantling.

3.1.8 Analysis for glass

3.1.8.1 Qualitative analysis for glass

3.1.8.1.1 Qualitative analysis for glass

Four measures were shortlisted for glass including the following measures:

Title	Chapter
2.1.g) Establishment of mandatory recycled content targets for glass used in cars	2.1.5.1.8
2.4.a) Align definition of ‘recycling’ with the WFD to prohibit the backfilling of glass	2.1.5.4.1
2.4.b) Making it mandatory to remove glass windows before shredding to encourage their recycling	2.1.5.4.2
2.4.c) Set a material-specific recycling target for glass	2.1.5.4.3

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

The feasibility of the proposed measures is assessed as follows:

- Measure 2.1.g: A recycled content target might affect the quality of recycling but would probably require more data to conclude on technical feasibility than is currently available. Current data suggests that technically glass from vehicles can easily be recycled into container glass or insulation materials but is mainly limited due to a lack in ELV cullet supply (i.e., uncommon dismantling). Recycling back into vehicle applications (windows) may be technically possible and is mentioned by some facilities (see data on Maltha Glasrecycling under (ARN 2022a)), however other sources clarify that it is not (widely) practiced. Given that only little glass is dismantled from ELV at present, it is however not surprising that there is little data as to such recycling. In this sense, it could be that a target would not be difficult to fulfil if use of secondary materials sourced from vehicles is not required and would then not necessarily affect the waste management of vehicles. As for the opposite case, the benefit of a closed loop recycling is questionable. Glass for Europe (2022) explains in this respect that though closed-loop recycling from flat glass into flat glass is desirable, it is most difficult to attain due to the required quality requirements of vehicle glass. They furthermore consider that this measure would not support effective dismantling and sorting of automotive glazing but only exacerbate competition between glass manufacturers to source an already scarce resource. This measure is thus discarded at this stage but could be reconsidered in the future if the implementation of other measures does not lead to a sufficient improvement in circularity.
- Measure 2.4.a: Alignment of the definition of recycling with the WFD will exclude backfilling as a viable treatment for fulfilling the recycling target. As coherence with the WFD and with other waste legislation is understood to be of importance, this measure is assumed to be an essential supportive measure to be considered in all scenarios.
- Measure 2.4.b: For glass, the data (see section 2.1.2.5.4) suggests that dismantling and separate recycling could lead to a large benefit in terms of circularity, quality of recycled material and respective environmental impacts. This is particularly the case as at least at present, when glass is shredded, it is diverted to the mineral fraction that can be used as a filling material (downcycling) but that currently does not allow high quality recycling. Though PST could develop in the future to remedy this situation, there is no data to suggest that such treatments exist or are in final development stages. Dismantling and separate recycling, however, are not considered to be economically viable, mainly due to the transport costs and are not commonly practiced. However, there are countries that remove glass (in some, it is required by law, in others, supported through financial compensations, etc.) and thus it is assumed that such MS assume that the environmental benefits set off the economic costs and that the practice is not far from economic viability.

- Measure 2.4.c: A recycling target is also an option to increase the high-quality recycling of glass. Its advantage is that it leaves more flexibility as to how the target is to be achieved, but it would also require ensuring that certain recycling practices (use as filling materials) are not counted towards fulfilment of the target. The level of recycling could be associated to the volume of the glass stream expected to result from destructive dismantling of glass, seeing as shredding and PST currently do not deliver products that can be considered to reflect high quality recycling.

3.1.8.1.2 Scenarios for quantitative analysis

Between 2012-2013 a few studies were performed for Flanders (OVAM 2022) about technical, economic and environmental aspects of the dismantling and recycling of automotive glass (Intertek RDC & OVAM 2013?; VITO & OVAM 2013?; OVAM 2012?). These studies are the most comprehensive source on the waste management of vehicle glass at end-of-life, and as such comprise a source that has been taken into consideration for many of the assumptions made in the following analysis. More recent sources usually did not include quantifiable data, though supporting for the most part aspects raised in the OVAM studies.

3.1.8.1.2.1 Baseline

Though the ELVD specifies that glass should be removed under Annex I(4), "Treatment operation[s] in order to promote recycling", it does not specify whether this needs to be done prior to shredding operations or not. In so far it is left open to MS how to deal with this requirement. According to OVAM (2012?), in 2012, selective glass removal was not widely applied in the EU 27: at this time, glass removal took place in six member states: the Netherlands, Austria, Poland, Portugal and, to some extent, Spain and Sweden. In France and Hungary, the legal obligation to remove glass had recently been approved and implementation was expected in the short term. In two out of six countries where glass removal was said to already occur – the Netherlands and Poland – OVAM (2012?), explains that dismantlers receive an allowance for glass removal alone, or for the complete depollution process and dismantling of the ELV, which compensates for the costs of glass dismantling and logistics. Though a full survey of the practices of glass removal in the EU 27 was not performed in recent years, data on a few MS presented in section 2.1.2.5.4 suggests that at present the situation is similar, with glass mainly being removed when reuse is targeted, resulting in the production of only small amounts of cullet and subsequently only little high quality recycling. On this basis, the consultants assume that under the baseline, glass shall continue to be removed in a few Member States, but post-shredder technologies shall be widely applied, resulting in glass being diverted to the mineral fraction and sent to use as a filling material, which is considered as downcycling.

3.1.8.1.2.2 Scenario Glass 1: alignment of 'recycling' definition with WFD

Under this scenario, it is assumed that the use of post-shredder mineral fractions containing glass for backfilling operations will no longer count as a recycling operation, effective by 2025. Subsequently, it is assumed that countries that have accounted such operations as recycling until now, will either use mineral post-shredder fractions as a construction filling material (majority) or start dismantling and recycling glass (minority) from 2025 and on to enable compliance with the current RRR targets.

3.1.8.1.2.3 Scenario Glass 2: mandatory removal of glass and separate recycling

Under this scenario it shall become mandatory to remove window glass from vehicles and send it separately from other waste to recycling facilities. For this purpose, destructive removal (the window is broken with various tools and the pieces are collected and sent to separate recycling) is assumed to comply with the requirement, meaning that around 30% of the glass is lost in the process[263]. Stakeholders (e.g., FEAD (2022) but also 6 stakeholders who responded to interactive questions at the workshop) have confirmed that destructive removal techniques retrieve around 80 % of the glass in an ELV at the time it is treated at the ATF. Together with other losses, it is assumed that 70 % of the glass in vehicles can be removed from ELVs and recycled at high quality. To ensure that a minimum amount is removed and sent to recycling, the measure could include a requirement that at least 20 kg is to be removed per vehicle (average value) and transferred to a recycler as glass cullet to comply with the provision. A minimum amount of glass is suggested to facilitate a straightforward reporting that is not overly burdensome in terms of administrative costs. The reference to cullet is made to ensure that the output of ATFs is the secondary material sought by glass manufacturers to reduce their dependability on primary material, and subsequently the footprint of manufacturing new glass.

3.1.8.1.2.4 Scenario Glass 3: alignment of 'recycling' definition with WFD + material specific recycling target for glass

Under this scenario, a recycling target would be specified in the future legislation of ELVs, requiring a minimum share of glass in vehicles to be recycled at high quality, i.e., without downcycling. In the case of glass, high quality is interpreted to mean that the cullet can be used for production of container glass, insulation materials, flat glass and other equivalent uses in terms of quality. Vehicle glass use in windows would also be considered a high-quality use, as the glass is retained in the material cycle and can be recycled again, contributing to circularity. However, the feasibility is not clear from available data. Based on Intertek RDC & OVAM (2013), it is assumed that at present, an average of 20.8 kg could be recovered per vehicle, amounting to around 70% recycling that could be achieved. 60% and 80% recycling will also be looked at quantitatively. This measure leaves open whether the glass is removed and treated separately or recovered from the shredder through application of PST. Available data suggests that current PST technologies would not result in a glass fraction that is of sufficient quality[264], however, such technologies could still be developed and applied in the future if minimum quality requirements are to be achieved. Monitoring and enforcement would require ATFs to provide evidence of the number of vehicles treated and the amount of glass dismantled from all vehicles and sent to recyclers. Shredders and PST operators would probably also be required to report on vehicle inputs and recycled material outputs (glass sent to recyclers and glass containing mineral fractions that can be used in construction or in

[263] According to Intertek RDC & OVAM (2013?), aside from the glass that is lost in the logistics of transporting a car to an ATF and also to depollution and dismantling processing at the ATFs premises, when glass is dismantled "destructively", a container or tray will be used to collect glass that is broken out of the vehicle window frames. Glass that lands outside the container or tray, will be swept from the floor of the dismantling space, however as it usually contains dust and other impurities, it will not be collected with the glass sent to recycling to avoid contamination. The study estimates that 20.8 kg is recovered per ELV when destructive dismantling is applied. Assuming an average weight of 30 kg of glass per vehicle means that this reflects around 70% of the glass in a vehicle.

[264] Intertek RDC & OVAM (2013?) explain that automotive glass separated after shredding and PST is not accepted (in 2012) by the glass recyclers. This is due to it still containing many impurities (plastics, metals, stones), as it is a mix of glass of different sources (i.e., heterogenous – sourced form ELVs but also from e.g., washing machines, car lamps) and as it is provided in very small pieces (< 8 mm) which with the current technologies applied hinders the separation at the glass recycling plant into glass of different types (composition). The mineral fraction containing automotive glass is either recycled as building material (Examples: road basement and landfill covering), to replace other mineral materials (sand, rocks…) if the quality is sufficient, or is landfilled.

backfilling operations (limited amounts may be "recovered")). Finally, recyclers will also need to report as to their vehicle inputs and about the amount recycled at high quality.

3.1.8.1.3 Results of qualitative analysis

Though **scenario Glass 1** shall prohibit the use of post shredder mineral fraction for backfilling, it will still allow its use for construction purposes. Compared to the baseline, though some MS may shift to glass dismantling and separate recycling, this scenario is not expected to increase the level of high-quality recycling substantially. In contrast, both in **scenario Glass 2 and Glass 3**, the level of dismantling is expected to increase.

Scenario Glass 2 requires ATFs to show that at least 20 kg of dismantled glass cullet is sent to (and accepted by) glass recyclers. This level is based on the average amounts of glass reported by Intertek RDC & OVAM (2013?) as feasible by application of destructive dismantling and thus also considered to require an acceptable increase in dismantling time and costs.

In **Scenario Glass 3**, the achieved level depends on the target to be set. A target of 70% of the glass in a vehicle is also based on the application of destructive dismantling and an average use of 30 kg of glass per vehicle and thus assumed to achieve a similar level of glass recycling. A lower target, e.g., 60% would not apply the full potential of destructive dismantling: The data on dismantling methods presented by Intertek RDC & OVAM (2013?) shows that there are multiple methods achieving a removal rate of 85% and above of the glass in the vehicle at the time of dismantling (glass losses occur also prior to dismantling). It is thus assumed that 60% would not be ambitious in relation to what is possible through technologies already available a decade ago. Similarly, based on the Intertek RDC & OVAM (2013?) data, a higher target, e.g., 80% would be over reaching in relation to destructive dismantling. This would result in ATFs needing to apply techniques that are more intensive in labour and/or more costly in terms of equipment, affecting the costs of the process for ATFs. As removal is currently not practiced due to a low economic feasibility, it is assumed that is assumed that the costs in this case would not be proportional to benefits should such a target be applied at present. In parallel, a higher target could be considered for the future with the understanding that it could lead to better design of vehicle windows for removal. As the vehicle lifetime is relatively long, it would take time until such changes facilitate higher removal levels and would thus only be expected to allow compliance in the long-term, if at all.

From an environmental perspective, in both **Scenario Glass 2** and **3**, the level of high-quality recycling is expected to increase significantly and to be similar. High quality recycling is expected to have environmental benefits as opposed to downcycling (to be analysed in the next section). However, these scenarios are expected to differ in terms of administrative burden, as monitoring would be more complicated in a case where it is left open for operators to decide how to achieve the target.

3.1.8.1.4 Results of quantitative analysis

From the available data it can be understood that various shares of glass are not directed to recycling due to breakage at various process stages, being sent to reuse or losses and process inefficiencies. Thus, to specify the amounts of glass going into each fraction, it is first necessary to make some assumptions as to the volume of breakage, reuse and inefficiencies.

Intertek RDC & OVAM (2013?) estimates that that 5-10 % of glass does not reach ATFs due to breakage in accidents or during transport to ATFs and that another 5-10 % of glass windows are dismantled (usually with doors) and reused.

Thus, under all scenarios, it is assumed that 10 % of vehicle window glass from vehicles that arrive at an ATF is missing due to accidents or breakage during the transport to the operator. This 10% is part of the total losses considered. Furthermore, a different share is assumed to be dismantled in each scenario. In all cases, this dismantled share is assumed to include:

- 5 % of glass that is removed for reuse (usually with the door),
- The European average of glass sent to separate recycling (in the baseline, 5% represents the MS that already require removal of glass or provide compensations that facilitate the practice),
- A further 5 % "breakage" is collected at the ATF premises and sent to the shredder. This is either glass broken during transport processes or during dismantling when glass is shattered but does not land in trays or curtains used to collect it for separate recycling.
- Losses of 3% for process inefficiencies.

As for glass that is not recycled at high quality, it is either recycled after shredder operations (mineral fraction used for construction) or considered to be recovered through backfilling. Though in the baseline, backfilling also counts towards recycling, this is not allowed in other scenarios and thus assumed to decrease to zero.

Both in **scenario glass 2** and **3** a high level of glass that is dismantled and then sent to a recycler (without shredding) is assumed. This is based on the available data for efficiencies of destructive dismantling and on the amount of glass that can be recovered per vehicle.

- Intertek RDC & OVAM (2013?) detail various dismantling techniques, most of which allow the removal of 75-95[265]% of the glass. The rest is explained to remain in part in the vehicle and to be sent to shredder or is collected from the facility premises and sent to shredder due to contamination with dust etc.
- The Intertek RDC & OVAM study estimates that 20.8 kg per vehicle can be recovered through destructive dismantling and separate recycling. The shares specified here thus assume that around 70 % can be recovered as a secondary material when dismantled and sent to pre-shredder recycling.

As for consideration of changes in the use of glass in the future, according to stakeholders (Intertek RDC & OVAM 2013), the function of glass windows (particularly of the wind-screen) has evolved over the last two decades and is expected to evolve further. Glass windows may be designed to accommodate additional functions e.g., sun-protection, antenna, head-up display, solar-cell, heating and sensor. Such components are similar in terms of composition to those already applied in the windscreen and the rear window and said not to hinder the recycling of glass and it is anticipated that this will not change. Intertek RDC & OVAM (2013?) further expect an increase in the use of sun-roofs in vehicles, which are mainly made of laminated glass. However here to, it is not expected that this shall affect recyclability. In any case Intertek RDC & OVAM (2013?) expect sunroofs to be present in ELV only in (very) small amounts in the coming decade(s) as they have a relatively low market share (mainly the luxurious cars). In conclusion, neither of these evolutions are reflected in the following analysis, however they would also not be expected to change the nature of results.

The following table specifies the rates that have been assumed for each scenario as dismantled, reused, recycled pre- or post-shredder, recovered, or lost; and with which quantitative impacts have been calculated. This is followed by a description of expected

[265] This is generally based on the data on the share of glass sent to recyclers specified under Table 2(Summary dismantling technique) of the report but also on data for some methods where RDC performed field observations as to the amounts removed and sent for recycling, This number only reflects the share of glass removed form the vehicle in the dismantling stage. Some losses may occur prior to this stage, i.e., it is not to be concluded that 0.75-95% recycling is viable through destructive dismantling.

impacts in each scenario after which impacts are presented for the impact categories environmental, economic, and social.

Table 3-37 Routes of treatment for glass from ELVs in 2035 under the various scenarios in shares (%) of total material stream

Vehicle glass	Baseline	Scenario 1	Scenario 2	Scenario 3
In components for reuse/remanufacturing	5%*	5%	5%	5%
Recycled material of potentially higher quality (directly recycled, no shredding)	10%	12%	70%**	70%**
Dismantled --> shredded --> recycled	5%	5%	12%	12%
Shredded --> recycled (no dismantling)	50%	65%	0%	0%
Recovery: backfilling	17%	0%	0%	0%
Losses	13%*	13%*	13%*	13%*

Source: Oeko-Institut: own assumptions based on available data.

**Based on *Intertek RDC & OVAM (2013?) estimates 5-10 % of glass windows are dismantled (usually with doors) and reused and that 5-10 % of glass does not reach ATFs due to breakage in accidents or during transport to ATFs. For reuse of glass, 5 % has been assumed and for losses prior to ATFs 10 % has been assumed – both reflecting a conservative assumption.*

***Based on Intertek RDC & OVAM (2013?) See explanations above.*

Under **scenario Glass 1**, post-shredder mineral fractions containing glass for backfilling operations will no longer count as a recycling operation. In some countries where such treatment is counted towards reaching the reuse and recycling target, this would make it more difficult to achieve the target, as glass constitutes around 3 % of the vehicle weight. However, the prohibition of accounting backfilling as recycling would still allow counting post-shredder mineral fractions used for construction purposes as recycled. Based on OVAM (2012?), in the past, at least 6 MS removed glass although this was not a requirement. For the remaining 21 MS, it can be assumed that all of them shred glass with the vehicle in most cases, reporting it as recycled. Under this scenario, those that applied the backfilling route could either require removal of glass prior to shredding or send post-shredder mineral fraction for use as filling material in construction works. It is assumed that most of the 21 MS would choose the latter route, as glass removal would increase the costs of ELV waste management. Intertek RDC & OVAM (2013?) explains that automotive glass separated after shredding and PST is not accepted (in 2012) by glass recyclers. This is due to the fact that it still contains many impurities (plastics, metals, stones), as it is a mix of glass of different sources (i.e., heterogenous – sourced from ELVs but also from other waste e.g., washing machines, car lamps), and that it is generated in very small pieces (< 8 mm) which, with the current technologies applied, hinders the separation at the glass recycling plant into glass of different types (composition). FERVER and Denuo (2022) also refer to the impurities after shredder as an obstacle for recycling. The mineral fraction containing automotive glass is either recycled as building material (examples: road basement and landfill covering), to replace other mineral materials (e.g., sand, rocks) if the quality is sufficient, or is landfilled. It is assumed that both in the **baseline scenario** and in **scenario Glass 1** most MS will continue to treat glass in the shredder, resulting in its application as a construction filling material (baseline and scenario Glass 1) or backfilling (baseline only) material. Only a small share of MS will continue (baseline) or shift (scenario Glass 1) to glass removal and recycling.

Under **scenario Glass 2**, all glass will need to be removed prior to shredding. In a study prepared by Intertek RDC & OVAM (2013?), various dismantling methods were presented, looking at their different characteristics. Multiple methods were presented that require an average of 6-10 minutes for removal of all glass windows (windscreen, side windows and rear window). Depending on the type of window removed, the various methods achieved a removal rate between 75-95 % of the glass applied in windows. It is, however, noted that some of the glass may be missing by the time the ELVs arrives at the dismantling station. Considering all losses, the study assumed that the removal of glass would result in a recovery of 20.8 kg of glass on average from each vehicle, corresponding to almost 70 % of the glass used in vehicles[266]. The study confirms that such glass will be collected separately and then shipped to a recycler. Concerns were raised that the use of foils and electric components (e.g. heating elements) in some windows can hinder the recycling quality of the glass (FERVER and Denuo 2022). However, Intertek RDC & OVAM (2013?) confirmed with various operators and recyclers that separated glass is crushed and sorted to remove metal, foil and other materials upon arrival. The non-glass components of automotive glass (PVB, heating wires) do not hinder glass recycling, and glass from all types of windows (windscreen, side, rear) is accepted even when mixed. Recycling of cullet sourced from vehicles has a good market in the production of container glass and insulation material production (flat glass is a potential market but technically more complicated). This view is also supported by FERVER and Denuo (2022), who explain that the global demand of the glass industry for used/ recyclable automotive glass is rather high since it is a rather pure waste stream (assuming the glass is separated pre-shredder).

Under **scenario Glass 3**, it is up to operators how to achieve the target, however, as currently only destructive dismantling of glass would cater for the quality of recycling addressed by the target, it is assumed that at least in the short term, the level of dismantling would be similar to that applied in scenario Glass 2. This could change in the future, should PST technologies be developed to achieve higher quality separation of glass from shredder fractions. But as there is currently no data that supports such developments, they are assumed not to develop in the short term.

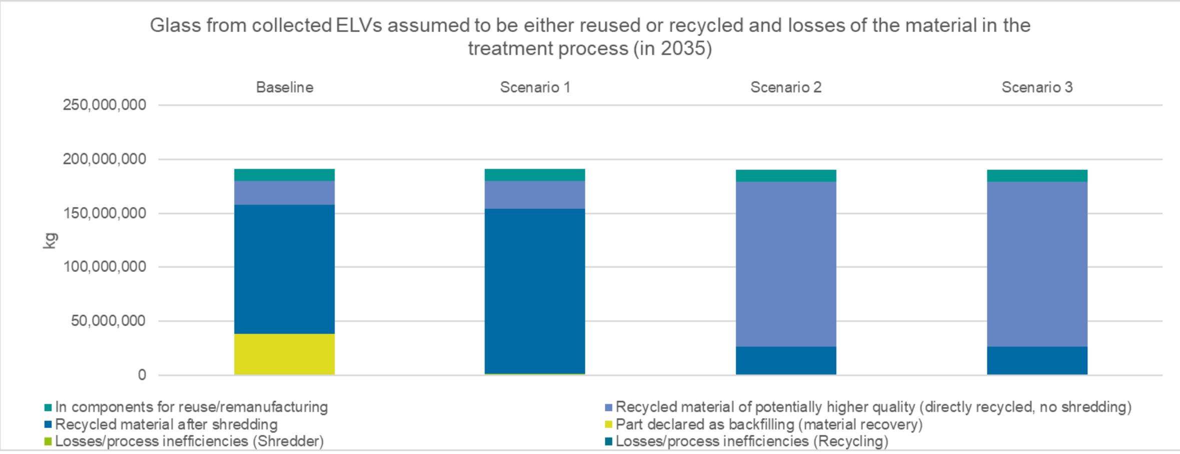
3.1.8.1.4.1 Environmental impacts

For the analysis at hand, the model developed for this study specifies that the around 220 thousand tonnes of glass will be contained in ELVs to be collected in 2035, when all measures could be expected to be fully implemented. This assumes a weight of vehicle glass of between 21 and 26 kg per vehicle depending on the vehicle type [267]. Based on above assumptions and the shares specified in Table 3-37, the tonnage of vehicle glass treated in different routes was calculated and is presented in Figure 3-11 below.

[266] Intertek RDC & OVAM (2013?) refers to individual weights in a range of 10-20 kg for windscreens, 2-5 kg for each side window and 3-10 kg for rear windows, globally 20-40 kg altogether. 30 kg glass per vehicle has been assumed for convenience.

[267] Weights used in the model depend on vehicle type and were 24 kg for ICE, 21 kg for HEV, 22 kg for PHEV and 26 kg for BEV. Data suggest that vehicle glass will averagely weigh 30 kg per vehicle.

Figure 3-11 Tonnage of glass treated in the different routes under each scenario, in kg

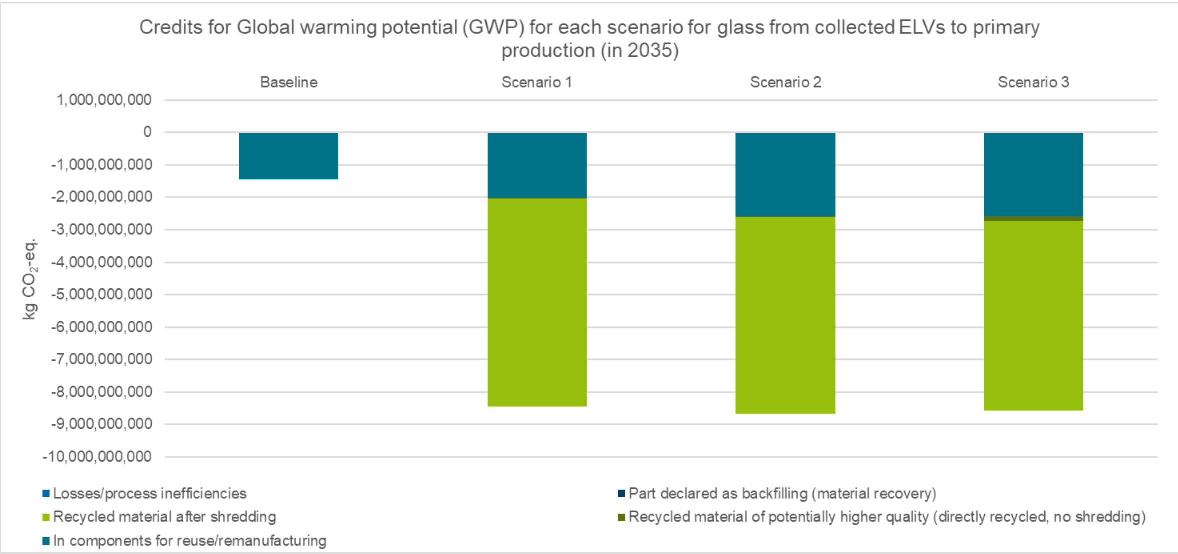


Source: Own illustration

The higher rates of dismantling of vehicle glass that can be recycled at high quality in Scenario Glass 2 and 3 result in around 131 thousand tonnes of vehicle glass being recycled in 2035, which is 6 times higher than the baseline and almost 5 times higher than Scenario Glass 1 in that year.

Based on the above tonnage calculated for the baseline and for each scenario, the respective environmental impacts in terms of global warming potential were quantified for each scenario. This is shown below for all vehicles to be collected as ELVs in the year 2035 (Figure 3-12). Specific data can also be seen in annex 6.4.2.1, representing impacts based on the functional unit (all window glass of a typical vehicle) to show impacts in terms of global warming potential when the glass is directed to different treatment routes.

Figure 3-12 Credits for Global warming potential (GWP) of the treatment options for all vehicle glass compared to primary production, calculated for all vehicles collected as ELVs in 2035 (kgCO₂eq)



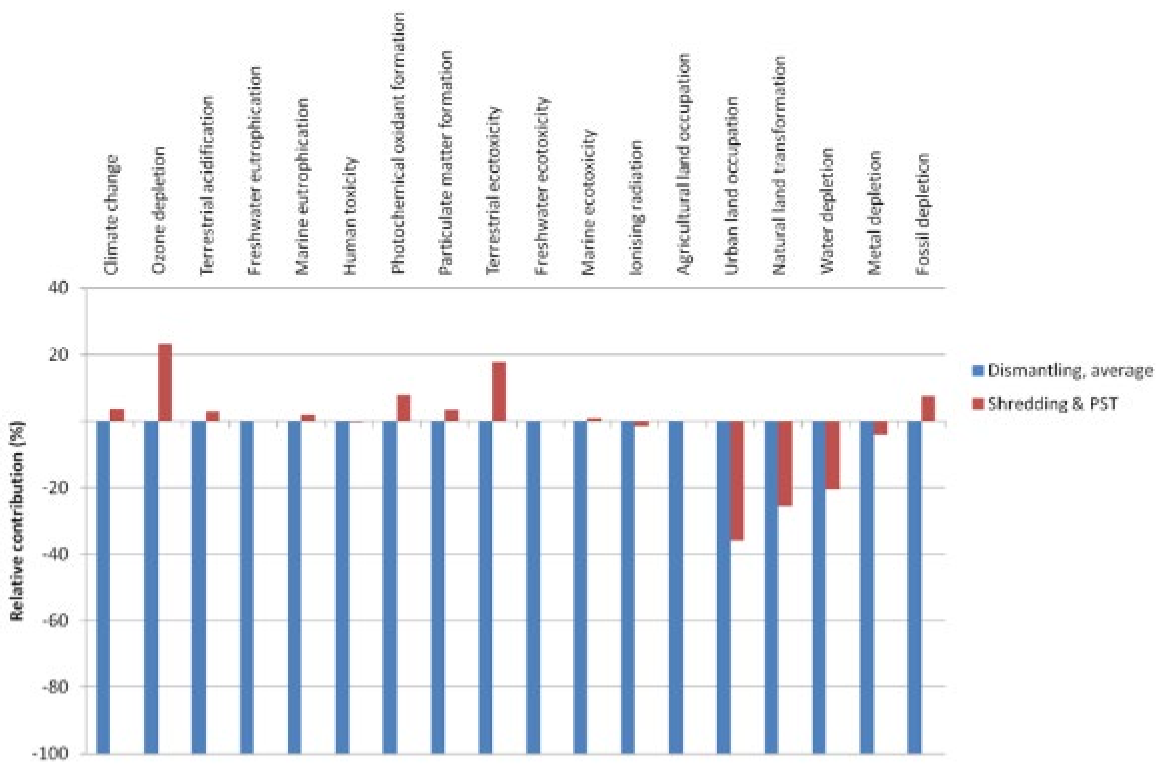
Source: Own illustration

Though Figure 3-12 refers to additional routes besides reuse and pre-shredder recycling, the figure specifies these as zero. Though glass sent to the shredder and then backfilled (or used for filling in construction) will have a certain environmental benefit (e.g., GWP credits) over glass losses, the value of these is negligible in comparison to the credits achieved from recycling at high quality. For simplicity it is shown as zero here.

Based on this analysis, though the credits for reuse are the same in all scenarios (not expected to be affected by the measures under consideration), credits for dismantling and then recycling increase the total credits of Scenario Glass 2 and 3 significantly to around 139 thousand tonnes of CO_2 equivalents, as compared to the more modest credits in the baseline and Scenario Glass 1 that amount to around 12.8 and 16.8 thousand tonnes CO2eq respectively. As explained, the contribution of vehicle glass sent to shredding and thus considered downcycled is negligible, reflecting the fact that this material leaves the material cycle.

This is further supported by an LCA comparison of the dismantling and recycling route with the shredder route (use of mineral fraction for construction) performed by VITO & OVAM (2013?) that concluded that the shredding route has minor environmental impacts and benefits depending on the impact category, while dismantling in all categories has a much larger environmental benefit. The differences estimated in this comparison refer to additional impact categories as can be seen in the figure below. Whereas 100% represents the impact under each category for dismantling, the related impact for the shredder route (referred to as shredding and PST) is shown in comparison to this level. In this respect, a negative value is understood to mean that there is a contribution to reducing impacts, whereas a positive value reflects a negative impact related to the indicator in question.

Figure 3-13 Comparison of the environmental impacts of dismantling (and recycling) versus post shredder recycling (backfilling or construction uses) in %



Source: VITO & OVAM (2013?)

VITO & OVAM (2013?) explains that by using cullet in glass production, primary materials (silica sand, soda, limestone, dolomite) and energy are saved, which yields higher environmental benefits than avoiding the use of building sand by replacement with the post-shredder mineral fraction. The study also explains that, despite the fact that dismantling of glass generates a net environmental benefit, even in the best-case scenario, the environmental benefits that can be expected from glass dismantling and recycling are relatively small. This treatment of automotive glass yields the same average CO_2 reduction per ELV (6.4 kg) as a reduction in personal car use of 27 km. For comparison in the estimations made with the environmental impacts model of this study, the average CO_2 reduction per ELV was calculated to be slightly higher (around 11 kg per ELV), which has a similar order of magnitude.

Furthermore, according to VITO & OVAM (2013?), the total glass flow generated annually by ELVs is estimated to be about 5,000 tonnes (in Belgium), which is also a limited quantity. Assuming, an average car drives about 15,600 km per year, the CO_2 reduction potential of dismantling and recycling glass from 170,000 ELVs annually (in Belgium) equals the yearly CO_2 emissions of roughly 300 average personal cars (1100 tonnes CO_2).

Although it may sound as if the benefit from glass removal is small when looking at the vehicle level, it needs to be kept in mind that currently the use phase of a vehicle is assumed to have the largest contribution to its total global warming potential. In other words, it is not a surprise that contributions related to a specific material are more modest.

To give additional context to the impact of generating more glass cullet for recycling, it is worth considering the CO_2 savings that this generates for glass recyclers. In this respect, Glass for Europe (2022) estimated that replacing 1.2 t of raw materials by 1 t cullet saves 310 kg CO_2 at the manufacturing site (process emissions) and 315 kg CO_2 related to the non-production of primary raw materials. Thus assuming 625 kg CO_2 savings for each tonne of cullet that can be generated in Scenario Glass 2 and 3, would mean that in total 95 thousand tonnes of CO_2 savings would be generated form the increase in available cullet, in comparison to only 13.7 thousand tonnes of CO_2 savings in the baseline and 16.4 thousand tonnes of CO_2 savings in Scenario Glass 1. These impacts are already reflected in the calculated impact presented in Figure 3-12 and are only mentioned to clarify that the range of impact may differ but remains in the same order of magnitude.

3.1.8.1.4.2 Economic impacts

From an economic perspective, glass dismantled and recycled separately results in higher costs for operators than when it is left in the vehicle and sent to shredding. Intertek RDC & OVAM (2013) estimated the total costs when glass is shredded and used for backfilling or construction at 49 € per tonne of glass as compared to 213 € per tonne when glass is dismantled and recycled separately. Costs differ depending on the size of the facility (in terms of ELVs treated) and economies of scale which affect both the cost of dismantling and of transport and logistics of separated glass.

Looking at the differences in costs of the various scenarios to the baseline based on the Intertek RDC & OVAM (2013?) data, scenario Glass 1 (prohibition of backfilling) would result in an increase in costs of around 0.75 million €. An increase in costs of around 22.8 million € is estimated for both scenario Glass 2 and 3, which result in the same amounts of glass being recycled pre-shredder as well as post-shredder. This calculation is understood to take into consideration the additional costs of equipment needed for glass dismantling (investments and maintenance) as well as any revenues related to the sales of recycled glass or mineral fraction (benefits).

It is noted that the Intertek RDC & OVAM (2013?) quantification is based on a calculation representative for an average facility in Belgium. Costs can vary depending on the size of the ATF. Larger ATFs may be expected to have higher costs for logistics (storage of glass), but probably also lower costs for dismantling and transport in light of economies of scale.

A further study (ADEME, France 2015) that looked at the costs for recycling vehicle glass in France states that the total costs associated with glass dismantling (sometimes including revenues from the sale of glass to recyclers) specified in various sources, ranges from € 3 to € 15/ELV, with the majority of estimates from various sources ranging between € 4 and € 8/ELV. As part of the study, an ATF survey was performed, where ELV centres surveyed reported average dismantling times of 30 minutes (10 minutes on average for the windscreen, 9.5 minutes for the side windows, 12 minutes for the rear window). Assuming a labour cost of 40 €/hour, a total labour cost of 21 €/ELV was estimated. The ELV centres also reported collection and processing costs of 64 €/t on average, which corresponds to 1.4 €/ELV considering 22 kg of dismantlable glass. The study refers to the Netherlands, where ARN financed the dismantling of glass by ELV centres until 2011 at a cost of 19 €/ELV, based on a dismantling time of 18 minutes - these estimates are said to be particularly high. The estimated cost of dismantling from the ADEME survey questionnaires is therefore 22.4 €/ELV, which is assumed to be relatively high compared to other available data. Post shredder treatment costs for glass are also mentioned, however, explaining that much less information is available. The OVAM studies are referred (treatment costs of 1.02 €/ELV as well as a much higher value estimated in Germany to be between 2.80 € and 4.20 €/ELV. The ADEME costs are compiled in the table below.

Table 3-38 Cost differences between glass processing by dismantling and post-shredding sorting identified in the studies

Source	Cost of dismantling	Cost of post shredder treatment	Differences
Estimations OVAM	Between 4.3 and 5 €/ELV (4.4 €/ELV on average)	1.02 €/ELV	3.4 €/ELV
German estimations	Between 4.6 and 8 €/ELV	Between 2.80 and 4.20 €/ELV	Between 1.8 and 3.8 €/ELV
Other studies and interviews	Between 3 and 15 €/ELV (mostly between 4 and 8 €/ELV)		

Source: translated and reproduced from table 3 in ADEME, France (2015)

In some countries, the distance between an ATF and a glass recycler may also affect the cost of transport and result in a further increase (or decrease) of costs. For PST the Intertek RDC & OVAM (2013?) study assumed that 56 % of shredders have PST operations at the same site and would have no additional transport costs. 44 % of shredders would need to transport the heavy fraction to a PST with costs varying "between 3 and 10 €/tonne, as it is a transport of a heavy fraction (high density) and as the distances are relatively short (maximum 150 km)".

For the transport of glass from a dismantler to a recycler, 45 €/tonne were assumed for both storage and transport. The transport cost alone was estimated to range between 10 and 30 €/tonne, as low volume facilities will transport a smaller container than large volume ones, resulting in a higher costs per tonne. Additionally, the difference is also related to the lower density of broken glass that results in larger volumes for transport. Detail was not given as to the distance between ATFs and recyclers, but this is assumed to be similar to the average distance of shredders to PST facilities, i.e., relatively low distances.

What is not accounted for in the costs of glass dismantling and glass shredding + PST presented above are possible benefits for shredders. Glass entering the shredders is understood to cause abrasion of the shredder surfaces and to increase the frequency of maintenance works and related costs. In that sense, though Scenario Glass 1 is very close to the baseline in this respect, under Scenarios 2 and 3 a decrease in such costs is expected that would be beneficial. Though this benefit cannot be estimated, shredder statements support this notion in terms of having a preference to accept vehicle hulks after the removal of glass (ARN 2022b).

ARN were contacted and asked about a pilot (the glass indicator) they had run to support that ATFs removing glass prior to shredding are compensated. In a personal communication, ARN stated that “4 car dismantling companies (ATF’s) joined the glass indicator pilot project (from the 213 affiliated car dismantling companies). The pilot has been run with one shredder location”. In 2021 the pilot resulted in 117 tons of dismantled glass being transported to recyclers, on average 16-17 kg dismantled glass per ELV (of on average it was said that an ELV contained >25 kg of glass). Data on the benefits for shredders was not made available and it was explained that the pilot was stopped for various reasons. It was also said that the “past has shown that payment for manual glass dismantling has led to substantial fraud“. Asked to explain this, ARN stated that ”If ATFs get paid for taking out and handing in glass, an intensive monitoring system should be set up. It turned out to be very simple and commercially interesting to put other glass in a container (such as glass from car glass repair and replacement shops) and in the meanwhile not dismantle the glass from EOL vehicles. Glass from still driving vehicles is difficult to distinguish from glass coming from EOL vehicles. From a mass balance perspective, it can reflect a perfect situation, but in reality, an incentive is given to 1. Not do the work and 2. Create a paid gateway for waste streams form other market players. (This is not a hypothetical situation but was the case with a number of ATFs when ARN still reimbursed ATFs for glass dismantling.)[268]

As for the cost to recycle the PST fraction, Intertek RDC & OVAM refer to between 0-3 €/tonne and to between 0-20 €/tonne for the cost to recycle the dismantled fraction. The cost is understood to reflect the quality of the glass delivered to a recycler. In particular, the lower part of the range given for dismantled glass is assumed to reflect cases where despite dismantling the glass is highly contaminated. In this sense, in terms of economic benefits, the consultants assume around 1.5 € revenue per tonne when shredded glass is sent to backfilling (only relevant in the baseline), 10 € per tonne when shredded and used as a filling material and 18 €/tonne when dismantled and sent as cullet for recycling. Looking at the differences in the tonnes recycled pre-shredder and post shredder under each scenario, an additional benefit of 0.36 million € is generated from sales of fractions to recyclers under scenario Glass 1 as compared to the baseline. For Scenario Glass 2 and 3 the difference amounts to 1.37 million €. In all scenarios the difference in range depends on the quality of the glass delivered.

Though glass recycling is relevant from a circularity perspective and considered critical by FERVER and Denuo (2022) to improve the recycling of this fraction, they also mention that the resulting reduction in the amounts of materials that could be used for backfilling could have economic implications: “*Glass in landfill material is frequently used to ensure landfill stability and is therefore a useful material in the landfill mixture; glass in landfill is not a problem, but its absence could be. Consequently, the glass fraction in landfill is sometimes exempt from landfill taxes. It must therefore be considered how landfill costs would be impacted if a larger proportion of glass were removed from the landfill material. But the general trend is to reduce the landfilling of waste, especially with high organic contents as it is the case for post-shredder waste, promoting recycling, material recovery and waste-to energy recovery*”. Data is not available to allow quantification.

[268] Personal communication per emails between Janet Kes and Yifaat Baron on 27.9.2022 and 29.9.2022.

Administrative costs

Aside from the difference in costs of glass processing from ELVs, a further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the total weight of dismantled glass reused (A1) and recycled (B1) in their country, however this reporting is on a voluntary basis. Glass recycled from the post-shredder heavy fraction as mineral fraction can be reported under “other” as recycled fraction (B2), currently covering the use of this fraction for both backfilling and construction. These rules could partially be applied under **Scenario Glass 1**, however, any backfilled fractions could no longer be reported as recycled (B2) and would probably require the rules to be adjusted so that they could be reported under recovery (C2 currently refers only to energy recovery). When landfilled in both cases, the heavy fraction or any materials recovered from it (mineral fraction) are to be reported as disposal (E2). Though this would require a small revision of the rules, it would seem that for MS that use the post-shredder mineral fraction for construction (at present or in the future for scenario Glass 1) nothing would change. For those reporting on backfilling as recycling, if the use changes to construction, the effort of reporting would also remain unchanged. Increases in dismantled and recycled glass would need to be reported in differently from today, also requiring the MS to collect documentation from waste operators: “declarations from the receiving recycling/recovery or collection company, weighing notes, other forms of bookkeeping or disposal notes”. Any mineral fraction still backfilled would require a change in the mode of reporting (recovery or backfilled instead of recycling), but not in the documentation to be provided by waste facilities. Though this is a higher effort as compared to the baseline, it is assumed to result in a negligible increase in comparison with the other scenarios. See quantification in vehicle level analysis (excluded here to avoid double counting).

Under **Scenario Glass 2**, the existing rules could also be applied if MS are obliged to report on the weight of dismantled recycled glass separately, as they are also required to report on the number and weight of ELVs treated in their country. This provision of data enables a relatively simple check of compliance. However, it is expected that more documentation would need to be collected and checked for the increased amount of dismantled and recycled glass, increasing the effort somewhat for regulators and operators in countries that currently do not remove and recycle glass separately. In this sense, the administrative burden is expected to be somewhat higher under this scenario – i.e., a low to moderate increase in administrative burden, due to the fact that currently, reporting on glass is voluntary, so the reporting scheme on this material in some MS might not be developed yet. See quantification in vehicle level analysis (excluded here to avoid double counting).

In contrast, under **Scenario Glass 3**, the reporting will become more complex. Though the aspects reported on for Scenario Glass 2 would still be relevant, under Scenario Glass 3 it will also be necessary to report data by the recyclers, optimally obtained at the calculation point or alternatively measurement point, to ensure that the total amount received and processed complies with the target of 70 % recycled glass. For most recyclers, this could be more than a standard reporting of inputs and outputs, as in the recycling process, glass will be mixed with other fraction, requiring an effort in allocation. Though the exact effort cannot be quantified, it is assumed that the reporting under this scenario would require a larger effort both in the development of the future reporting rules and in their implementation by both regulators and waste facilities. The administrative burden is expected to the highest under this scenario – i.e., a moderate – high increase in administrative burden. See quantification in vehicle level analysis (excluded here to avoid double counting).

Under both Scenarios Glass 2 and 3, any mineral fraction used for construction or backfilled could be reported as described under Scenario 1, but only small amounts would still be possible due to the obligatory dismantling and recycling, with the separately recycled fraction having the main influence on the range of total costs.

3.1.8.1.4.3 Social impacts

As scenario 2 and 3 will result in significantly more glass windows being dismantled, an increase in the time needed for dismantling is expected. Intertek RDC & OVAM (2013?) assumed that 6 - 10 minutes are needed for the dismantling of all vehicle windows. Assuming 10 minutes per vehicle as a conservative assumption and based on a workload of 200 days per employee, this would translate to 19 additional jobs in scenario Glass 1 and to 644 additional jobs in scenario Glass 2 and 3 in the dismantling sector alone.

3.1.8.1.5 Comparison of scenarios for glass

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-39 below to allow an easier comparison.

Table 3-39 Summarising table for the comparison of the glass scenarios

Impacts		Scenario Glass 1	Scenario Glass 2	Scenario Glass 3
Economic	on ATFs	0.76 million € due to additional dismantling and separate recycling -	23 million € costs due to additional dismantling and separate recycling - - -	23 million € costs due to additional dismantling and separate recycling - - -
	on Shredders	Loss of shredding material set-off by lower maintenance costs Estimated to result in an addition of 0.3 mil. € Negligible	Loss of shredding material set-off by lower maintenance costs Estimated to result in a decrease of 1.3 mil. € +	Loss of shredding material set-off by lower maintenance costs +
	On recyclers	Small increase in business, due to glass fraction available for high-quality recycling Additional revenue of 0.08 mil. € +	Large increase in business, due to glass fraction available for high-quality recycling Additional revenue of 2.4 mil. € +++	Large increase in business, due to glass fraction available for high-quality recycling Additional revenue of 2.4 mil. € +++
	on SME	Small ATFs would probably have higher costs than larger ones		
	Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal Costs for dismantling and separate recycling may be higher where the distance to recycling facilities is significantly >150 km		
	Administrative costs burden	Additional reporting costs: ATF – 123 thousand € MS: 0 €	Additional reporting costs: ATF – 988 thousand € MS: 1000 €	Additional reporting costs: ATF – 1,235 thousand € Shredders/recyclers:206 thousand € MS: 2000 €

Impacts		Scenario Glass 1	Scenario Glass 2	Scenario Glass 3
	2ndary resources	Small increase in availability of secondary glass for high-quality applications 4,000 tonnes	Large increase in availability of secondary glass for high-quality applications 131,000 tonnes	Large increase in availability of secondary glass for high-quality applications 131,000 tonnes
Environmental	Environmental impacts: LCA credits for recycling	Increase in credits from recycling: ~4,000 t CO2-eq. (negligible)	Increase in credits from recycling: ~126,000 t CO2-eq. ++	Increase in credits from recycling: ~126,000 t CO2-eq. ++
Social	Employment	Increase in jobs (ca. 20)	Increase in jobs (ca. 645)	Increase in jobs (ca. 645)
	Proportionality	All scenarios are considered proportional for achieving the objectives that the EU the Treaties intends to implement		
	Cost effectiveness	Low costs but low benefits +	Higher effectiveness than scenario Glass 3 High costs but higher benefits ++	Highest costs to result in benefits of the same range as scenario Glass 3 +
	Coherence	high coherence with WFD in relation to recycling definition but limited contribution to circularity +	General coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity) ++	General coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity) ++
Stakeholder acceptance		Stakeholders of all categories generally support the exclusion of backfilling, explaining that it is not a problem for the recycling industry but may require a revision of the targets (EuRIC 2021).	Though stakeholders expressed concern at the workshop (particularly ATFs) as to any obligatory requirements as to how certain fractions are treated, for glass there is support that high-quality recycling would be feasible possibly requiring EPR compensations for ensuring the economic feasibility (EuRIC 2021; EGARA 2021). Glass manufacturers highly support measures that would increase availability of cullet for recycling (Glass for Europe 2022; FERVER and Denuo 2022). Though one car manufacturer did not object to a target for glass, ACEA (2021a) generally does not support material specific targets.	

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

Regarding the **effectiveness** of the scenarios, each of them allows increasing the amounts of high-quality recycled glass through provision of ELV glass cullet to the market. Under **Scenario Glass 1** however only a slight increase of glass is expected to be recycled prior to dismantling and thus this scenario is expected to have the lowest effectiveness. **Scenarios Glass 2 and 3** are expected to result in much higher amounts of ELV glass cullet becoming available to the market and are thus considered to be much more effective. In the short to mid-term these scenarios could be expected to have a very similar effectiveness, however **Scenario Glass 3** has a higher flexibility as to how this objective is achieved and could thus promote more creativity in the further future in the development of technologies that would simplify glass removal. This cannot be excluded for **Scenario Glass 2** but is considered to be less probable.

Efficiency describes the cost-benefit-ratio. Though the costs for implementing **Scenario Glass 1** are expected to be low for the different actors, this scenario also does not result in significant impacts. It could be considered efficient in terms of the cost-benefit ratio but remains does not affectively achieve the objective. Both **Scenario Glass 2** and **3** are expected to increase ATF costs for dismantling, though these could be supported by an EPR, in which case they would shift to OEMs. Considering the costs of a new vehicle, the additional dismantling costs are not considered to be so high and in contrast to the first scenario they achieve much higher benefits. For these actors the two more progressive scenarios could be considered to be more effective, however **Scenario Glass 3** is expected to result in a higher administrative burden for, in particular for ATFs. This scenario is thus considered to have a somewhat lower efficiency as compared to **Scenario Glass 2**.

In terms of the **coherence** of the options with the overarching objectives of EU policies, all of the three options contribute to the goals set out in the Circular Economy Action Plan (European Commission 2020a). This is related to backfilling activities (downcycling) being avoided in line with the WFD and also to increases in the availability of ELV glass cullet that will decrease the reliance on primary materials. Nonetheless, only **Scenario Glass 2** and **3** are expected to generate high amounts of ELV glass cullet, suggesting a lower coherency of **Scenario Glass 1**. The situation of proportionality is similar. As they support circularity to a much higher degree in terms of decreasing the dependency on primary materials, **Scenario Glass 2** and **3** may have higher costs than **Scenario Glass 1**, but these are still considered proportionate in terms of achieving their objective.

Looking at the different scenarios and the impacts detailed in the earlier sections, a few conclusions can be made:

- Though of relevance for ensuring coherence with the WFD, **Scenario Glass 1** shall be very limited in promoting circularity. Despite the fact that it would significantly limit the practice of backfilling with mineral fractions derived from SHF, it still allows using this fraction as a filling material in construction: a practice that results in the downcycling of glass and in (permanent) removal of the related glass from the material cycle. Revising the definition, so that all practices that would be considered as downcycling (and that remove glass from the material cycle) cannot be counted as recycling would have an improved affect insofar that such practices could no longer be considered when accounting for compliance with the reuse & recycling target. This would push the waste sector towards high-quality recycling, however, without prescribing methods or minimum amounts. In this respect, instead of excluding backfilling, (Glass for Europe 2022) propose an alignment of the ‘recycling’ definition with the WFD, where a requirement for the quality of recycling is included, “adding the criterion of preservation or recovery of the distinct characteristics of the material with the view of maximising their potential to be re-used”. The amount of high-quality recycled glass that this flexibility would result in will then mainly depend on how much of other materials of the car composition can be reused or recycled and if the ATF can still reach the reuse and recycling target without glass dismantling and recycling (or with lower amounts). Assuming that other materials are addressed with more rigid provisions, this sub-scenario could prove to be a good compromise between environmental benefits and economic costs, as it has a high flexibility and only requires small revisions of the reporting, making reporting on glass recycling obligatory to allow monitoring.

- **Scenarios Glass 2 and 3** are very similar in their expected environmental impact, which achieves a significant improvement in terms of the circularity of glass. As a high quality of glass treatment is required for a minimum amount by the provisions in each of the scenarios, it appears that this result would be achieved regardless of whether the recycling definition is aligned with the WFD to exclude backfilling or not. Nonetheless, if backfilling and other forms of downcycling are not excluded form Scenario Glass 3 as currently suggested, achieving the target would be possible without increasing the quality of recycling, subsequently meaning that the environmental benefits would probably be lower, making this scenario less attractive. For Scenario Glass 2 the exclusion of backfilling was not suggested and as the scenario requires reporting on the amount of glass cullet sent from ATFs to recyclers it is not considered that such an exclusion would have an impact on the environmental impacts in either direction. That said, to ensure alignment with the WFD, it would be preferable to exclude backfilling under this scenario as well. As the obligatory dismantling of this scenario will already generate a shift away from backfilling and will affect the reporting, this change would not be considered to result in additional costs. Both **Scenarios Glass 2 and 3** are expected to result in significantly higher costs for dismantlers in terms of operations. Though the difference in the administrative costs give a preference for scenario Glass 2, it is more prescriptive, leaving little room for PST to develop towards high-quality glass removal. For the latter reasons, it is not proposed to discard either of the two scenarios.

EPR considerations:

- The additional costs related to dismantling and separate glass recycling could have a significant effect on the profitability of vehicle dismantling. Per vehicle, the costs that Intertek RDC & OVAM (2013?) specify for pre-and post-shredder recycling show a difference of over 150 €/tonne. This value seems high as it refers to the cost per tonne of glass, however, a vehicle typically contains around 30 kg of glass, meaning that the cost per vehicle is significantly lower.

A later study (ADEME, France 2015) specifies various sources regarding glass dismantling ranging between 2 € - 15 € per vehicle, with the majority of sources referring to values between 4 € - 8 € per vehicle. Following a comparison of these costs with post shredder recycling costs, ADEME specified the differences to range between 1.8 and 3.8 €/ELV depending on the study cited. ADEME also surveyed the dismantling times for windows at dismantling facilities specifying an average dismantling times of 30 minutes (10 minutes on average for the windscreen, 9.5 minutes for the side windows, 12 minutes for the rear window).

- There is also some data from MS that require the removal of glass (or have required it in the past) such as in cases in which ATFs are compensated for glass removal. For example, according to EGARA (2021), in the past, ARN (the Dutch EPR) rewarded dismantlers for material separation, resulting in mono streams of plastics, glass, rubber and fibre from seatbelts. For this removal, the first car owner was charged a sum of 45 €/vehicle and annum to cover depollution, unprofitable collection / transport and recycling (EGARA 2021). This fee covered other materials and not just glass and has since decreased to 25 €/vehicle and annum. EuRIC (2021) explains in this respect that recycling (in the WFD sense, excluding backfilling) is technically feasible, referring to studies carried out in France and Belgium, showing that it is not an economic practice. However, EuRIC state that with an EPR such recycling could be achieved.

3.1.8.1.6 Preferred Scenarios for inclusion in final policy options

It is proposed to look at the three following measures for comparison under the various policy options:

- Revision of the definition of recycling to exclude all practices that remove glass from the material cycle and are considered to be a recycling of low quality (down cycling) --> high flexibility, low economic costs, low to moderate environmental benefits,
- Obligatory removal and separate recycling of a minimum of 20 kg glass per ELV (average) --> low flexibility, high economic costs, high environmental benefits,
- Recycling target of 70 % glass recycling --> moderate flexibility, high economic costs, high environmental benefits.

3.1.8.1.7 Reporting and monitoring requirements

Reporting requirements are detailed in earlier sections of the analysis. As recommended by ARN, should dismantling be implemented in an obligatory basis, it may make sense to develop a monitoring system for ATFs to see that glass is removed form ELVs and not replaced or supplemented with glass from new vehicles. This would probably require additional market surveillance efforts in the MS. That said, if this would lead to a general increase in cullet sent to recycling, this would also be beneficial, whereas monitoring should ensure that only glass dismantled form ELVs is accountable should compensations be made to ATFs through the EPR schemes.

3.1.9 Analysis for plastic

3.1.9.1 Analysis for plastic

A variety of plastic polymers and elastomers are used in vehicles in many different components. The following tables, reproduced from (Maury et al. 2022) provide a good overview of the composition of components and their weights.

Table 3-40 Main polymer types per application in all types of vehicles: Components understood to be larger in volume (and heavier in weight) are specified in bold

Polymer type	Applications
POLYPROPYLENE (PP)	Front/rear **bumpers**, interior panels, **dashboard**, cable insulation
POLYETHYLENE HIGH DENSITY (PEHD)	**Fuel tank**
POLYURETHANE (PUR)	Flexible foam seating, foam insulation panels, elastomeric wheels and tires, automotive suspension bushings, cushions, electrical potting compounds, hard plastic parts
ACRYLONITRILE BUTADIENE STYRENE (ABS)	Body parts, dashboards, wheel covers
POLYAMIDE (PA, NYLON 6/6, NYLON 6)	Gears, bushes, cams, bearings, weatherproof coatings, carpet fibres
POLYVINYL CHLORIDE (PVC)	Instruments panels, electrical cables, pipes, doors
POLYSTYRENE (PS)	Equipment housings, buttons, fittings.
POLYETHYLENE (PE)	Car bodies (glass reinforced), electrical insulation.
POLYOXYMETHYLENE (POM)	**Interior and exterior trims**, fuel systems, small gears

POLYCARBONATE (PC)	**Bumpers**, headlamp lenses
ACRYLIC (PMMA)	Windows, displays, screens
POLYBUTYLENE TEREPHTHALATE (PBT)	Door handles, **bumpers**, carburettor components
POLYETHYLENE TERAPHTHALATE (PET)	Wiper arm and gear housings, headlamp retainer, engine cover, connector housings.
ACRYLONITRILE STYRENE ACRYLATE (ASA)	Housings, profiles, interior parts

Source: Specified by (Maury et al. 2022) as adapted from the Plastics Industry Trade Association (2016)

Table 3-41 Example of mass distribution intervals of recycled plastic materials per application types for a passenger car representing a potential 'front-runner case'. Percentage of recycled content is averaged based on the estimated masses of both pre-CR and post-CR

Plastics materials application	tot. mass (kg)	tot. recycled (kg)	% rec. content
External accessories - Bumpers	18-20	10-11	60%
Removable parts – Labels	6-8	4-6	80%
Interior trim	35-40	2-4	9%
Heating, Air conditioning	6-8	2-4	46%
Engine cooling system	6-8	1-3	30%
Electrotechnical	2-5	0-2	45%
Pedal unit, break, tools	2-5	0-2	45%
Power distribution systems(*)	6-8	0	0
Safety systems(*)	2-3	0	0
Dashboard	15-20	0	0
Fuel tank (*)	8-10	0	0
Seats(**)	15-20	0	0
Lighting – indicators	6-8	0	0
Sealing, windows, mirrors	10-15	0	0
Upper engine	3-5	0	0
Total	**150-170**	**25-32**	**15-18%**

(*) Technical or safety parts for which recycled plastics materials is excluded. Chemical recycling might be an option in the coming decade
(**) At the moment, PUR is downgraded during recycling and is not eligible for the same applications (seat foams).

Sources: Specified by (Maury et al. 2022) as (Gallone and Zeni-Guido, 2019), personal communication with relevant stakeholders

Five measures were shortlisted for plastics, including the following measures:

Title	Chapter
2.1.g: Establishment of mandatory recycled content targets for plastics used in cars	2.1.5.1.8
2.4.a: Align definition of 'recycling' with the WFD to prohibit backfilling of plastic residues	2.1.5.4.1
2.4.b: Making it mandatory to remove certain plastic parts before shredding to encourage their recycling	2.1.5.4.2
2.4.c: Set material-specific recycling target for plastic	2.1.5.4.3
2.4.e: Ban disposal or landfilling of waste from ELVs --> requiring PST targeted at plastics	2.1.5.4.5

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

- Measure 2.4.b making the dismantling of plastic parts obligatory is considered to be redundant and thus discarded: The ELVD already refers to large plastic components in Annex I(4) referring to bumpers, the dashboard, fluid containers, etc., as components that should be removed "if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials". Though a threshold could be considered on the weight of components to be removed and additional components could be added to the list, the measure is considered to already exist and would only need to be updated as relevant. Looking however at the data specified for plastic in section 2.1.2.5.8, it seems that there are not many mono-plastic components in a vehicle that would justify setting such a threshold: aside from bumpers, the above tables clarify the larger weights for dashboards, fuel tanks, interior trims and seats. However, most of these cannot be recycled (PU foam in seats, dashboard need to be disassembled and this is usually not performed[269], mono material fuel tanks understood to not be recycled at high quality). Adding a threshold for polymers with known recycling capabilities could ensure recycling for the case of bumpers, but it is not clear if it would make a difference for other components, whereas for bumpers it would suffice to adapt the annex so that bumpers need to be removed in any case. This measure is thus discarded.
- Measure 2.4.a, which would exclude backfilling is also discarded. It is understood that plastics that are included in the shredder fraction would be removed in the various sorting processes and do not remain in large amounts in the (sorted) mineral fraction that is sent to backfilling. This measure would thus not be considered to be effective in this case and is discarded.
- Measure 2.1.g, considering a recycled content target for plastics has been investigated by the Joint Research Centre (Maury et al. 2022). Results of the analysis are reported in the context of this analysis, however, without revising the analysis itself. This measure will be looked at initially as an alternative to the other measures investigated so that a distinction can be made on the contributions of each measure, however it is likely that it would later be combined with either one or both of the other measures considered.
- Measure 2.4.c, A recycling target is also an option to increase the high-quality recycling of plastic. High quality recycling would be a pre-condition for introducing a recycled content target but could also be considered as a single measure.
- Measure 2.4.e, ban disposal or landfilling of waste from ELVs is explained to be achieved through requirements of PST targeting the removal of PVC and POPs from SLF, either directly or after it has been subject to PST treatments (granulates). Through a prohibition on disposal of PST to landfills and a ban on material recycling of these fractions when SLF is treated with PST or when fraction resulting from PST have a specific weight above

[269] This was specified by EGARA (2021) who also explained that it was obligatory in the past in Denmark to dismantle the dashboard, however there was no specific recycling at the time and was stored and later sent to shredder. The obligation is understood to have been removed. The instruments panel of the dashboard is now recycled by STENA, but this is understood to focus more on the recycling of the EEC, i.e., the dismantling is not performed to obtain the plastic.

1.3 g/cm^3. Though this measure is expected to reduce amounts of SLF to be disposed in landfill, it is also expected to promote PST that targets fractions that can be sent to material recycling. In so far it would also be expected to increase the recycling of vehicle plastics.

3.1.9.1.1 Scenarios for quantitative analysis

3.1.9.1.1.1 Baseline

Plastic is used in increasing amounts in vehicles. At EoL some of the plastic components are dismantled and sent to separate recycling (after sorting into different polymers, e.g., PP, ABS) and some remain in the vehicle and go through shredding and PST operations. According to Maury et al. (2022), at present, Polypropylene (PP), Polyurethane (PUR) and Polyamide (PA) are the 3 main polymers used in the overall plastic composition of the EU ICE equivalent vehicles' plastic components. The share of PVC in vehicles is significantly decreasing in Europe according to recyclers feedbacks, being around 3%. However, the polymers composition is expected to change in the future, mainly due to the wide uptake of battery electric vehicles (BEV). According to some stakeholders, a simplification in the number of polymer types and grades, i.e., less diversity on the plastic types and grades may occur (e.g. more PP and PET and less PA in the future).

- PP will remain the most used polymers in cars with a probable future growth due to the crucial need of lightweight for BEV as well as new "under the hood" applications such as casing for batteries.
- PA substitution by PP and PE might stem from the lower thermal constraints of BEVs as compared to internal combustion engine vehicles.
- Potential new "under the hood" applications for PE should compensate, at least partly, the loss of fuel tank made with HDPE (i.e., with the shift from ICEs to BEVs).
- Several experts forecast that PVC applications will continue to decrease, already used to a lower extent than in the past in vehicles. This is explained to partly be due the complexity of the PVC recycling operations. The ABS consumption is expected to decline as polystyrene and PP composites with improved properties continue to replace ABS in decorative parts in the interior, except perhaps for the highest premium / executive car.
- Finally, a higher PC consumption is expected (around 2% today) due to wider development of glazing applications in automotive. PC could substitute heavier glass material in the next decades. The higher level of connectivity for future cars should also generate more demand for PC entering in the composition of sensors and optical devices

Maury et al. (2022) explains that integration of recycled plastics in vehicles today is often considered as less straightforward by the automotive stakeholders due to the potential difference in mechanical or aesthetics properties and substances composition between virgin and recycled materials. However, for most of the automotive manufacturers (OEMs), JRC understands from ACEA and CLEPA, that integration of recycled plastics is already a common practice. First, automotive companies reuse their own plastic production scraps, defective parts and other materials in a closed loop process to minimise potential waste streams. Going further, many manufacturers already integrate in their vehicles pre- and post-consumer recycled materials coming from both closed-loop, i.e. materials coming from automotive industry, and open loop, i.e. materials from other sectors. For instance, PET from packaging waste and PA from carpet textiles find application in vehicle textile interiors. To a lesser extent, they also use recyclates sourced from ELV plastics. Interviews of stakeholders show that the main recycled polymers that are used are PP, followed by PET and to a lesser extent PA. Data also suggests that nowadays, up to 90% of the recyclates used in the vehicles come from pre-consumer sources rather than post-consumer. This is expected to change in the future as the supply of pre-consumer sources is limited. Where pre-consumer recyclates have known and stable composition that may be suitable for interiors, aesthetics, or even safety plastics parts, for post-consumer recyclates there are uncertainties on composition, and these are thus usually used for non-aesthetics and non-safety parts. Technical applications may be more limited than when using pre consumer materials. JRC assumes that 8% is the current average of recycled content in vehicles, with 18% assumed for the more advanced OEMs. 6% of pre-consumer recyclates are assumed for both ICE and BEV vehicles for the baseline, differentiating between the various polymer types.

Considering the composition of current vehicles reaching end-of-life the following values seem relevant: PP (37%); PUR (15%); PA (12%); ABS (7%); PE (8%); PET (5%) others (incl. PC, PMMA, PBT, POM…) (16%). (Maury et al. 2022)

On average, of the plastic included in ELVs, 19 % is diverted to recycling, 41% to energy recovery and 40% to disposal (mainly landfill), though there are deviations between the various MS. Only a few countries in the EEA achieve levels above 35 % of plastic recycling including Norway, Sweden and Switzerland with most EU countries achieving less than 25% recycling (Maury et al. 2022). This is among others a result of the fact that metal recycling is more economical than plastic recycling, while also contributing more to achieving the targets which are weight based.

End-of-life vehicles (ELVs) are considered as a substantial high-value waste stream, in which mixed plastics waste is estimated to account for around 1.5 Mt annually of which more than 1 Mt is collected at ATFs. This latter amount refers to around 6 million of ELVs annually treated in EU-27 in compliance with the ELVD. The current stream of plastic waste from automotive sector sent for recycling is estimated in 350 kt/a, and the remaining fraction is sent either to energy recovery or to landfill. PP from bumpers and PE from fuel tanks are the most recycled plastics removed by dismantlers and bumpers can be recycled back into bumpers though not common as it is cheaper to send the bumper with the hulk to shredding. Plastic from dismantled fuel tanks is usually sent to recycling in drainage tubing or for heat valorisation in cement kilns. In total it is assumed that an average of 1% of the total plastic in ELVs can be estimated to be dismantled at ATF and sent to recycling without shredding, while other dismantled parts for reuse are estimated to represent up to 18.5% of the vehicle plastic. (Maury et al. 2022)

1.05 Mt of mixed plastics fractions is typically generated in the EU 27 in the automotive shredder residues (ASR) fraction. Plastics in ASR usually vary from 20 to 40%wt and PUR foam from 4 to 15%wt. Sorting fractions out of the ASR is challenging, among others due to the ASR being a mix of ELV and waste of other sectors (e.g., WEEE) and due to the presence of various hazardous substances. Standard PST, sorts ASF into sub-fractions and is mainly aimed at sorting ferrous metal from non-ferrous metal fractions. Advanced PST aims to separate plastic fractions (in shredder light and shredder heavy fractions or SLF and SHF fractions) in addition to metal fractions from the output, by using e.g., density and gravity separation processes which allow the recovery of polyolefins or styrenics compounds. Advanced PST is in place in Germany, France, Belgium and the Netherlands, and their importance for environmentally suitable waste treatment has been recognized (achieving a recycling rate of 56% for some plastics such as PP/PE. The SLF is composed of plastics, PUR foam, textiles and rubber, metal & wire, and others (such as wood, paper, soil/sand, glass), produced when the non-ferrous fraction is separated into metal and non-metallic streams. In SLF the share of plastics usually varies from 9 to 37%wt and of PUR foam from 5 to 29%wt. The SHF is the remaining fraction and mainly composed of heavy materials, such as metal fines, rubber, glass, or soil/sand fraction, however it can also contain plastic and textiles. In the SHF the share of plastic varies the from 12 to 31%wt and PUR foam from 2 to 3%wt. (Maury et al. 2022)

In PST and later in advanced PST, a plastic rich stream is separated from other fractions and then sorted into separate polymers based on different densities, electrostatic charging and separation, and surface properties of the streams within the ASR. According to stakeholders the number of facilities across Europe is rather limited, with around 20-25 facilities with advanced PST mainly in France, Belgium, the Netherlands and Germany. Advanced PST sorts plastic polymers by applying different steps of float/sink separation aimed at separating mixed plastics and grading them by means of density differences. Density-based separators include, among other, settling tanks, hydrocyclones and jigs. Other techniques, such as froth flotation or laser and infra-red systems have been developed to separate plastics by colour and polymers type, as well as eliminate impurities such as wood fragments. Other separation sensor technologies are based on optical or atomic differences and chemical analysis. A few further technologies have been suggested and could develop in the future to allow elimination of impurities (such as styrenic polymers, foams and films) by means of airflow technologies, such as zigzag separators or densiometric tables, or to over-separate the flow products through use of electrostatic separation. As for long-term developments related to advanced PST that can be understood to require changes in design relates to certain limitations in optical sorting of ASR plastics by near infrared, due to presence of humidity, oil residue, coatings and plastic colouring with carbon black. To promote optical sorting, R&D focus on adding chemical compounds (e.g., phosphor markers) to components as a fingerprint easily identified by sensors. (Maury et al. 2022)

For 2019, the CPA (2021) estimated that from 1.5 million tonnes of plastics collected from ELVs, only 350 thousand tonnes were sorted for recycling, resulting in a total of 150 thousand tonnes recycled (~10 %). According to the CPA (2021) the separation of different plastics has made significant progress in recent years and several thousand tonnes (approx. 0.35 Mt) of different polymers (e.g., PP, PE, ABS, PVC...) can be obtained from ASR through advanced PST to generate higher-quality recycled plastics (appr. 0.15 Mt) able to meet the requirements (e.g., legal, technical, and quality) for the automotive market or other sectors (e.g., construction).

The following table provides details on the outputs of plastics to reuse, recycling, recovery and disposal during the treatment cycle of ELVs in a few countries and is a compilation of results of a study performed by (Ramboll 2020). The data demonstrates that recycling can be a result of dismantling or of shredding (with or without PST), with the quality of recyclates depending on the specific country and the waste management facilities that treat ELVs in the various stages.

Table 3-42 Outputs of plastic in tonnes to the 3Rs along the treatment cycle of ELVs (data representing 2014)

	Total plastic	Dismantled	Shredded	PST
Germany	73,839	1,410 Recycling: 1,274 Reuse: 108 Disposal: 28	69,337	n.a.
Netherlands	28,858	No data	No data	19,712 (68%) Landfilling: 169 Recovery:15,598 Mechanical recycling: 3,945*
France	125,092	14,400 Recycling: 5,019 Reuse: 9,363 Disposal: 18	98,062 SLF Recycling: 13,102 SLF Recovery: 21,813 SLF Disposal: 38,824 Heavy residues & fines: SLF Recycling: 11,842 SLF Recovery: 6,338 SLF Disposal: 11,665	90,901** Disposal: 25,377 Recovery:17,415 Mechanical recycling: 48,110 (recycled PP and PE are sent to automotive industry, PS and ABS sent to other recipient

*Notes: *Used for manufacturing road signs and waterfront facing sheets*

Plastic entering PST in France assumed to partly already be accounted for in the shredder fraction

Compiled from data in (Ramboll 2020), PST shares are calculated based on the data included in the report.

JRC estimates that an average of 1% of the total plastic contained in a vehicle (on average 132 kg/ELV) is currently dismantled and recycled separately. After the shredder operations, various sources indicate that the plastic content usually varies from 9 to 37%wt and PUR foam from 5 to 29%wt in the shredder light fraction, and from 12 to 31%wt and PUR foam from 2 to 3%wt in the shredder heavy fraction (Maury et al. 2022).

According to the JRC assumptions (Maury et al. 2022) and based on a vehicle of 1,000,kg, the following shares (and amounts) are assumed to be treated through the various routes in the baseline:

- An ELV contains 12% or 132 kg of plastics.
- At the ATF (depollution and) dismantling result in stream of 11 kg of plastics per vehicle, with 9.7 kg (8.3% of the total plastic stream) diverted to reuse and 1.3 kg (or 1%) to recycling (no shredder).
- 121 kg (91.6 %) of plastics is sent to the shredder.
- After all processing stages, the EU standard level of operation results in 21 kg (16%) of recycled plastics and where advanced PST is applied this is said to result in 31 kg (23.5%).

The JRC data does not allow specifying how much of the shredded fraction is diverted to energy recovery and how much is “lost” due to process inefficiency of the sorting and PST as well as of polymer compounding. For convenience it has been assumed that the remaining plastic is split half-half between these two streams, i.e., in the standard level, 50 kg (38%) is sent to energy recovery (possibly also a little bit of backfilling due to plastic residues in the heavy fraction) and 50 kg (38%) is disposed of or landfilled. Where the current state of advanced PST is applied, this stream is reduced to 45 kg (34%) sent to energy recovery and the same amount sent to disposal.

3.1.9.1.1.2 Scenario Plastic 1: Establishing a recycled content target for plastic

The recycled content targets measure for plastics was developed by JRC and details of the analysis and further options can be viewed in their final report. (Maury et al. 2022). This scenario is thus presented in lesser detail, as compared to the other sub-scenarios presented here.

The share of recycled content from all plastics used in vehicles remains relatively modest and is mainly comprised of pre-consumer recyclates. The latter is due to uncertainties in the quality and consistent supply of post-consumer plastics. Though the costs of secondary plastics by now are usually below those of virgin material, there are price fluctuations that can be a disadvantage, for recyclates in terms of increasing the recycled content share. An increase in uptake of recycled content could also drive an increase in the costs of secondary plastics, creating competition between OEMs on supply. (Maury et al. 2022)

A few alternatives could be considered under this scenario.

- Scenario plastic 1.0: To allow quick deployment and to collect information form OEMs on the status of recycled content in their vehicles, an obligatory declaration of plastic recycled content in new vehicles placed on the market (with no minimal threshold) could be introduced, entering into force 2 years after the adoption of the legislative instrument (2025). This alternative can be seen as a supporting measure, allowing a better understanding of the actual situation. It could be applied on its own or coupled at a later stage with one of the target alternatives presented below. This alternative reflects scenario 2a of the JRC report.

Other alternative prescribes setting a recycled content target for vehicles to be put on the EU market as to the minimum amount of plastic recycled content that they are to contain. Two options have been shortlisted after consultation with the Commission for the current analysis, considered to be most relevant in terms of the ratios of environmental benefits and economic costs:

- Scenario plastic 1.a: very ambitious mandatory targets for 25% in 2030 and 30% in 2035., This alternative reflects scenario 3c of the JRC report. It is based on proposals of EuRIC with the difference that it does not differentiate between plastic types and incorporates PUR foams.
- Scenario plastic 1.b: highest ambition mandatory targets for 30% in 2030 and 35% in 2035. This alternative reflects scenario 3d of the JRC report. It expects large availability of recyclate materials within the automotive sector and from other sectors and is thus proposed to be combined with scenario plastic 2 (see below). It also considers the future availability of new recycled grades that are not available today in the market (e.g. rPUR or rPC) but could be produced thanks to innovative recycling processes.

For these last two alternatives, it is furthermore envisioned to require OEMs to provide the declaration referred to under Scenario plastic 1.0, on the content of recycled plastics in the specific model, presumably through the 3R Type-approval.

3.1.9.1.1.3 Scenario Plastic 2: Establishing a material specific recycling target for plastic

As opposed to other measures, a material specific target for plastic has an advantage insofar as it leaves flexible for waste operators to decide what processing stages to apply to ensure it is complied with. In this sense, operators could consider whether to increase dismantling and separate recycling or to adopt advanced PST and promote the development of further PST technologies, to improve their outputs but also to allow the sporting and recycling of additional plastic types (such as PU foams mentioned above under scenario plastic 1b). Development of additional technologies would also not be excluded as explained below.

The CPA (2021) mentions that separate waste collection is correlated with higher recycling rates (one of the important conclusions from a Plastics Europe report performed in 2019)[270]. In parallel, it also explains that for polyolefins and other polymers (e.g., ABS) mechanical recycling is good. However, to increase plastic circularity, chemical recycling (CR) should focus on the recycling of those polymers (40-50 % of those present in a car) with a very low or nonmaterial recovery rate (e.g., PU, PCS, ETP …). In other words, an important question behind the setting of a target for plastic is whether chemical recycling would be counted towards recycling or not (currently unknown and may also vary between CR technologies).

This study uses the JRC simplification to include all types of physical recycling such as solvent-based methods or series of purification steps that may allow converting polymers into chemicals, and processes such as selective dissolution, pyrolysis, gasification and both chemical and thermal depolymerisation (but excluding energy recovery) under the term chemical recycling. According to Maury et al. (2022), not all CR processes can treat mixed plastic waste, only cracking (pyrolysis or gasification) may be able to perform such feat. CR is also explained to not yet be mature and cost effective when compared to mechanical recycling and the environmental competitiveness of different technologies is sometimes questioned. It is not yet clear how CR technologies will develop in the future and also whether they would be accredited at the same level as mechanical recycling (and accountable towards

[270] Referenced in (CPA 2021) as PlasticsEurope “The Circular Economy for plastics – A European overview”

reaching recycling targets). At this stage it can thus not be considered whether to include or exclude them from this measure, and the decision is thus left open.

Stakeholders were asked during interviews to comment on some proposed levels and following their responses ((EuRIC (2021); a plastics recyclers association (2021)) it is considered that 30% recycling is ambitious but could be achieved, whereas 40% was considered to be too high by the plastic recycling association.

Stakeholders also specify that some polymers are more relevant than others in terms of secondary plastics to be used in vehicles but advise a mutual target for all polymers (as opposed to e.g., limitation to thermoplastics), to avoid that OEMs shift from one polymer to another to allow achieving a polymer specific recycling target.

Against the various uncertainties, a target could be considered to require that 30-40 % of all plastics in the vehicle are to be recycled by 2030. This would allow operators to decide how to combine dismantling and existing and new PST technologies to achieve the minimum level. Depending on how it would develop and whether it will be seen as an alternative to mechanical recycling, CR technologies could also be considered, in particular where this could allow removal of hazardous substances. As with other materials, the actual level of recycling is to depend on where recycled plastics need to be measured for monitoring. Reporting similar to the current one will result in higher rates being reported as the basis is how much material can be sold to various plastic recyclers (high quality recycling but also downcycling). Monitoring of the plastic containing fraction when entering a treatment facility and the corresponding actual recycling efficiency will lower the targets that can be achieved but will be more effective in ensuring a higher quality. In the latter case the target should be set at 30 % by 2030 and in the former one at 40 %.

A plastic recycling target could be applied on its own or together with a recycled content target. The following analysis considers this option together with a recycled content target of the highest ambition (sub-scenario plastics 1c) mandatory targets of 30% in 2030 and 35% in 2035, as it is assumed to achieve the highest amounts of recycling and is assumed to ensure a more stable supply of recyclates as compared to the following scenario where the actual level achieved could differ from time to time.

3.1.9.1.1.4 Scenario Plastic 3: Banning the landfilling of fractions with a high content of plastics

Most plastic is understood to be sent with the vehicle hulk to shredder operations and to later require a series of treatment processes to allow recovering the plastic fractions and sending them to recycling (high quality but also downcycling). It is considered by some stakeholders that the application of various PST technologies (current ones but also future developments) is the best option for material recovery of plastic, as once the capacities have been installed the operating costs are said to be lower than dismantling costs.

In the Dutch PST facility in Tiel, raw materials contained in the shredder waste undergo a process that includes around 180 machines. This results in four different fractions, roughly classified as: metals, plastics, fibres and minerals. To separate plastics a pre-separator step is used to remove aluminium, iron and copper form the fraction. A magnet, an Eddy Current and a special sieve are used to remove iron, aluminium and copper. Crushed plastic goes into a zinc float separator and the plastics are separated in two baths on the basis of specific weight. This results in three plastic streams: PP & PE, blast furnace fraction and a heavy fraction containing a lot of copper. The heavy plastic fraction and additional copper wires from the fibre fraction are treated to extract copper and aluminium, contributing to the recovery of the plastic in this fraction.[271]

As mentioned above, advanced PST is in place in in only few countries (Germany, France, Belgium and the Netherlands, possibly also Denmark), and their importance for environmentally suitable waste treatment has been recognized (achieving a recycling rate of 56 % for some plastics such as PP/PE" (Maury et al. 2022). As advanced PST is still not very common in the EU, it is assumed that increasing its application could raise plastic recycling in the short term, whereas in the longer term it is assumed that more advanced technologies would develop to improve the sorting of fractions and possibly also to recycle additional plastic types.

A ban will be introduced on the disposal of shredder light fraction that is not sent to PST and PST output fractions with a specific weight of > 1.3 g/cm^3. Additionally, minimum performance requirements could be set for PST treatment of fractions containing plastics. The available data on post shredder technologies that could assist in the recovery of plastics is sparse and to a large degree also outdated. Further specification would require an in-depth investigation and possibly also development of a standard on such technologies.

3.1.9.1.2 Results of qualitative analysis

Under **scenario plastic 1** the sub-scenarios differ in terms of the targeted uptake of recyclates in the automotive sector. This will affect both the benefits expected from each sub-scenario but also results in differences regarding the costs that achieving the targets is expected to result in. A mandatory declaration by OEMs (scenario plastic 1.0) will prepare the ground for audit and traceability schemes, letting time to adapt to a most ambitious regulatory measure, should one be considered in the future. Very ambitious level targets (scenario plastic 1.a) would represent important efforts for OEMs as well as for recyclers to supply the increased demand. Highest level targets (scenario plastic 1.b) would represent substantial efforts for OEMs as well as for recyclers to supply the increased demand. An increase of availability of recyclates from all sectors is to be expected in this case, meaning that the amount of secondary material derived from ELVs would need to increase. Where mandatory targets of recycled plastic content are included, this is expected to increase the circularity of vehicles, expected to be marginal under scenario 1.0, low under scenario 1.a and moderate under scenario 1.b. The level of ambition will determine to what degree and will also affect costs. Though a more ambitious target results in high investment costs in the beginning, it also secures the future demand for recycled plastics, which is of particular importance when targets also require a certain level of closed loop recycling, as this will ensure that investments are also returned to a higher degree over time. This is also expected to help in potential job creation.

One of the advantages of **scenario plastic 2** is that it leaves open how to achieve the recycling targets, as opposed to obligatory dismantling or requirements for PST. Though some stakeholders support PST as being a less expensive option for increasing recycling, in EGARAs (2022a) opinion, the costs of PST are the same as separation at the source (dismantling) due to many unprofitable materials. What is more expensive can differ from country to country. Some will prefer to invest in dismantling as the cost of labour is not so high, whereas others will prefer a one-time investment in PST that then reduces the annul operational cost. Other factors may also affect such choices such as the distance between ATFs to further treatment and recycling facilities. The recycling target ensures that over time a minimal level of recycling would be achieved (assuming set realistically) but gives more

[271] Summary from https://adoc.pub/dossier-pst-fabriek-de-onmisbare-schakel-dossier-grondstoffe.html, last viewed 25.6.2022

flexibility for operators to consider what the most economically efficient way is of achieving the target. Introducing a target is expected to increase the amounts of plastic material recycled from vehicles, which will lead to an increase in costs for the processing of plastics by operators. For some this will mean more dismantling and separation of certain plastics (e.g., PP, ABS) and for others an investment in PST capacities that enable separation of the plastic fraction into separate polymers that can be recycled. Various actors (EGARA 2021; CPA 2021) refer to dismantling of plastic components as having a positive effect on the use of recycled content as it will result in better quality of shredded plastic fractions and foams and a higher quantity of recovered plastics fractions (thanks to easier sorting) as well as PUR, however little evidence has been provided by stakeholders to clarify plastic components, the dismantling of which would lead to higher quality recycling. In parallel, from the data compiled by (Maury et al. 2022) it is understood that application of advanced PST technologies by more MS is expected to allow a shift from the standard 16% recycling to the frontrunner 24%. Chemical recycling may also play a role in achieving a target, depending on how it is to develop and whether it will count as recycling. In short, this measure is assumed to promote a more heterogenous application of methods to achieve the target, giving operators more flexibility. The latter will lead operators in different MS to promote the alternative considered most economically feasible in their area. .

As for **scenario plastic 3**, the CPA (2021) explains that “the recycling sector still favours PST over dismantling based on the experience with the cost/benefit of both approaches. Investment in PST makes more economic sense in terms of improving plastic recovery from the ASR and recycling through advanced PST. ASR represents approx. 90 % of plastics present in a car and shows the opportunity to increase the recovery of plastic material from this ASR”. Advanced PST also has the benefit that it will allow better sorting of plastic contaminated with hazardous substances from the plastic stream, i.e., reducing losses of material currently disposed of due to such contaminants. JRC estimate that a ban on the disposal or landfilling of waste from ELVs shall lead to a higher quantity of plastic from ELV entering the recycling route (Maury et al. 2022). It is however not clear how this would affect the total quantity of recyclates and more importantly could also result in an increase in low quality recycling or energy recovery. In terms of costs, at present the capacities of PST facilities in the EU are rather limited and only available in some countries (4-5 MS), so that it can be expected that this scenario may result in high costs a least for some MS. Nonetheless, the current experience with advanced PST shows that it can increase the share of recycled plastics significantly already with existing technologies (16% --> 24 %) and it is probably that additional innovations will be developed, considering the already existing research in this direction.

3.1.9.1.3 Results of quantitative analysis

In the baseline, it is assumed that 5% of plastics are diverted to reuse in various components. The actual amount of material recovered (recyclates) amounts to 17 % of the plastics in vehicles. Of this 1 % is recycled as a result of dismantling and sorting into separate streams. The rest of the amount is split half-half between energy recovery (39%) and losses (39% assumed to be disposed of).

Under **scenario plastic 1**, obligatory declaration on use of recycled content and/or a recycled content target shall be introduced, its impacts on the vehicle waste management will depend on the nature of the requirement.

Sub-scenario plastic 1.0 looks at the sole results of an obligatory declaration. It assumes only a marginal increase in reuse (6%) and in recycling after dismantling (2%), meaning that 18% of plastics are recycled.

Sub-scenario plastic 1.a assumes that a target for recycled plastic content is introduced, requiring 25% of min rec. content in 20230 and then 30% in 2035. This is understood to be ambitious and is assumed to drive more significant improvements under the baseline, namely the implementation of advanced PST across the EU at its current level. This will lead to an increase of reuse to 10% and of recycling after dismantling to 4%. Post shredder recycling would be assumed to increase to 20%, making for a total of 24% of recycled plastics from vehicles.

Sub-scenario plastic 1.b is understood to require a higher increase in recycling of plastics from vehicles and is thus coupled with a material recycling target for plastics, i.e., it is combined into scenario plastic 2 (see there for details).

Under **scenario plastic 2**, a 40 % target is to be introduced, under the assumption that it addresses the quantities sent to recycling (e.g., includes losses, but monitoring is less burdensome). The sector will develop more separation at the source (dismantling) as well as improving both shredding and post-shredder techniques. Reuse is expected to remain stable (10%) but recycling after dismantling will increase to 6% and post shredder recycling to 24%, making for a total plastic recycling (actual recyclates) of 30%. This scenario is coupled with a recycled content target of 30% in 2030 and 35% in 2035 and the recycled amounts are assumed to support this target with higher contributions from the vehicle sector.

Under **scenario plastic 3**, operators are required to introduce PST requirements and it can be expected that this would need to be supported with the development of a PST standard to clarify the minimum level of performance. Advanced PST would be adopted across the EU. For some operators this would mean the current level of recycling of 24% could be reached, but it is also assumed that technologies would continue to develop and that some operators would achieve higher levels. Here reuse is assumed to remain 10%, recycling after dismantling will amount to 5% and post shredder recycling will achieve an additional 24%, making for a total plastic recycling (actual recyclates) of 29%. As disposal is only allowed after PST and only for fractions with a specific weight of < 1.3 g/cm^3 it is assumed that removal of hazardous substances shall achieve a higher level, thus decreasing amounts sent to recovery and inefficiencies (disposal) as cleaner fraction support more recycling.

The following table specifies the routes of treatment assumed under each option.

Table 3-43 Routes of treatment for plastics from ELVs under the various scenarios

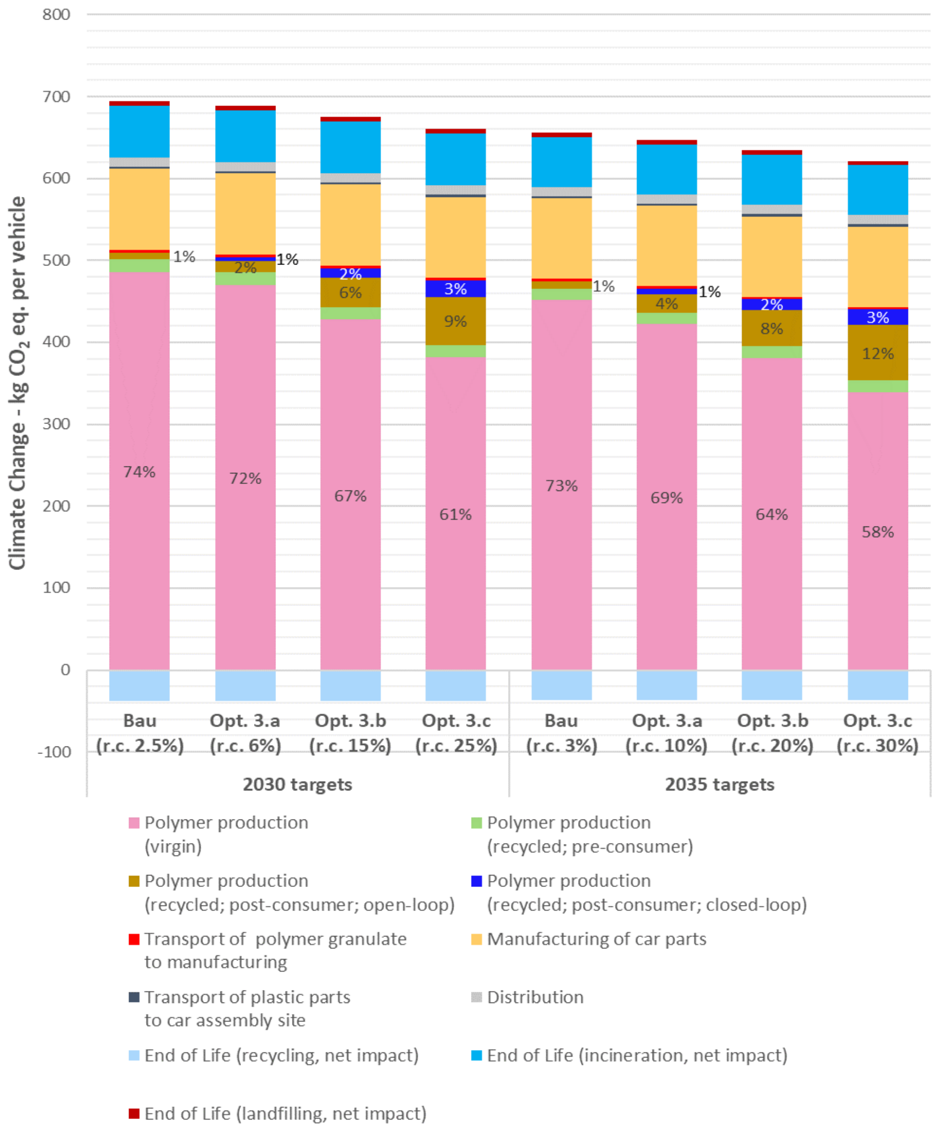
Plastics	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	5%	6%	10%	10%	10%
Dismantled -> recycled (no shredding)	1%	2%	4%	6%	5%
Dismantled -> shredded ->recycled	0%	0%	0%	0%	0%
Shredded -> recycled	43.5%	41.5%	42.0%	49.0%	45.0%
Recovered: (energy recovery or backfilling)	50.5%	50.5%	44.0%	35.0%	40.0%
Losses/process inefficiencies	5%	6%	10%	10%	10%

Source: Oeko-Institut: own assumptions based on available data.

3.1.9.1.3.1 Environmental impacts

For **scenario plastic 1**, JRC presents detailed results in their report, whereas here only estimations for: Climate Change (in kg CO2 eq.), are reproduced. Figure 3-14 compares the potential impacts of some of the assessed policy scenarios with those of the corresponding Business as Usual (BaU) scenario, focusing on the Climate change category. The overall climate change impact of plastic materials used in one average vehicle at a given year is progressively reduced when more recycled plastic is incorporated in the vehicle compared to the relevant BaU scenario. In other words, an impact reduction occurs with the implementation of the proposed policy options, and this reduction increases with the level of ambition of the option itself, and hence with the uptake of recyclates in new vehicles. (summarised from Maury et al. (2022))

Figure 3-14 Potential impact on Climate Change of plastic granulates from different feedstock sources, as calculated for the purpose of the JRC analysis. (kg CO2 eq. per kg of plastic granulates)



Source: JRC report, figure 22 (Maury et al. 2022)

The JRC report explains that the impact on climate change is reduced by at least 50 % when comparing post-consumer recycled plastics from open-loop or closed-loop recycling with their virgin counterpart, and this for all the polymer types. The increased use of recycled plastic in scenario plastic 1-1 and 1-2 is thus expected to reduce the consumption of virgin plastics, consequently improving the environmental performances related to GHG emissions from plastic material use in vehicles or elsewhere. (summarised from Maury et al. (2022))

Relating to the scenarios proposed in this study that includes a recycled content element, it is assumed that in Scenario plastic 1-0, though there shall be a small increase in the level of recycling, however this shall not necessarily feed into the use of recycled content in vehicle production, given that there is no target, and even of the declaration shall motivate OEMS to apply my recycled content, this would not rely on the recycling from the sector.

For Scenario plastic 1-2, a high target is adopted, according to which vehicles reach 30% recycled content by 2035. This results in a reduction of ca. 75 kg CO_2 eq. per vehicle. A tenth of this is reduction is understood to be achieved through post-consumer closed loop plastics, meaning that the ELV recycling contributes around 7.5 kg CO_2 eq to the process. This share is subtracted to avoid double counting when combining the EoL material flows, resulting in 67.5 kgCO2eq per vehicle.

For Scenario plastic 1-2, the target is 5% higher. Assuming a linear increase kg CO_2 eq would mean that per each vehicle ca. 71 kgCO2eq are saved.

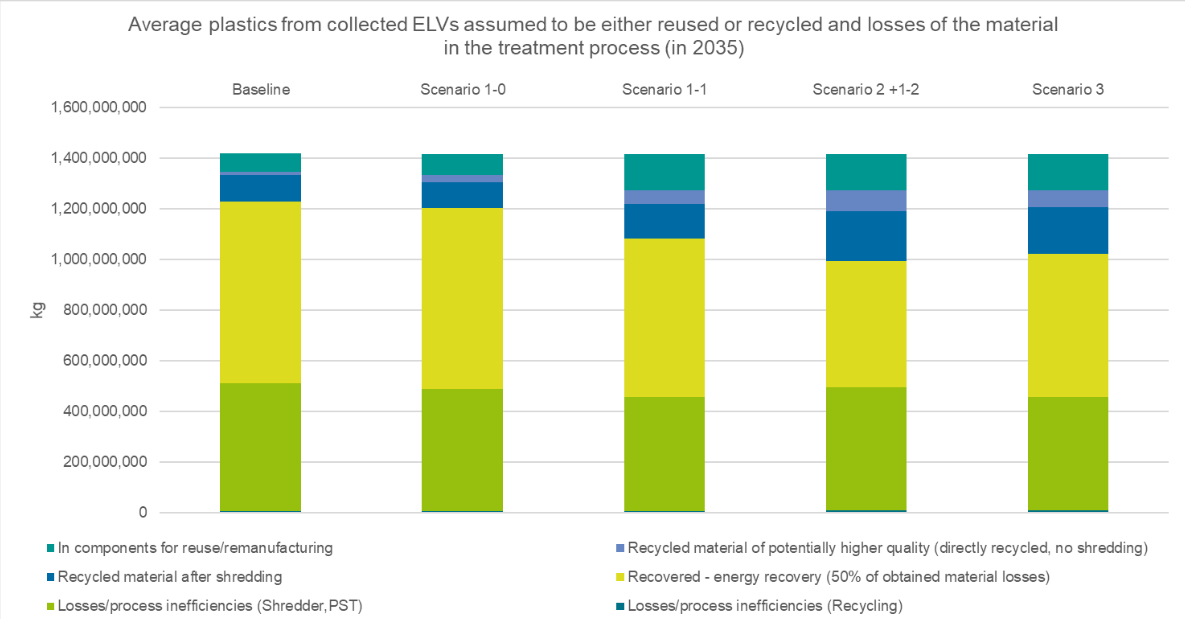
To summarise:

- ➔ Scenario plastic 1-0: it is assumed that even if recycled content shall increase, it shall be marginal and shall not be sourced from vehicles.
- ➔ Scenario plastic 1-1: An increase of 67.5 kgCO2eq per vehicle is assumed to be sourced from other sectors.
- ➔ Scenario plastic 1-2: An increase of ca 71 kgCO2eq per vehicle is assumed to be sourced from other sectors.

These amounts have been used to calculate the additional contribution of each scenario to climate change reduction.

Based on the shares of plastic to undergo various treatments at EoL, presented in Table 3-43, the material flows in the waste management sector were calculated. And are presented in Figure 3-15.

Figure 3-15 Average plastics from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035), in kg



Source: Own illustration

The total increase in recycled plastics in comparison to the baseline under each scenario is specified in Table 3-44, which also specifies the increase of recycled plastics that originate form dismantled components and thus is potentially of higher quality.

Table 3-44 Recycled plastics volume generated as compared to the baseline under the various scenarios in tonnes

	Scenario 1-0	Scenario 1-1	Scenario 2 + 1-2	Scenario 3
Delta recycled plastics as compared to baseline	127,600	191,200	279,000	249,400
Delta recycled plastics from dismantling with potentially higher quality	13,500	40,450	67,400	53,900

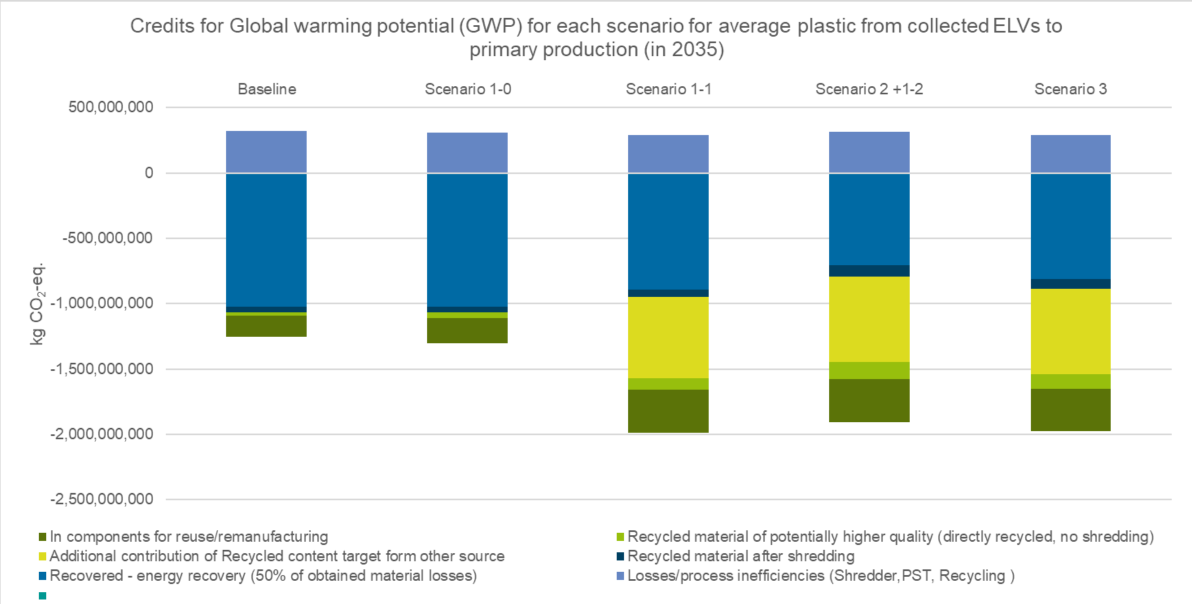
Source: Oeko-Institut: own assumptions based on available data.

Though the total amount of recycled plastics is similar between scenario 2+1-2 and scenario 3, the former is assumed to initiate a little bit more dismantling to ensure that the targets are reached – both the material specific recycling target and the recycled content one.

It is furthermore assumed that, when recycling after dismantling, the plastic does not undergo the various shredding and sorting processes, so the benefit in terms of kg recyclate would be expected to be higher, i.e. as inefficiency losses to the shredder and PST are spared.

Based on the material flows presented in Table 3-43, and on the estimations on the additional contributions of recycled content scenario to climate changes, the total GWP reductions were calculated for the various scenarios and are presented below.

Figure 3-16 Credits for Global warming potential (GWP) for each scenario for average plastic from collected ELVs to primary production (in 2035) in kgCO2 eq.



Source: Oeko-Institut: own assumptions based on available data.

Despite the lower recycling rates in scenario 1-1, the contribution of the recycled content target to the general status of recycling has a large contribution to the total benefit in terms of GWP. Generally, the two scenarios where recycled content targets are included show significantly higher benefits. Whereas scenario 1-0 shows an additional benefit of 67 thousand tonne CO_2 eq, (or 7%), in scenario 1-1 and 2 + 1-2 the benefits amount to an additional 766 and 660 thousand tonnes CO2eq (or 89 % and 81 %) respectively. Scenario 3 still has benefits that are significant in relation to the baseline, of 119 CO_2eq or (or 13%) less emissions, however this is significantly lower than the two other scenarios.

3.1.9.1.3.2 Economic impacts

JRC estimates (Maury et al. 2022) the average recycling costs of plastic from ELVs (dismantling, shredding and post shredding phase) would range from 80 to 110 €/tonne. While the compounding costs are approximately 300 €/t of processed material. The costs for new investments in the sector are assumed to be 1,000 €/t of processed materials, according to targeted stakeholder consultation, and refer to the construction of new recycling facilities (i.e., new capacities). It is not completely clear if the latter is a one-time cost, or an annual investment overtime due to financing. Assuming the latter, would mean that a total of 1380-1410 € per tonne of material recycled.

These costs will be applied to calculate the total costs of the scenario for the ELV sector, based on the amount of recyclates. 80 € is applied for recycling from dismantled fractions (given that there are assumed to be less losses and that this fraction is assumed to potentially result in higher quality recyclate, i.e., to take into considerations that the ATF may receive a higher price per kg than operators of PST. This is an assumption and has uncertainties, however due to the low differences in plastics recycled after dismantling between the scenarios of higher performance, the rate of error is not expected to have a significant impact. For the waste management actors, the costs of:

- ➔ scenario 1-0 are ca. 11.75 million € higher than the baseline or 1.28 € per vehicle.
- ➔ scenario 1-1 are ca. 100.5 million € higher than the baseline or 10.9 € per vehicle

- ➔ scenario 2 + 1-2 are ca. 223.5 million € higher than the baseline or 24.25 € per vehicle
- ➔ scenario 3 are ca. 182.2 million € higher than the baseline or 19.76 € per vehicle

Assuming 400 € revenues for each kg of plastic sold to the recyclers and the expected tonnage of recycled plastics, the following revenues incur for the waste management sector from plastic recycling:

- ➔ scenario 1-0 are ca. 3.5 million € higher than the baseline or 0.37 € per vehicle.
- ➔ scenario 1-1 are ca. 28.8 million € higher than the baseline or 3.13 € per vehicle
- ➔ scenario 2 + 1-2 are ca. 64 million € higher than the baseline or 6.94 € per vehicle
- ➔ scenario 3 are ca. 52.1 million € higher than the baseline or 5.65 € per vehicle

When combined with the costs, the NET benefits or losses accrue to:

- ➔ scenario 1-0 are ca. 8.3 million € higher than the baseline or 1.10 € per vehicle.
- ➔ scenario 1-1 are ca. 71.6 million € higher than the baseline or 9.49 € per vehicle
- ➔ scenario 2 + 1-2 are ca. 159.5 million € higher than the baseline or 21.13 € per vehicle
- ➔ scenario 3 are ca. 130 million € higher than the baseline or 17.22 € per vehicle

The costs increase from scenario to scenario (and decrease slightly in scenario 3) as in each case more investments are needed to finance the production of recycled plastics.

To put this cost into perspective, in a survey conducted in this study, Member States were asked whether landfilling (e.g., of shredder/PST residues) is allowed in their countries. Though only about half the MS responded, it was clarified that in half of the responding MS landfilling is prohibited. At EU level, according to CEWEP[272], slightly less than half (11) MS have not adopted any restrictions. Though only 4 MS were stated not to have a landfill tax, in those that do tax landfilling Tax rates vary from 5 €/t (LT) to more than 100 €/t (BE). Assuming a case in which no plastic is recycled would result in a landfilling cost of between 0.66-13.2 € in countries applying a tax. Assuming that a higher tax will drive countries to apply more advanced PST (as in the case of Belgium) could explain in part why some countries have invested in advanced PST whereas most have not. This would speak in favour of scenario 3 as a means to promote advanced PST throughout the EU, in particular if a higher level of recyclates can be ensured in such cases.

According to JRC, as a consequence of introducing higher targets for recycled plastics, the vehicle manufacturing lines will have to most likely be adapted, in order to comply with the safety standards of the vehicles. Introducing new policy options would lead to a potential variation in the production costs of new cars. For ICEs an increase of around 12 to 38 €/vehicle is expected for policy options 3.a, 3.b and 3.c in 2030, while in 2035 the additional costs range approximately from 15 to 64 €/vehicle (see Figure 25 in JRC report). Similar costs are expected for BEVs as well (see Figure 26 in JRC report). (Maury et al. 2022)

From the above costs, the higher range of costs is assumed to be relevant per vehicle in scenario 1-1, i.e., 64 € for ICEs and BEVs. In scenario 2 + 1-2, the costs would be expected to be somewhat higher as manufacturers must reach a 5% higher target. In the other scenarios, where a recycling content target is not assumed such costs are not considered for manufacturers, however it is possible that OEMs would need to compensate the waste management costs if the additional costs are not covered by other activities.

[272] See: https://www.cewep.eu/landfill-taxes-and-restrictions/, last viewed 24.8.2022

In addition, JRC estimated the Δ€ (benefit) / per tonne for recyclers, of additionally produced recyclates being integrated in a vehicle. These are reproduced in the following figure, considering the ambition of the target for each policy option in 2030 and 2035 and also considering reaching demand with 25 % closed loop. Maury et al. 2022)

Table 3-45 Δ € (benefit) / per tonne of recyclates additionally produced compared to the baseline and being then integrated in a vehicle

Year	Additional production of recyclates	Δ € revenues/vehicle
Option 3.a		
2030	58	90
2035	100	129
Option 3.b		
2030	145	226
2035	200	257
Option 3.c		
2030	241	376
2035	300	386

Source: JRC report, table 21 (Maury et al. 2022)

The NET benefit from recycling plastic of 386 € per tonne is representative for scenario 1-1 (or around 3.5 million €), whereas as here too, the cost for scenario 2+1-2 would be expected to be somewhat higher.

As for audit, certification and verification schemes of the recycling content, the corresponding costs would need to be distributed across the value chain. The costs estimated by JRC were explained to be very low per vehicle and are not reproduced here. These costs are assumed to be relevant for scenario 1-0 and could be considered as well for scenarios with a recycling target, in terms of manufacturers administrative burden, however as they are very low, they are disregarded.

To summarise, the costs and benefits are compiled into the table below.

Table 3-46 Costs and benefits of the scenarios in terms of the difference to the baseline, in total (and in €/vehicle) unless otherwise stated

	Scenario 1-0	Scenario 1-1	Scenario 2 + 1-2	Scenario 3
Costs for waste management actors	11.75 million € (1.28)	100.5 million € (10.90 €)	223.5 million € (24.25 €)	182.2 million € (19.76 €)
Revenues for recyclers from plastic sales	3.5 million € (0.37 €)	28.8 million € (3.13 €)	64 million € (6.94 €)	52.1 million € (5.65 €)
Net benefit for recyclers per tonne		386 € / tonne	Somewhat higher than 386 € / tonne	
Cost for manufacturing (OEMS)	No recycled content target	64€/ vehicle	Somewhat higher than 64 €/vehicle	No recycled content target
Cost of landfilling were plastics not recycled at all, nor recovered	Hypothetical cost as perspective for the costs of recycling: 0.66-13.2 €/vehicle			

Source: Oeko-Institut: own assumptions based on available data.

3.1.9.1.3.3 Social impacts

Under **scenario plastic 1**, JRC estimates that jobs will increase under each of the sub-scenarios by 2035 as follows:

Table 3-47 Summary of employment impacts under scenario 1

Scenario	Scenario plastic 1.a	Scenario plastic 1.b	Scenario plastic 1.c
Number of jobs in manufacturing sector	~1630	~3265	~6530
Number of jobs in waste management sector	~600	~1195	~1795

Employment in the JRC scenario 1c represents additional employment in scenario 1-1, with 6530 jobs assumed for the manufacturing sector and 1795 for the waste management sector.

For scenario 2+1-2, the jobs for the manufacturing sector could be expected to be higher. Judging by the amounts of recycled plastics produced, the number of jobs for the waste management sector would be higher, with scenario 3 having a level in between the two.

It is assumed that scenarios 1-1, 2 + 1-2 and 3 will all result in an increase in the level of PST facilities. This is assumed as today only 4-5 MS are understood to have advanced facilities. It is not clear how many employees would be needed for new facilities. In some cases, it is expected that the new facilities would be independent (i.e., single installation run by an operator), and in others, existing operators could be expected to invest in new facilities. Assuming that installations are relatively automated and thus, that the latter would not require a large number of additional employees, 5 employees are assumed for an “independent” operator and 2 for an existing one. With 22 MS assumed not to have advanced facilities, this would make up for between 44 and 110 new jobs if only one installation is erected per MS. Additional employment would be generated for dismantlers, however there is lacking data to consider which components would be dismantled and what the dismantling times would be.

These numbers would be relevant for all three scenarios where PST is expected to develop, with scenario 2 + 2-1 expected to have the highest costs and scenario 3 somewhere in between.

Though in scenario 1-0 costs incur for the preparation of the declarations (manufacturers) these are understood to be very low and would be assumed to be covered by the existing level of employment.

In addition, where PST shall be developed, it can be assumed that less materials will be disposed of and that fractions contaminated with hazardous substances will be better controlled. Lacking data would not allow to estimate the level of benefit, but it is assumed to be proportional to the amount of PST recyclates.

.

3.1.9.1.4 Comparison of scenarios for plastic

Table 3-48 Summarising table for the comparison of the plastic scenarios

Impacts		Scenario plastic 1-0 recycled content declaration	Scenario plastic 1-1 (3c) - recycling content target 30%	Scenario plastic 2 + 1-2 (3d) -recycling target 30% + recycling content target 35%	Scenario plastic 3 – PST + disposal ban
Economic	on ATFs	1 million €	3.2 million €	5.4 million €	4.3 million €
	on PST/Shredders	-0.5 million €	3.5 million €	10.2 million €	8.4 million €
	On recyclers - revenues	3.5 million €	28.8 million €	64 million €	52.1 million €
	Recycler compounding costs	2.6 €	21.6 €	48 €	39.1 million €
	Investments in waste management	8.6 million €	72 million €	160 million €	130 million €
	Vehicle manufacturers – production costs	n.a	64 €/vehicle	➢ 64 €/vehicle	n.a
	on SME	Small operators may have higher logistics costs assuming they have less storage space, need to send plastic scrap batches more often and thus also in smaller batches			
	Administrative costs Burden	Costs covered under vehicle level analysis OEM may have costs for declarations/certification; however these are understood to be very small			
	2ndary resources: total recyclate Recyclate from dismantling	127.6 thousand tonnes 13.5 thousand tonnes	191.2 thousand tonnes 40.4 thousand tonnes	279 thousand tonnes 67.4 thousand tonnes	249.3 thousand tonnes 53.9 thousand tonnes
Environmental	Environmental impacts: LCA credits for recycling in CO_2eq	67 thousand tonne	766 thousand tonne	660 thousand tonne	758 thousand tonne
Social	Employment	low	6530 jobs (OEMS)	Higher number of jobs for OEMS	Higher for waste sector

Impacts		Scenario plastic 1-0 recycled content declaration	Scenario plastic 1-1 (3c) - recycling content target 30%	Scenario plastic 2 + 1-2 (3d) -recycling target 30% + recycling content target 35%	Scenario plastic 3 – PST + disposal ban
			1795 (waste sector)	Highest for waste sector	
	Decrease in hazardous substance emissions	n.a	Low	moderate	High
	Proportionality	Does not contribute much to objectives but considered necessary in the case of a recycled content target	All scenarios contribute to objectives that the EU Treaties intend to implement through increase in circularity. Emission reduction contribution are more modest, in particular when considering the high cost per vehicle that this generates in the more ambitious scenarios		
	Cost effectiveness	Not effective in achieving circularity but considered supporting measure to monitor recycled content targets	Possibly most effective as costs are more moderate than scenario 2 + 1.2 and scenario 3, but recycled content target still has a higher contribution to GWP than scenario 3	Moderate effectiveness as costs are high per vehicle, but benefits are the highest	Low effectiveness - Higher costs, significant generation of recyclables, however with low contribution to emissions. +
	Coherence		All scenarios considered coherent as they lead to an increase in circularity (coherence with the CEAP) and towards waste treatment of higher hierarchy (coherence with the WFD) + with better control of POPs and other BFRs.		
Stakeholder acceptance		Plastic was one of the materials for which stakeholders (particularly in the waste management) view a recycling content as a measure to give certainty and allow investments in the recycling of plastics in vehicles. Plastics Europe (2022) is understood to support the measure, stressing however the need to ensure quality of vehicle recyclates to support its implementation. A few stakeholders stated that PST is more cost effective than dismantling (though there are also voices saying that the costs are similar). The main view expressed is that it is better to leave more flexibility as to how targets are achieved than to prescribe a certain technology. In this sense though the target may be high, the flexibility it provides is preferable to the PST development required under scenario 3. EuRIC stated that a 40 % target would be very ambitious but is considered ok. A plastic recyclers association agreed that 20 % by 2025 would be possible but referred to			

Impacts		Scenario plastic 1-0 recycled content declaration	Scenario plastic 1-1 (3c) - recycling content target 30%	Scenario plastic 2 + 1-2 (3d) -recycling target 30% + recycling content target 35%	Scenario plastic 3 – PST + disposal ban
		the 40 % target in 2035 as too ambitious. Generally, it is preferred not to have separate targets for specific polymers.			

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

Except for scenario 1-0, which in any case is considered a supporting scenario that will not affect circularity significantly on its own, all scenarios achieve nice levels of recyclates, though it is unclear to what degree this would also result in high quality plastic. Scenario 2+1-2 is expected to have the highest benefit to both circularity (amounts of recyclates) and to emission reductions, however the latter is related to the recycled content target that the proposed recycled target is combined with. In particular this is related to the contribution of other sectors to secondary materials which has nice savings in terms of avoiding manufacture of primary materials and results in the significant difference in GWP between Scenario 2+1-2 and Scenario 1-1 as compared to Scenario 3.

Nonetheless, the understanding that under scenario 3 a high level of PST would be established throughout the EU is expected to eliminate landfilling significantly (only fractions with hazardous substances could be disposed of as hazardous waste).

The assumptions assumed that Scenario 2 + 1-2 would have the highest dismantling of all scenarios and this is related to the flexibility that a target provides in terms of implementation, however in practice it is hard to say if this scenario would not be more similar to scenario 3 in terms of the capacities of PST to be developed.

EPR considerations:

JRC explain that modulated EPR fees related to the declared recycled content (as proposed in the JRC policy option 2, to be implemented in a relatively short term, e.g. 3 to 5 years after entry into force) is seen as a promising way to reward, via e.g. bonus or lowered fees, vehicles produced by frontrunners who can prove they meet given contents of recycled plastics. (Maury et al. 2022) This option would be particularly relevant for scenario plastic 1-0 as it would probably lead to higher circularity at least for some OEMs,

For **scenario plastic 1-1 2 + 1-2 and 3**, the additional costs for recycling of plastics per vehicle have been estimated to range between 10.9 and 24.25 € per vehicle, with the higher costs applying to alternatives requiring generating larger amounts of recyclates. As the production of recycled fractions is assumed to allow their sale, it could be expected that such sales would cover at least part of the costs of recycling, though this can also fluctuate in corelation to changes in the costs of primary plastics. Of interest is to observe the differences between MS in terms of whether landfilling is still allowed and how this is reflected in taxes on waste. Corelation of the higher taxes with advanced PST is assumed to be explained to some degree by the expensive landfilling costs of such countries (BE and possibly also NL, FR, DE). This suggests that in such countries the additional costs are acceptable or financed by EPR in some cases. In particular at times of high competition of the prices of secondary plastics with those of primary plastics, it could be that some form of compensations will need to be provided by the EPR to ensure that operations remain profitable.

3.1.9.1.5 Preferred Scenarios for inclusion in final policy options

It is proposed to look at following measures for comparison under the various policy options:

- Combination of a recycled content declaration with PST (ban on disposal)
- Combination of a recycled content target with a recycling target (30%) in 2030,
- Combination of a recycled content target with a recycling target (40%) in 2030 – this scenario could be investigated but is considered too ambitious at this time. Perhaps it would be more useful to specify a revise clause to allow an increase in the farer future.

3.1.9.1.6 Reporting and monitoring requirements

The JRC report (Maury et al. 2022), details various aspects of the monitoring required to support recycled content targets. The need to develop a standardise calculation for recycling content targets and a format for declarations of vehicle manufacturers is elaborated there, also explaining what needs may arise for certification through this measure.

The reporting on a recycling target could be simpler, as is the case today, specifying that all fractions sent to recycling must be reported on. This method of calculation does not account for material losses and would mean that a higher target is relevant to ensure that the actual recycling achieves a minimum level. If the reporting is more developed, also requiring reporting of input and output (vehicle sourced) fractions from recyclers, it will result in a higher administrative burden but will allow specifying the target in relation to the actual amount recycled. Reporting on a ban of disposal and PST requirements could be done in the same way, however here, due to the lack on data on the status of PST among the various MS, it is also recommended to require a reporting from MS as to the PST capacities established in their country (type of treatment, available capacity and amounts treated per annum. This should allow establishing the status of PST and will also enable a more critical review of the reporting on vehicle waste treatment by the various MS.

3.1.10 Analysis for electric and electronic components (EEC)

Though EEC are a group of components rather than a material, as explained in section 0, they are quite intensive in various precious and critical materials. As they are usually not removed and recycled separately, most of these materials are not recovered in high qualities or at all, as the sorting operations that follow the shredding of ELVs mainly targets the commodity metals (steel and aluminium and to a lesser degree copper). Thus, with a view of increasing the recovery of precious and critical metals, this section focuses on measures that could facilitate the reuse and recycling of materials contained in EEC.

Three measures were shortlisted for electric and electronic components (EEC), including the following measures:

Title	Chapter
2.3.e) Establish provisions to support the market of used EEC	2.1.5.3.5
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing of EEC	2.1.5.3.6
2.4.b) Making it mandatory to remove certain EEC before shredding to encourage their recycling	2.1.5.4.2
2.4.d) Regulate shredder/post shredder facilities to improve recovery of precious and critical metals contained in EEC	2.1.5.4.4

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

- Monitoring of components for reuse/remanufacturing is considered a supporting measure (2.3.f) that will need to accompany provisions designed to increase the demand of components for reuse/remanufacturing (2.3.e) such as EEC.
- A mandatory removal of certain EEC or those above a certain size or weight is of interest as separate sorting could allow recycling that is more targeted towards the resources contained in such components.
- Under the current situation, most EEC is not removed from vehicles by ATFs and is thus sent with the hulk to the shredder. As explained in (Restrepo et al. 2017), this results in large shares of these elements ending up in the steel and aluminium scrap fraction, in shredder residues and in other fractions. The low concentration in such fractions would probably render recycling of these elements as non-feasible, i.e., without disrupting the recycling of other elements dominant in these fractions (see also (Andersson et al. 2019)). Restrepo et al. (2018) refers to scarce technology metals in this respect and explains that most are lost after the shredder, either remaining as tramp metals in industrial base metals (Fe, Cu and Al) or being directed to the shredder light fraction. In parallel in this study, requiring post shredder treatment to improve the recycling of copper is being investigated (see analysis under section 3.1.6). Possibly, elements that associate to the copper in the shredded fractions could be recovered to some degree through this measure. Nonetheless, it is understood that to further facilitate the removal of copper from steel, it will likely be beneficial to dismantle certain copper containing electronic components anyway. With the understanding that EEC dismantling obligations will probably not address all EEC but rather a sub-set, this measure for copper may be useful to target EEC that is shredded. It is however not analysed here again to avoid double counting with the measure being investigated in the copper analysis. A measure requiring PST and targeted only at specific precious and CRM is not considered to be feasible.

3.1.10.1.1 Scenarios for quantitative analysis

Various resources are contained in EEC, including valuable metals like copper, gold, PGMs, (e.g., for conductivity), nickel and chromium (in coatings), aluminium for heat (dissipation), lead, silver, tin and other materials used in solders and electrical contacts. Other resources that can be included in such components include antimony, bismuth, cobalt, fluorite, magnesium, silicon and others. Some of these are included in the 2020 CRM list, making them of interest for recycling. However, these valuable materials are strongly intertwined with other vehicle components. After shredding, their non-metallurgical separation from other recyclables and from shredding residue is usually not economically viable, since the CRM are mixed with bulk material during shredding.

3.1.10.1.1.1 Baseline

Various studies name a large variety of different EEC that are included in vehicles. Main components include the following (additional detail can be found in annex 6.3.1.2):

Restrepo et al. (2018) refers to:

- components that contain REE include: ABS Block, alternator, starter, window raising motor (front and rear), radiator fan motor, wind wiper motor (front and rear) (Restrepo et al. 2017)
- components that contain other CRM include: airbag controller, engine controller, multifunctional display, navigation system GPS, radio CD, speedometer (Restrepo et al. 2017)

Groke et al. (2017) refers to the following (a list with the 30 most relevant components in terms of CRM content is reproduced in Annex 6.3.1.2):

- magnets as the most important applications for rare earth oxides, assuming 20 motors as the average number of electric motors in a vehicle and a total amount of neodymium of 28-297 g: electric motor, compressors in hybrid vehicles, circuits, power transference, braking, loudspeaker, theft protection, doors and control units. According to a JRC report from 2021, new investigations suggest that the content per vehicle is closer to the bottom range. According to the study: The Nd content, was estimated at 107 g per vehicle based on a 2015 vehicle in the PROSUM project, with all characteristics unknown, but new investigations allowed the JRC to recently estimate 44 g (Løvik et al. 2021).
- printed wire boards are mentioned, referring to control devices which supervise the power transmission, braking, car body functions, air bag systems and other systems (between 9-100 different components are mentioned by different sources) and to distributors. The highest number of precious metals are said to be found within the control units for the engine and infotainment, display and control unit, control panel, airbag control and auxiliary stop light.
- LCDs and LED displays are said to contain indium tin oxide, yttrium, europium, lanthanum, cerium, terbium and gadolinium with an amount of some milligram per cm2 screen surface, for example in the navigation system in the central console and in infotainment.
- Sensors for measuring various physical states are also reported, referring to magnet sensors (neodymium or ferrite), oxygen sensors (platinum or palladium, yttrium, e.g., lambda sensor), radar controls (gallium or germanium) and temperature sensors (e.g. silver) as the most relevant sensor applications.

Arnold et al. (2021) conducted a study on the economic feasibility of manually dismantling electronic components from end-of-life vehicles for the recycling of valuable metals. It is explained that in countries with higher labour costs and at current raw material prices, only a few components, such as inverter for hybrid vehicles, oxygen sensor, side assistant sensor, distance and near distance sensors are beneficial to be manually removed from ELV. On this basis it is hard to say if these components will be dismantled or not as it can be understood from the literature that EEC is generally not dismantled with a view to recycle it separately from other vehicle parts.

Rather in the baseline it is assumed that EEC are dismantled when reuse is relevant. Where the component is finally not sold for reuse or where it is damaged during dismantling, components already dismantled would be assumed to be sent to separate recycling (e.g., through copper smelters). Thus, in the baseline, most EEC is assumed to be directed to the shredder together with the hulk as explained under section 0. As EEC contain many valuable and critical metals, this results in the loss of most of these materials that end up in various fractions after the shredder and are usually not recovered thereafter.

Restrepo et al. (2017) calculated for average new vehicles (cohort 2014) a total mass of critical metals (originally referred to as CM but here as CRM) in EE devices per average vehicle as follows: Ag: 1g, Au: 0,3g, Pd: 0,06, Ru: 0,001g, Dy: 5g, La: 40g, Nd: 40g, and Co: 50g. Thereby, the precious metals are located in the PWB, while the rare earths and Co are contained in the actuators in form of permanent magnets. Actuators also contain steel and copper. Quantities vary depending on the size of the components. During the combined ELV dismantling, depollution, shredding and separation processes, these critical metals are transferred to the output fractions in the following proportions compared to the extrapolated content in ELV (based on the Median measurements of 100 000 shredded ELV). Restrepo et al. (2017) notes for the data presented in the table that that the calculated transfer coefficients between the input flow of CRM into the ELV shredding and the extrapolated output flow as part of the different shredding fractions (Fe and Al scrap, shredder residues, other) do not match for almost all CRM types considered. Restrepo et al (2017) assume that the mass balance is influenced by CRM, contained in non-EEC in ELVEE components of ELV. In other words where for example for one of these fractions more than 100% is specified is understood to mean that there are other inputs to the total amount beyond the amount assumed to be in the investigated vehicle EEC.

Table 3-49 Fate of critical metals during ELV waste management

Element in vehicle (100%)	Share that ends up in Fe&Al scrap	Share that ends up in shredder Residue	Other
Ag	40%	>100%	>100%
Au	1.9%	88%	25%
Pd	0.7%	>100%	>100%
Ru	>100%	>100%	>100%
Dy	0%	80%	10%
La	0.5%	2.3%	0.3%
Nd	5%	46%	3%
Co	>100%	29%	4%

Source: (Restrepo et al. 2017)

From the above table it can be concluded that where EEC is not removed prior to shredding, that a large share of the above elements will land in steel scrap, aluminium scrap, shredder residues and other fractions where according to explanations (see 0 as well as (Andersson et al. 2019)) the amounts are too low to render separation and recycling economically and sometimes also technically feasible.

For further data on CRM and precious metal content of specific components see annex 6.3.1.2.

3.1.10.1.1.2 Scenario EEC 1: Monitoring of EEC components for reuse/remanufacturing

This scenario aims to support reuse/remanufacturing of used ELV components by introducing a list of components recommended for reuse/remanufacturing (Annex to ELVD). A preliminary list prepared in this report contains various components with a potential for reuse and it is considered whether to add EEC to this list.

This scenario also considers implementation of harmonised monitoring of EEC that have been removed for reuse/remanufacturing to understand the actual volume of reuse in different MS and to enable the comparability of monitoring data. Obtained information will allow a better understanding of the potential for reuse and how it is influenced by measures that affect market demand. It will also help in the future in the revision of the list of removed spare parts as well as to potentially set out the targets. The reporting obligation would be limited to the components listed in the Annex to ELVD ("list of components recommended for reuse/remanufacturing"). However, separate reporting on components sold for reuse/remanufacturing could also be required though it may create a burden for ATFs if it cannot be linked to an existing list of sales.

3.1.10.1.1.3 Scenario EEC 2: market support of used EEC spare parts

Under this scenario the market demand for spare parts, in this case EEC, should be regulated by requiring car repair shops to provide customers with an offer to repair a vehicle with used/remanufactured components alongside offers for repair with new components. Insurance companies will also be obliged to offer car owners discounted policies if they agree that repairs are performed with reused/remanufactured parts when these are available. Furthermore, a ban of the online sales of illegally operating facilities would be introduced.

Obligations for insurance companies may only be implementable through national legislation, possibly affecting their feasibility as a measure in future ELV legislation.

3.1.10.1.1.4 Scenario EEC 3: Obligatory dismantling and separate recycling of EEC

Under this scenario it shall be required to dismantle EEC for reuse or for separate recycling to avoid shredding operations that hinder recovery of contained resources. A threshold weight or size could be considered for this purpose. In particular it is recommended to align the ELV with the current WEEE Directive depollution requirements to dismantle and separately treat **PWB with a surface area greater than 10 square centimetres**. Regarding the possible dismantling of displays, considered to at least be relevant for dismantling when containing PWB as described above, other treatment requirements for e.g., WEEE displays specified under CENELEC standard EN 50625-2-2s-Displays, are mainly focused on the depollution and recovery of mercury from backlighting discharge lamps of flat panel displays and of fluorescent powders and lead oxide from cathode ray tube (CRT) displays. CRT displays are not expected to be of relevance for vehicles. As for mercury containing flat panel displays, such displays would already need to be dismantled to remove mercury containing components as required in ELVD Annex II (3) and in any case are not expected to have high relevance as they were phased out in vehicles type approved from July 2012 and on[273]. Similarly, CENELEC standard EN-50625-2-4 which specifies how WEEE photovoltaic panels are to be treated at EoL could be considered as relevant for PV contained in ELV. Such

[273] According to remaining exemptions for mercury in vehicles, i.e., exemptions 15a and 15b of Annex II of the ELVD, which is by now only applicable to spare parts of older vehicles.

components are currently not expected to be contained in ELV (at least not in significant amounts) but could become more relevant in the future should they be included in new models. For WEEE, dismantling and sorting according to PV technology is required for PV that fall in the scope of the above standard, i.e., with a surface area of 0.2 square meters. Whether PV above this size threshold are to be integrated into vehicles in the future remains to be seen, however in such cases, this threshold could be applied, requiring dismantling and separate treatment according to WEEE requirements. Whether it is necessary to require the same treatment as similar components removed from WEEE has not been investigated in detail, however it stands to reason that if there is a requirement to dismantle and treat these parts separately, that they would often be sent to treatment by the operators that treat similar WEEE components.

Additionally, the following components are recommended for obligatory dismantling, based on studies already performed with a similar focus:

The UBA ORKAM report (Groke et al. 2017) investigated the profitability of dismantling of certain electrical components due to their contents of valuable resources. the study refers to the **heating fan** and **generator** (in the group of engine components), the **engine/gear control unit**, **inverter**, **drive control unit**, **start-stop-control unit** (in the group of controller components), and the **oxygen sensor** (in the sensor component group) as components for which dismantling is economically profitable, however they are understood to not be commonly removed prior to shredding operations. The **alternator** and **transmission control unit** are also mentioned.

Arnold et al. (2021) concluded that even in countries with high labour costs it is economically feasible to dismantle the inverter for hybrid vehicles, oxygen sensor, **side assistant sensor**, **distance and near distance sensors**. Dismantling can also be cost-effective for other components, depending on the vehicle model, labour costs and current material prices, referring to the ***heating blower***, ***generator***, ***starter***, engine and transmission control, start/stop motor, drive control, ***infotainment*** and ***chassis control***.

Restrepo et al. (2018) refer additionally to the following components and calculate that ca. 190 minutes would be needed to dismantle these:

- ABS Block, alternator, starter, window raising motor (front and rear), radiator fan motor, wind wiper motor (front and rear) - REE relevant
- airbag controller, engine controller, multifunctional display, navigation system GPS, radio CD, speedometer – relevant for other CRM.

Components for which dismantling is understood to be economically feasible appear in bold. Components for where feasibility is marginal (e.g., in countries with high labour costs) appear in bold and italics.

The Swiss Institute EMPA, behind Restrepo et al. (2017) and Restrepo et al. (2018) is still researching options for obligatory dismantling for the Swiss Government. This is related to the SWISS VREG[274] legislation published in January 2022, according to which EEC permanently installed in vehicles are in the scope of the regulation if they can be dismantled and if their treatment, to allow material recovery, is feasible according to scientific and technical progress (VREG Article 2(2)). The EMPA research is to contribute to decisions of the Swiss government as to which sub-set of EEC will be affected by obligatory dismantling and treatment requirements of the VREG. Publication of more recent results is still pending but anticipated for the beginning of 2023. Preliminary results were not available; however it

[274] Regulation on the collection and treatment of WEEE – Verordnung über die Rückgabe, die Rücknahme und die Entsorgung elektrischer und elektronischer Geräte, see https://www.fedlex.admin.ch/eli/cc/2021/633/de, last viewed 21.8.2022

is recommended to consider the final results and how Switzerland shall set the dismantling obligation as a source to align to regarding the final list of components to be in the scope of a dismantling obligation.

To understand the economic feasibility of dismantling EEC components from vehicles for the purpose of reuse and recycling, Groke et al. (2017) compared costs and benefits of three courses of action: Reprocessing of reusable parts, separate recycling of vehicle electronics and shredding of end-of-life vehicles. The reuse of ELV vehicle parts (with the exception of the lambda sensor) shows a higher revenue than recycling, while the economic benefit of secondary materials recovered from separately recycled EEC still shows a positive balance. Shredding, on the other hand, was rated as the least economically attractive. Against the background of the results of the economic assessment, Groke et al. (2017) recommend dismantling individual EE components from ELV. Separate dismantling is recommended for the following parts: Heating fan, alternator, inverter, engine control unit, transmission control unit, drive control unit, start/stop engine and oxygen sensor. For nine other components, separate recycling also appears to make sense, but a clear recommendation for or against dismantling cannot be given, as the economic viability of dismantling depends heavily on the boundary conditions.

Opportunities to increase economic efficiency of separate recycling of embedded automotive electronics are mentioned as follows:

- Accelerate dismantling through qualified mechanics that are provided with appropriate tools,
- Well organised procedures and in-house logistics, and
- Access to sufficient sources of information on vehicle electronics, vehicle design, and markets to market the components (e.g., via product passport)

Arnold et al. (2021) conducted a study on the economic feasibility of manually dismantling electronic components from end-of-life vehicles for the recycling of valuable metals. They conclude that disassembly is economically viable only if disassembly can be accomplished in less than or equal to 2 minutes per part, since the revenue from the recovered material is small. In countries with higher labour costs and at current raw material prices, only a few components, such as inverter for hybrid vehicles, oxygen sensor, side assistant sensor, distance and near distance sensors are beneficial to be manually removed from ELV. Manual disassembly can also be cost-effective for other components, depending on the vehicle model, labour costs and current material prices. These components include heating blower, generator, starter, engine and transmission control, start/stop motor, drive control, infotainment and chassis control. For most components however, the profit margin is very small.

3.1.10.1.2 Results of qualitative analysis

Though **scenario EEC 1** shall help get a better understanding of the type of EEC that have potential for reuse, it is not expected to increase the rate of reuse significantly as it is mainly proposed as a monitoring measure.

Scenario EEC 2 would be expected to have a higher contribution to the reuse of such components, possibly increasing recycling, though it is unclear if ATFs would send such components to separate recycling as their removal is understood not to be common and shipping for recycling would require a sufficient amount of removed components to justify transport costs.

Scenario EEC 3 is expected to have the highest contribution to both reuse and separate recycling as it shall increase the amounts of EEC dismantled and subsequently accelerate the collection of sufficient amounts for transport. Separate recycling is understood to be common for e.g., printed circuit boards removed from electric and electronic equipment[275] and thus it is assumed that at least part of this fraction would have a recycling outlet, increasing the probability of recycling precious metals from such components.

For example, Umicore recycle printed circuit boards (also known as printed wiring boards) among others as a source of precious metals. Their plant is understood to also accept PCBs from automotive applications, though this is mainly relevant for dismantled separate fractions and not shredder non-ferrous fractions from PST due to their lower quality. Among others, the following materials can be recovered in this way: silver, gold, PGMs, but also other metals like lead, copper, nickel, antimony, tin, indium, bismuth, etc. It is further explained that the direct smelter routes (i.e., sending components directly to material recovery in smelters) have been found to be an eco-efficient solution for some electronics containing PWBs like cell-phones (Hagelüken 2006a). Hagelüken (2006b) explains this further: “In the case of circuit boards or small devices with a relatively high concentration of precious metals, further shredding and sorting out Fe, Al and plastics in many cases even can be counter-productive. In circuit boards most precious metals are strongly interlinked with plastics or non-ferrous-metals, part of them easily go into dusts, others follow the iron-fraction and the aluminium. Especially eddy current separation in many cases is not sharp enough for these materials and significant portions of circuit board pieces can be contained in the “Al-fraction”. Optical sorting or other scavenging processes can be applied”. However, the direct treatment of (i.e., dismantled) circuit boards in an efficient metallurgical process, designed to maximise precious metal-yields and to “co-separate” other metals by metallurgical means is more productive. This is explained for PWB of EEC origin but is also assumed to be the case for PWBs from vehicle origin, i.e., when these are dismantled and treated as a separate fraction.

3.1.10.1.3 Results of quantitative analysis

To understand the potential of measures for EEC it is first important to understand how common they are in vehicles. Some data on this is already presented above in section 0 and at the beginning of this chapter. For the most part this data clarifies that it is difficult to provide an exhaustive list of EEC contained in vehicles and to refer to their total weight in the vehicle and relevance in terms of contents of precious and CRM. Work of EMPA (Restrepo et al. 2018) is summarised below to provide partial quantification for a sub-set of components that were investigated by EMPA in various studies. In addition, the example of an inverter has been developed on the component level to provide some insight as to relevant impacts of components that have been recommended in various studies for dismantling and that are also relevant for new types of vehicles. Initial data on the inverter is specified in this section and analysed impacts are presented in the following sections.

Restrepo et al. (2018) looked at the number and type of embedded electronics in the Swiss vehicle fleet in 2014. They concluded at the time that on average, in 2014, ELVs contained 8 EEC components, the average vehicle in the stock contained 20 components and newly imported vehicles contained 21 components. For the various components the distribution of critical metal mass in passenger vehicles was also investigated, a summary of which is compiled in the following table.

[275] For example, Umicore accepts printed circuit boards from EEE in shipments above 10 tonnes. Shredded fractions with printed circuit boards are also accepted, but only from mechanical pre-processing of e-scrap and in quantities between 25-100 tonnes. See: https://pmr.umicore.com/en/recyclables/e-scrap/, last viewed 27.6.2022

Table 3-50 Distribution of critical metal mass in passenger vehicles in the Swiss vehicle fleet in 2014 - Total mass per average vehicle in gram

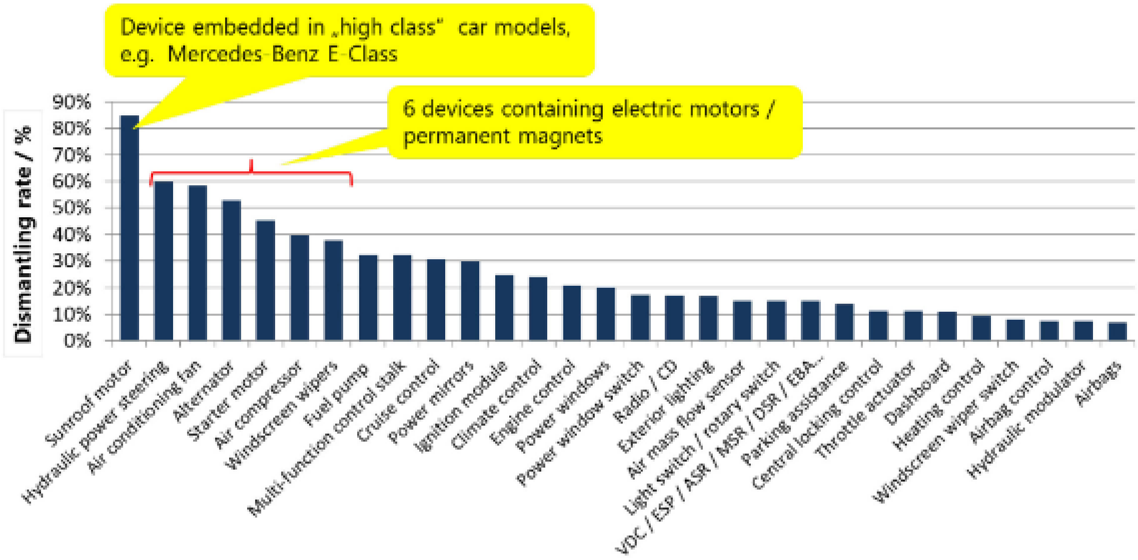
Elements in vehicles	Average content of a vehicle imported in 2014	Average content of a vehicle in the 2014 stock - 2010 vehicle as representative of the average	Average content of a vehicle that becomes an ELV in 2014, represented by average content of a vehicle form 2000
Ag	1	1	1
Au	0.3	0.3	0.2
Pd	0.06	0.06	0.03
Ru	0.001	0.001	0.001
Dy	5	2	0.1
La	40	30	30
Nd	40	20	3
CO	50	30	20

Note: The large differences between amounts for new imports and for ELV can be accounted for to 50% due to the larger number of vehicles imported in 2014 as compared to ELVs in the fleet and to 50% due to the increase of the amounts of the various elements in a single vehicle, through a larger number of embedded electric components and larger amount of the elements contained therein.

Source: (Restrepo et al. 2018)

To understand the current rate of EEC dismantled from vehicles, Restrepo et al. (2018) compiled data on dismantled components (it is not specifically mentioned but assumed that most EEC that are mentioned here and the relevant rates are dismantled for the purpose of reuse. In such cases it is further assumed that some components will end up being reused and some may be sent to separate recycling). The rate was calculated based on the relation between the number of dismantled EEC and the total number of embedded ones. The researchers noticed that EEC were more often dismantled from the upper-class vehicles (luxurious) than from standard ones. In other words, vehicle class was a better indicator for the dismantling probability than the dismantling time and costs. Additionally, EEC with electric motors have a higher dismantling rate than EEC with printed circuit boards (PWBs). Aside from four electric motors (sunroof motor, hydraulic power steering motor, air-conditioning fan motor, and alternator), most EEC devices had a disassembly rate below 50%. Thus, the potential for concentration of permanent magnets for later recovery of REE is smaller than that of PWBs for later recovery of precious metals. Reuse rates of different components are specified in the following figure:

Figure 3-17 dismantling rates for vehicle EEC



Source: (Restrepo et al. 2018)

On the basis of this data and additional research, a sub-set of components was selected for further investigation of 12 EEC. The choice of these components was made against the understanding that 80% of the precious metals and REE mass in EEC of ELVs from the year 2000 are found in the selected focus devices (6 ICT devices and 6 actuators). Results for these 12 components (and their identification) are presented in the following chapters to provide more insight as to the type of EEC for which dismantling is under consideration.

The inverter has been selected for analysing the potential of the scenarios described above, as it contains valuable materials in its housing and components. The UBA ORKAM report (Groke et al. 2017) gives an example composition from a 4X4 hybrid vehicle in which the inverter has a total weight of 12 kg and contains the following materials. Such components are also understood to be used in BEV.

Table 3-51 Materials contained in an inverter and they relative weight in kg/unit

Total mass (g)	Printed circuit board (g)*	Fe (g)	Al (g)	Cu (g)	Plastic (g)	Brass (g)
13,550	364	2,107	7,900	1,077	341	84

*Source: compiled from: (Groke et al. 2017), *the PWB is specified to contain amounts of gold, palladium, silver, copper and tin*

The ORKAM study refers to a dismantling time of around 3 minutes for the inverter, however this was derived together with dismantling of additional components and may be an underestimation when not all other components are removed. A dismantling cost of approx. 2.20 €/unit was estimated for the ATF, as well as a revenue from sales of the component of approx. 12.20 €/unit or of material sales of approx. 10.35 €/unit (Groke et al. 2017).

The following shares of dismantling (reuse, pre- and post-shredder recycling), post shredder recycling, recovery and losses were assumed for calculating the impacts of the inverter. For the Restrepo et al. (2018) sub-set of EEC, impacts are mainly based on those presented in the source, however in some cases the following shares were also used to calculate additional impacts for this case (e.g., dismantling costs and related social impacts).

To consider the initial dismantling rate for the shares, the dismantling rates displayed under Figure 3-17 have been considered. The calculated average of the rates displayed for 30 components returned 25.7 % dismantling, however it can also be understood that this list only reflects a sub-set and some components listed may be found in a vehicle more than once (e.g., exterior lighting, power mirrors). Furthermore, it is explained that higher dismantling rates were apparent for EEC sourced from vehicles in the upper-class range. Such vehicles are expected to be more common in Switzerland than in various EU countries, and as such, this average is assumed to be too high for the EU. With no other data to suggest an appropriate level, an initial rate of 15% dismantling has been assumed for the baseline as a conservative assumption. The final rate of reuse assumed to be achieved under scenario 2 is also considered to be conservative, due to the expectancy of an older fleet on average in EU countries. The allocation of all parts dismantled from the vehicle between the reuse and the recycling routes has been assumed according to a 2:1 relation, as in the baseline and the first two scenarios, dismantling is motivated by reuse. The increase of the total dismantling in scenario 3 is a result of the obligation to dismantle for the sake of recycling, thus here the share of components dismantled for separate recycling is significantly higher. The level of reuse is assumed not to be affected in this scenario as the potential for reuse is expected to be exhausted in the earlier scenarios, in particular scenario 2 which refers to measures to support the market for reused parts. In other words, the additional dismantling in this case is assumed to feed the separate recycling of EEC that has not undergone shredding operations. Under this scenario, it is probable that some EEC affected by the measure would be dismantled in a destructive way, i.e., vehicles for which demand for reused parts is negligible e.g., due to vehicle age. This could impact the costs for dismantling and will be reflected in the next sections where relevant. Recycling after shredder operations would in most cases mean that precious and CRM are lost to other fractions (e.g., impurities in steel and aluminium fractions or in ASR fractions. Thus, the assumptions for recovery and for losses are relatively low. Reduced losses are assumed for scenario 2, where dismantling results in recycling prior to shredder, where recovery of precious and CRM has a higher probability of being sought.

Table 3-52 Routes of treatment for EEC from ELVs under the various scenarios

EEC	Baseline	Scenario 1	Scenario 2	Scenario 3
Dismantled -> reused/remanufactured	10%	12%	25%	25%
Dismantled -> recycled (no shredding)	5%	6%	12%	70%
Dismantled -> shredded ->recycled	0%	0%	0%	0%
Shredded -> recycled	77%	74%	55%	0%
Recovered: (energy recovery or backfilling)	3%	3%	3%	3%
Losses/process inefficiencies	5%	5%	5%	2%

Source: Oeko-Institut: own assumptions based on available data.

3.1.10.1.3.1 Environmental impacts

To estimate the effort of dismantling certain EEC and related impacts, in Restrepo et al. (2018) a list of 12 (or 14 when front and rear components are considered as separate components)) EEC was identified and subject to field testing to determine among others average dismantling times of each component and the total dismantling time for this EEC sub-set. The following table is reproduced from the report and presents the sub-set of components, the dismantling times for each component and for the total. 188 minutes or 3.13 hours were necessary in total, amounting to almost 3 hours. From a personal communication with members of the study team, this is representative for conservative dismantling that would still allow reuse of parts and is thus assumed to be more time intensive than destructive dismantling. Results also take into consideration the situation in Switzerland which is a relatively small country in terms of distances to relevant treatment facilities for EEC. In short, whether average costs would be higher or lower in the EU depends on the average distances between facilities as well as on how many of the EEC would be dismantled conservatively (related to age and class of average vehicles) and how much would be dismantled destructively.

Table 3-53 Average dismantling time of the EEC in minutes for the specified EEC

	Device	Average time	Min. time	Max. time	Estimated average time
Devices containing REEs	ABS Block	13.11	2	60	26.40
	Alternator	21.78	5	60	24.40
	Anlasser	25.64	5	95	20.80
	Fensterhebermotor hinten	16.00	5	20	no data
	Fensterhebermotor vorne	17.94	7	31	no data
	Kühlerlüftermotor	16.47	3	35	no data
	Wischermotor hinten	8.75	3	16	no data
	Wischermotor vorne	8.88	3	20	no data
Devices containing PMs	Airbagsteuergerät	14.07	1	35	no data
	Motorsteuergerät	9.84	3	30	14.80
	Multifunktionsanzeige	6.13	2	15	no data
	Navigations System GPS	9.75	7	12	no data
	Radio/CD	9.00	2	21	10.00
	Tachoinstrument	10.68	3	20	10.40
	Total time (min)	188.03			
	Total time (h)	3.13			

Note 1: the tale refers to the average time and to the estimated average time. According to the source, where data was available, estimations were made as to the time needed for dismantling (estimated average time). However most of the results presented were determined in dismantling tests which usually showed that the actual dismantling time (here referred to as average time) is lower than the value assumed based on literature.

Note 2: Translation of EEC, according to order: Devices containing REE: ABS Block, alternator, starter, window raising motor (front and rear), radiator fan motor, wind wiper motor (front and rear). Devices containing precious metals: airbag controller, engine controller, multifunctional display, navigation system GPS, radio CD, speedometer.

Source: (Restrepo et al. 2018)

The same sub-set of components was analysed by Restrepo et al. (2018) on the basis of LCA data to quantify the environmental impacts of various treatment scenarios. Aside from the baseline, advanced shredding was compared (resulting in smaller pieces being sorted and sent to further treatment) as well as two options for dismantling (combined with automated or manual sorting prior to recovery with EEE waste). It is noted that the data applied has various uncertainties and also is not representative of EEC relevant for EVs as at the time of the analysis such vehicles were very rare in the stock. Whereas the advanced shredding showed a reduction of 9% environmental impacts as compared to the baseline, dismantling scenarios showed a reduction of 49% and 120%[276] respectively. See Figure below. This shows that the further improvements of PST (as is contemplated for the copper fraction) can be expected to lead to marginal improvements in terms of environmental impacts, whereas dismantling in both cases leads to significant reductions.

[276] The comparison is made between the Net benefit that reflects both negative and positive impacts. This comparison results in the last scenario reflecting an improvement of 120%.

Figure 3-18 Environmental impacts of the four scenarios, in thousands of UBP (eco-points according to method of ecological scarcity, contribution per process

Note: The scenarios investigated are Baseline (0), treatment of shredded fractions in advanced PST facility (1), Dismantling of EEC and separate mechanical treatment at a WEEE treatment facility (3) and dismantling of EEC and manual disassembly (e.g., of PWBs and permanent magnets) prior to separate treatment.

Source: (Restrepo et al. 2018)

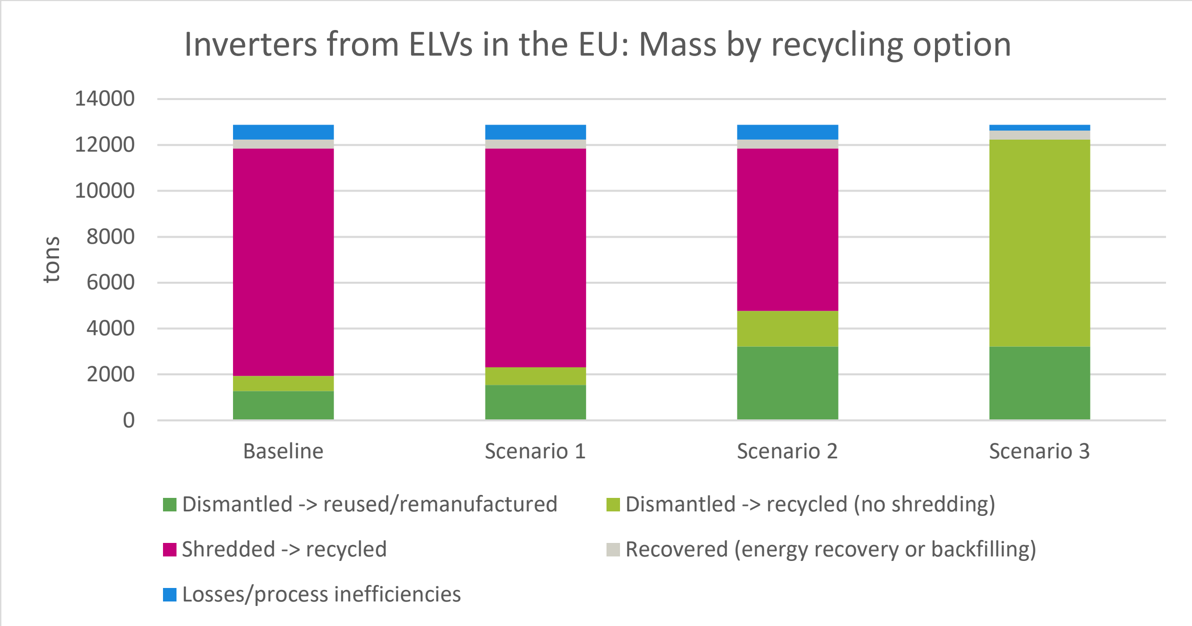
Restrepo et al. (2018) does not specify absolute impacts but only the relation between scenarios. In this sense, the impact is understood to refer to the impact for the same number of components dismantled as compared to not dismantled. This study however assumes a mix in most of the scenarios. Though the environmental impacts cannot be quantified based on the available data, however the consultants assume that on this basis the reduction in environmental impacts in a range of 49-120% is representative for the comparison between scenario 3 (where all components are dismantled) and the baseline of this study, depending on whether only dismantling would be required or also further manual sorting of disassembled parts. For other scenarios the environmental impact of dismantling is expected to be in the range between the baseline and scenario 3.

Restrepo et al. (2018) explain that the maximum environmental savings are achieved through the dismantling and recycling of relatively heavy actuators such as generators, cooling fan motors and starters. Savings from the dismantling and recycling of ICT devices (Information Communication and Control devices) are lower than for actuators. This is mainly due to the lower mass of ICT devices - on average 1.2 kg compared to 3 kg for actuators. The greatest savings for the control units are achieved by dismantling and recycling relatively heavy control units such as the navigation system and ICE/EM controls. With increasing electrification and automation of the vehicle fleet, an increase in heavy power electronics is foreseeable and with it, possibly, also an increase of the Scarce Technology Metals (STM) mass. Interestingly, the savings in environmental impacts from STM recovery measures are mainly due to the recovery of the base metals, mainly copper, iron (i.e., steel) and aluminium. The recovery of precious metals, especially Au, contributes significantly to the environmental impact of ICT equipment. For example, a navigation system contains about 800 times more copper than gold, but the environmental impact from the primary production of 1 kg of gold is 1000 times higher than from the primary production of 1 kg of copper, explaining why gold makes an important contribution to the overall savings from the recycling of navigation systems. The recycling of REE in EEC only contributes to minor reductions, as the impacts of primary production of precious metals are low. For example, an alternator contains about 900 times more copper than neodymium, but both metals cause comparable environmental impacts in their primary production. Thus, the environmental savings from the recovery of neodymium are small compared to the recovery of copper (and other base metals). From these results it could be concluded that only actuators should be dismantled before shredding. However, this would lead to high losses of STMs from ICT devices, which usually end up in post shredder fractions from which they cannot (be) recovered. However, if the goal is to maximize the recovery of STMs (rather than the total environmental benefit), then the actual quantities of STMs recovered per device should also be considered in the prioritization process and not just the environmental impact savings. Though not mentioned by Restrepo et al. (2018), this could be the case for CRMs for which there is a supply risk that is mainly an economic risk. In such cases, the economic risk is to be considered to conclude whether the cost of recovery through dismantling is set-off by the respective decrease in the supply risk.

To summarise, for the sub-set of components, a positive environmental impact can be concluded for all of the scenarios in relation to the baseline, due to higher dismantling and subsequently higher reuse and high-quality recycling rates. However, it is not possible to assume what amounts of materials would be recovered in each case. The Restrepo et al. (2018) data suggest that in terms of recovered material, this would mainly be reflected in increased recovery of the base metals (steel, aluminium, copper) and of precious and CRM contained in PWBs that can be recovered in separate recycling – for example silver, gold, PGMs, but also other metals like lead, copper, nickel, antimony, tin, indium, bismuth are mentioned for separate recycling of PWBs (Hagelüken 2006a). REE are understood to currently not be expected in terms of recovered elements. This is understood to be based on the technologies currently applied. The consultants are aware that recycling of REE from magnets is possible and practiced in Asia to some degree, however that capacities do not exist in the EU and that currently magnets are not dismantled for this purpose. As explained above, this is not understood to have a significant environmental impact, however, should there be economical reasons to collect and recycle magnets separately (to be investigated in a follow up study), this could be addressed through a requirement to disassemble REE containing magnets from relevant components (e.g., permanent magnets, actuators) though only expected to impact environmental impacts marginally.

For the inverter, based on this description and the shares specified in Table 3-52 in the baseline and in each scenario, the number of inverters for each route of the different scenarios was calculated based on the number of EV vehicles to be collected as ELVs in 2035. This allowed calculating the mass flows diverted in each scenario to the various treatment routes based on the BEV ELVs collected in the year 2035 (Figure 3-19).

Figure 3-19 Mass flows for scenarios for inverters sent to different treatment routes (tonnes)



Source: own illustration

The inverter flows that are sent to reuse are considered to have the highest contribution in terms of circularity. For inverter sent to recycling, these are assumed to enable recycling of contained precious metals as well as having a contribution to copper recycling and related impacts on the purity of the Al and FE scrap fractions. In contrast, for inverters sent to shredder, though the base materials (Fe and Al and to a lesser degree also copper) could be recovered, it is assumed that precious metals would be lost as impurities in Fe and Al or in shredder residues. General flows can be observed in the table below:

Table 3-54 Tonnes of inverters from collected ELVs assumed to be either reused or recycled or sent with hulks to the shredder (in 2035)

Inverter	Baseline	Scenario 1	Scenario 2	Scenario 3
Dismantled -> reused/remanufactured	1,470	1,760	3,670	3,670
Dismantled -> recycled (no shredding)	730	880	1,760	10,270
Shredded -> recycled	11,290	10,850	8,070	0

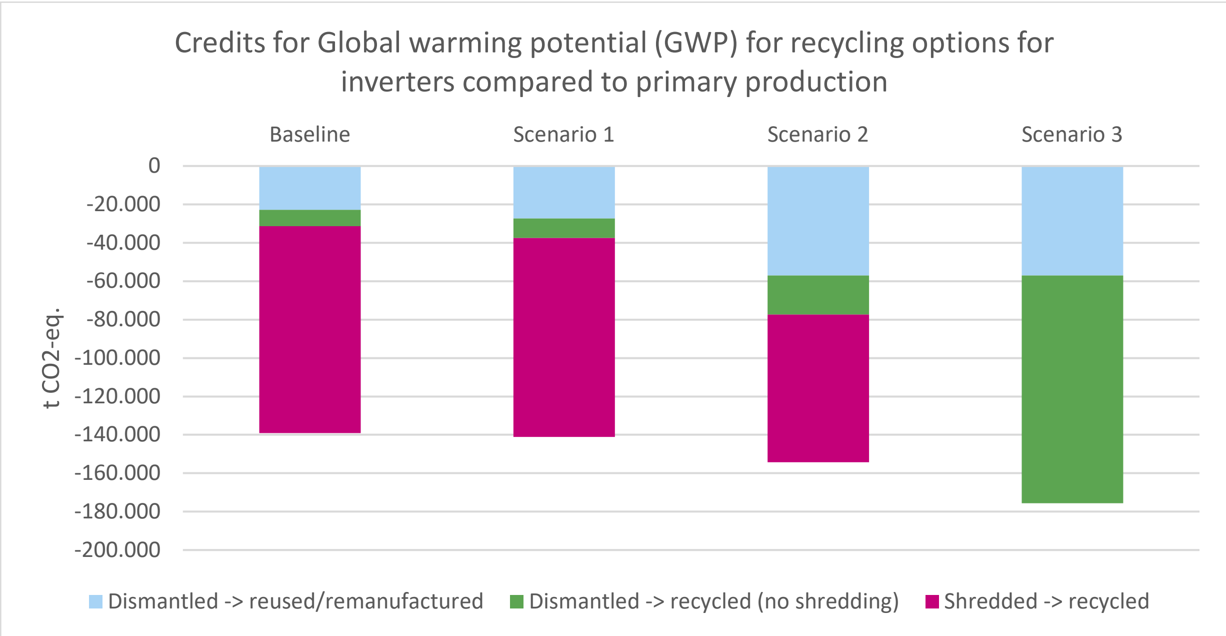
The amounts of various base and precious metals that can potentially be recovered in larger amounts or at higher quality from inverters sent to dismantling are specified in the table below. These amounts have been quantified based on data regarding the contents of such materials in inverters and their PCBs. They represent the potential available for recycling but not the final quantity actually recycled.

Table 3-55 Tonnes of base and precious materials contained in inverters dismantled in each scenario that are thus potentially available for recycling (in 2035), values are in tonnes and are rounded

Inverter	Baseline	Scenario 1	Scenario 2	Scenario 3
Iron	100	20	140	1320
Aluminium	390	80	550	5110
Copper	58	11.5	81	749
Brass	4.2	0.8	5.9	55
Gold	0.005	0.001	0.006	0.06
Palladium	0.01	0.002	0.01	0.13
Silver	4	0.8	5.6	52
Tin	1.6	0.3	2.3	21

Environmental impacts, represented in global warming potential were calculated for each of the scenarios. This is shown below for all inverters from BEV ELVs collected in the year 2035 (Figure 3-20).

Figure 3-20 Credits for Global warming potential (GWP) for scenarios for inverters compared to primary production – calculated for all inverters of ELVs collected (BEV) in 2035 (tCO_2eq)



Source: own illustration

The values of the GWP contributions (total for the baseline and the difference thereto for the scenarios) is further presented in the table below.

Table 3-56 GWP contributions in the baseline and the difference thereto in the various scenarios for the specific treatment route (in 2035), values in CO_2eq tonnes and are rounded

Inverter	Baseline - total	Scenario 1 - difference	Scenario 2 - difference	Scenario 3 - difference
Dismantled -> reused/remanufactured	-22,800	4,600	34,200	34,200
Dismantled -> recycled (no shredding)	-8,500	1,700	11,900	110,100
Shredded -> recycled	-107,800	-4,200	-30,800	-107,800

The figure above shows an LCA comparison of the different scenarios considering dismantling (incl. components for reuse/remanufacturing) and recycling route with and without the shredder route. The differences between the baseline and the other scenarios are not huge, with scenario 1 having only 1% more credits (2 thousand tonnes CO_2 eq.), scenario 2 having 11% more credits (15 thousand tonnes CO_2 eq.) and scenario 3 showing 26% more credits (36.5 thousand tonnes CO_2 eq.) than the baseline. The differences are assumed to be relatively modest, as the base metals, steel, aluminium and copper that have a significant share in the composition of the component will be recycled at a similar volume in all scenarios (though there would be some losses of copper and aluminium to the steel fraction in scenarios with more pre-shredder recycling, this is not reflected as much in the values, as some of the losses end up as impurities in other metals, affecting quality but not the total quantity). For the most part the differences are understood to reflect the small contents of other metals in the inverter that can be recovered to a higher degree when the inverter is dismantled prior to shredding (gold, palladium, silver and tin) and the PWB sent to separate recycling. Looking at the general amounts of credits related to the EEC scenarios, it is also relevant to note that this component is calculated for this scenario only for BEV which are expected un 2035 as ELV. However, in 2035 this reflects only 11.5% of the collected ELVs. In the long terms the absolute benefit would be expected to be more significant.

3.1.10.1.3.2 Economic impacts

For the sub-set of components, as already explained above, Restrepo et al. (2018) conclude that a total of 188 minutes or 3.13 hours would be necessary to dismantle all of the 12 components form a vehicle. This is assumed to reflect the time needed by ATFs to dismantle a component so that it is fit for reuse and can thus be used as a basis to calculate at least the dismantling costs in each of the scenarios. Assuming costs of 51 € per hour of labour, costs of ATFs were calculated for the various scenarios. In Scenario 1, additional costs of around 5.2 million € are to incur, representing an increase of around 20% for dismantling. In scenario 2, the additional costs amount to around 38 million €, representing an increase of 147 % in dismantling costs. In both cases, it has to be assumed that the increase in dismantling serves to provide a larger demand for reused parts, meaning that the costs of the additional dismantling are set off by the costs of sales of reused components. In scenario 3, the additional dismantling costs amount to around 147 million € and represent an increase in costs of ca. 565%. However, the calculation is based on the costs of dismantling for the sake of reuse, whereas it is to be expected:

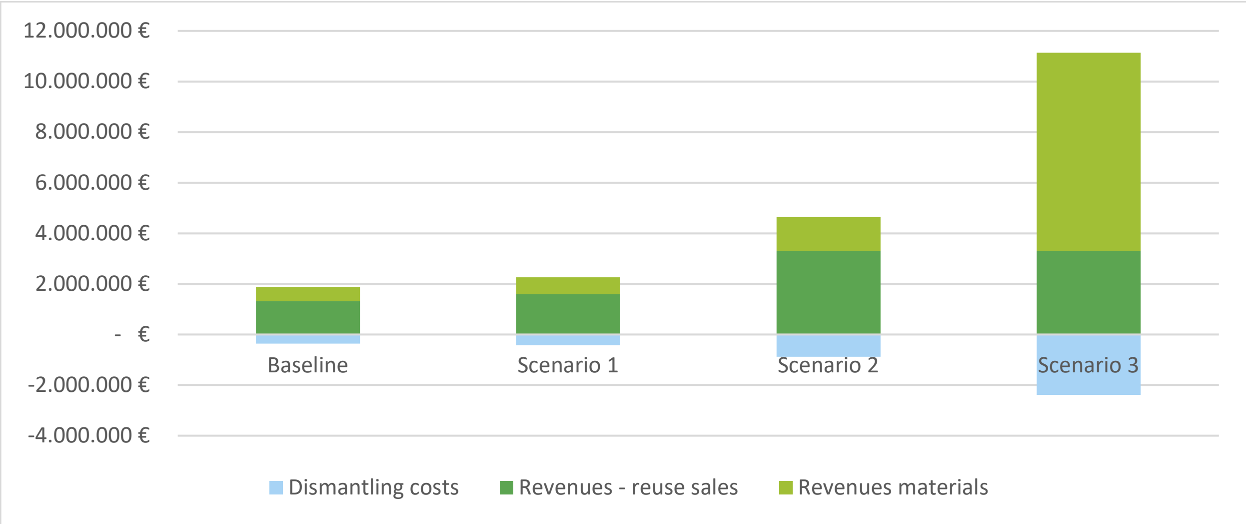
- a) that the costs for the dismantling of all components reused and 12% of the recycled components is also set-off by sales of reused components, as under scenario 2. This represents 26% of the costs for dismantling.
- b) that cost for the remainder of components to be dismantled could be lower, as they are not intended for reuse and could be dismantled destructively. Whether the costs are indeed lower, may also depend on how the components are treated after dismantling (i.e., automated sorting or manual sorting), though this is part of the costs for further treatment

and not for dismantling. In that sense, the dismantling costs would be assumed to be a worst-case scenario.

In all scenarios where a higher share of components is sent to reuse in comparison with the baseline, costs would also be expected for sorting and recycling, but also revenues for the materials to be recovered. The available data does not allow quantifying such costs. Nonetheless, after comparing the data on the dismantling rates (Figure 3-17) with the data on dismantling times (Table 3-53) Restrepo et al. (2018) notes that EEC with electric motors (and potentially with REE based magnets) are often dismantled despite the higher dismantling times. In contrast, despite low dismantling times, components with PWBs have lower dismantling rates. It is thus concluded that an obligation to dismantle such components would potentially increase the amount of precious metals that can be recovered from PWBs more significantly than it would increase amounts of materials recovered from EECs containing motors. This is particularly true for the engine control, power window, radio, hydraulic modulator (ABS pump), dashboard, airbag controller and the navigation system, which have a dismantling rate around 20% and below and a dismantling time between 8-18 minutes.

For the inverter, costs of ATFs were calculated for the various scenarios based on the data provided in Groke et al. (2017) for dismantling costs and revenues from sales of components of reuse and for recycling (pre-shredded). The comparison of costs of the various scenarios is shown in the figure below.

Figure 3-21 ATF dismantling costs and revenues from EEC reuse and material sales (€)



Source: Own illustration

On the example of EEC, the additional costs for scenarios EEC 1 to EEC 3 were calculated on the basis of dismantling costs and the revenues. The difference between each scenario and the baseline is as follows:

- scenario EEC 1: 0.3 million € or 20% higher revenues than in the baseline,
- scenario EEC 2: 2.2 million € or 147% higher revenues than in the baseline,
- scenario EEC 3: almost 7.2 million € or 475% higher revenues than in the baseline.

As for other stakeholders, here, data was not available to allow a quantification of impacts, however they can be specified quantitatively. Assuming that more EEC being dismantled in the various scenarios is expected to increase the rate of reuse of such components while also increasing separate recycling. As the amount of dismantling for reuse and dismantling for recycling increase from scenario to scenario, costs and benefits can be expected to increase or decrease proportionally to the reuse and recycling shares in each scenario unless specifically mentioned:

In the scenarios proposed, increases in the rate of reuse occur only on the basis of voluntary dismantling, i.e., increases are generally expected where there is also an increase in demand as there is no obligation to reuse components. This will mean that where more reused parts become available for reuse, this is accompanied by a higher demand for reuse by **consumers** (vehicle owners). The option to repair a vehicle with a reused or remanufactured part generally means that the consumer has lower expenses to repair a vehicle, considered as a benefit.

In parallel, **repair shops** that apply reused parts would not be expected to lose too much revenue as the price of the part is for the most part transferred to the customer. The effort to source spare parts could be somewhat higher than that of a new part as in some cases it may be necessary to consult multiple ATFs to find a part, however many ATFs have digitised their reuse inventory and now sale parts online, making the process easier. Furthermore, it is understood that repair shops already sell reused EEC in some cases, so any burdens are assumed to be acceptable in range.

For **shredders**, the understanding that less EEC will be sent to shredders will mean a loss of business. This is related in general to lower volumes of ELV scrap being sent to shredders but could also have a small impact on shredder revenues as EEC will contain some metals that are targeted in the treatment of ELV-waste after shredding operations. In parallel, depending on how much of the base metals no longer arrive at shredders, it could be that the reduction of copper in Fe and Al scrap would set-off losses on quantities due to reduction of scrap impurities.

For **recyclers** of steel and aluminium, amounts of recovered materials would not be expected to change drastically, though under the various scenarios, amounts sold by shredders would reduce somewhat and amounts sold by recyclers of EEC would increase proportionally to the amount of EEC recycled after dismantling. Nonetheless, as more copper is expected to be recovered by EEC recyclers, the purity of ELV steel and aluminium scrap would be expected to increase to some degree. For recyclers of EEC (in some cases copper smelters), an increase of business is expected depending on the amounts of EEC sent directly to recycling and also on the type of EEC in question and its metal content.

In total, it can be expected that recyclers will place more secondary copper and secondary precious and CRMs on the market, though the case for different elements may differ depending on the availability of recycling capacities that target the specific material. For REE from magnets, it is possible that a dismantling obligation alone will not suffice to promote recycling and thus will not result in increased REE availability on the European market. If the REE cannot to be sorted and sufficiently recovered from fractions after dismantled parts are subjected to dedicated shredding of EEC (separate from other equipment) it could be relevant to perform deep dismantling of certain EEC to disassemble e.g., magnets prior to shredding operations. For steel and aluminium, higher purities will have an impact in terms of less dependency on primary materials. In general, the higher availability of recyclables on the EU market will lower the dependability of the EU on extra-EU sources (primary but also secondary in some cases). With the current war in Ukraine and lacking clarity on further geo-political developments, this reduction in dependency is not only an advantage for the EU in general but could also reduce supply risks for the **European automotive industry** (or other manufacturers). The case of copper for example is a good demonstration in this respect. Ukraine is an important supplier of copper, and the current geopolitical situation has created difficulties in the supply of copper. In particular, lack of supply of copper wire harnesses can affect the business drastically as this component is assembled in the vehicle at early stages and a lack of supply means that completion of assembly can have heavy delays. In parallel, the vehicle manufacturing industry may also experience higher costs for material recovery, either directly through costs of recyclables, but possibly also through a necessity to support the dismantling of components for which dismantling and separate recycling is marginal (e.g., through EPR). A further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the “metal components” arising from depollution and dismantling in the required format. However, it is required to report a sum of all depolluted and dismantled materials and reporting on separately listed materials is voluntary. Introduction of scenario **EEC 1** (and especially the monitoring aspect) will require adjustment of the reporting format as well as changing the reporting from voluntary to mandatory. This adjustment is assumed to result in additional economical costs for public administration as well as for ATF that report on removed parts/components.

These additional costs will be related to the additional time for collecting all data by ATFs, developing a precise reporting of the total weight of reused parts/components is to be required for each component in the reporting table. More time will also be needed for the institution that collects, summarises, and validates data before its official publication. It is to assume that the expected additional administrative cost of reporting would be similar in the case of scenario **EEC 1 and EEC 2**, but not doubling when the two scenarios are implemented jointly. These costs are reflected in the analysis at vehicle level which looks among others at the administrative burden related to reporting on reuse and is thus not included here to avoid double counting.

Additional costs will also exist for reporting on the dismantled inverters sent to recycling in particular in scenario **EEC 3**. These costs will incur for facilities’ operators as well as for public authorities, however it is expected that these costs will be higher for facilities. As described above, public offices will need to collect data and validate it. Here too, costs treated to administrative burden are calculated in the analysis at vehicle level in relation to the measure on obligatory dismantling and are not included here to avoid double counting.

3.1.10.1.3.3 Social impacts

For the components sub-set, based on the dismantling time specified in Restrepo et al. (2018) and the total amount of time needed for the additional dismantling, in each scenario the time needed for dismantling was used as a basis for calculating the additional jobs to be created through this measure. 65 additional jobs are estimated to be created under scenario EEC 1, ca. 465 additional jobs under scenario EEC 2 and ca. 1800 additional jobs under scenario EEC 3.

For the inverter, additional dismantling could result in an increase in the number of employees in the sector, particularly for ATF. Based on the dismantling time (possibly an underestimation), additional jobs were calculated based on dismantling for each scenario and amounted to 1 in scenario EEC 1, 7 in scenario EEC 2 and 29 jobs in scenario EEC 3.

3.1.10.1.4 Comparison of scenarios for EEC

The differences in impacts of the scenarios as compared to the baseline are compiled in Table 3-57 below to allow an easier comparison.

Table 3-57 Summarising table for the comparison of the EEC scenarios on the basis of treatment of the inverter (the assessed impacts are based on the total of ELVs collected in 2035)

Impacts		Scenario EEC 1	Scenario EEC 2	Scenario EEC 3
Economic	on ATFs	Inverter: 0.3 million € benefits due to additional dismantling costs off-set by high revenues Component sub-set: 5.2 million € additional costs, benefits unclear but expected to be set-off by reuse related revenues. Between 0 and +	Inverter: 2,2 million € benefits due to additional dismantling costs off-set by high revenues Component sub-set:38 million € additional costs, benefits unclear but expected to be set off by reuse related revenues Between 0 and +	Inverter: 7.2 million € benefits due to additional dismantling costs off-set by high revenues Component sub-set:147 million € additional costs, benefits unclear but expected to set off at least 26 million € of costs related to dismantling for reuse Between – and +
	on shredders	Loss of shredding material (loss of revenue) -	Loss of shredding material (loss of revenue) --	Loss of shredding material (loss of revenue) ---
	on recyclers	Small decrease in business due to reuse --> less secondary material for recycling – however impact is only delayed between 0 to -	Higher decrease in business due to less reuse --> less secondary material for recycling – however impact is only delayed -	Benefits for recyclers of Fe and Al as copper impurities will decrease, increasing quality of secondary materials. Benefits for EEC recyclers in terms of higher amount of secondary material (copper and precious metals). In both cases higher revenues expected ++
	on SME	Small ATFs would probably have higher costs than larger ones		
	Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal		
	Administrative costs burden	Quantified under vehicle level analysis for reuse monitoring measure	Quantified under vehicle level analysis for measure for supporting the reuse market	Quantified under vehicle level analysis for measure for obligatory dismantling
	2ndary resources	Small increase in availability of secondary precious metals for manufacture and in the availability of reused parts, benefiting	Moderate increase in availability of secondary precious metals for manufacture and in the availability of reused parts, benefiting	Large increase in availability of secondary precious metals for manufacture and in the availability of reused parts, benefiting

Impacts		Scenario EEC 1	Scenario EEC 2	Scenario EEC 3
		ATFs and indirectly repair shops and consumers +	ATFs and indirectly repair shops and consumers ++	ATFs and indirectly repair shops and consumers +++
Environmental	Environmental impacts: LCA credits for reuse/ remanufacturing and recycling[277]	Inverter: Small increase of 1% (2,000 tonnes CO_2 eq) in comparison to baseline scenario Sub-set of components: increase in environmental credits – unknown range +	Inverter: Moderate increase of 11% (15,200 tonnes CO_2 eq) in comparison to baseline scenario Sub-set of components: increase in environmental credits – unknown range ++	Inverter: Large increase of about 26% (36,500 tonnes CO_2 eq) in comparison to baseline scenario Sub-set of components: increase in a rage of 49-120% in environmental credits +++
Social	Employment	Increase in jobs (~1) for the inverter and in 65 additional jobs for the component sub-set. +	Increase in jobs (~7) for the inverter and in 465 additional jobs for the component sub-set. ++	Increase in jobs (~29) for the inverter and in 1800 additional jobs for the component sub-set. +++
Stakeholder support			Stakeholders from all categories explained the importance of measures for supporting the reuse market as a means to boost demand for reused parts. A few examples include: (EGARA 2021; Eurometaux 21 Feb 2021; EUROFER 27.10.21)	Stakeholders who answered to the workshop interactive questions (Slido) agreed (12 from 15) that separate recycling would improve recycling of materials contained in EEC. In the OPC, around 50% supported obligatory dismantling for PWB, magnets and other EEC.
	Proportionality	All scenarios are considered proportional for achieving the objectives that the EU Treaties intends to implement		
	Cost effectiveness	Low costs but low benefits +	Moderate costs and benefits ++	Highest costs but also highest benefits Between + and -++
	Coherence	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity and also coherence with raw material policies as it	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity and also coherence with raw material policies as it	Coherence with waste legislation and the CEAP, promoting waste treatment of a higher hierarchy and circularity and also coherence with raw material policies as it

[277] As a difference to baseline scenario

Impacts		Scenario EEC 1	Scenario EEC 2	Scenario EEC 3
		supports the recovery of (critical and) precious metals (depending on EEC reused and recycled) +	supports the recovery of (critical and) precious metals (depending on EEC reused and recycled) ++	supports the recovery of (critical and) precious metals (depending on EEC reused and recycled) +++

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g., ++ to +++ or – to +

n.a.: not applicable

Though the data availability allows only a partial analysis, the analysis suggests that all scenarios would be **effective**. Scenario EEC 1 is to result in relatively small benefits but is also expected to have much lower costs. Under scenario 2 costs may be more significant but are expected to be set-off by revenues as reuse will only take place where there is a market for using reused components. Scenario EEC will have the highest costs as all components must be dismantled and treated separately. The costs are not completely clear however per vehicle, dismantling costs would be expected to be lower than in other scenarios, as a larger share of EEC that falls under dismantling obligations can probably be dismantled destructively.

In all cases, a higher **efficiency** is expected in relation to increasing the recovery of copper (and thus indirectly reducing impurities in steel and aluminium fractions (quality improvement) and of certain precious metals (e.g., gold palladium, silver, tin). This is related to dismantling of components containing PWB in which precious metals can be targeted for example through copper smelting. However, the efficiency for dismantling actuators containing REE is not clear. To begin with, such materials do not show a high environmental difference between the baseline and other scenarios as their primary production is similar in intensity to base metals (Fe, Al, Cu). REE are an important material for magnets used in various types of vehicle motors and currently the EU relies heavily on other countries (e.g., China) for their supply. This means that the recovery of REE has a political relevance that is also affected by geo-political developments, however this cannot be quantified to allow understanding how this affects the comparison of the scenarios. In addition, REE contained in magnets in such components would not be recovered based on the current recycling capacities in the EU. Though recycling capacities could develop by 2035, it may be worth investigating whether obligations to dismantle REE containing magnets would help advance the development of such capacities. Dismantled magnets would then either need to be stockpiled until recycling capacities in the EU are sufficiently developed, or alternatively could be exported for recycling in this transitional period.

A few recommendations made by Restrepo et al. (2018) can be reproduced here. After comparing the environmental impacts with the dismantling rates and times for each component, Restrepo et al. (2018) make the following recommendations:

- The example of an alternator is representative of the REE rich components, where dismantling results in smaller reductions of the environmental impacts as compared to the baseline. However, the results depend on how the fractions are treated after the initial shredding. When sorting is performed after the initial shredding, some of the copper sticks to clumps of other base metals (e.g., where the copper is “anchored” to such metals), which are relatively large. More copper thus ends up as an impurity in recovered steel and aluminium as compared to cases where advanced shredding is applied (resulting in smaller pieces sent to sorting). In this case, if advanced shredding is not applied, it is recommended to dismantle such components even just to increase the recovery of copper, which also has benefits to the purity of other metals. After dismantling, components not sold for reuse (as well as the malfunctional ones being replaced) should be disassembled so that the copper anchoring is removed and sent to separate recycling.

- The example of the GPS navigation system (representative for the PWB containing EEC) shows a somewhat different picture: these EECs are hardly ever removed for reuse as spare parts, i.e. they are all shredded, which means that the possible environmental reduction is small. Only when Cu and other metal content (mostly precious metals) are also recovered, is there a considerable environmental benefit. Accordingly, here it is recommended to dismantle all GPS navigation systems and in a second step to disassemble some of their sub-components (cables, plugs and printed circuit boards) and send them to Cu and precious metals treatment plants.

As regards proportionality, here the situation may somewhat differ for the various scenarios. Though some benefits have been assumed for scenario EEC 1 on the basis that the need to monitor reuse may push ATFs to more dismantling for reuse, however this benefit is considered to be relatively small. In parallel, ATFs will be required to provide a detailed reporting of the number and type of EEC dismantled and related weights. Though it is expected that many ATFs will have such information digitized (more and more ATFs conduct the sale of reused components online), it is not completely clear what the costs of such dismantling would be and whether they would be proportional to expected benefits. Nonetheless, as without a more detailed monitoring on reuse it is considered that the actual status of reuse will remain very vague, perhaps other benefits need to be considered in this case. For scenario 2, the assumption is that components will only be dismantled (and sold) where there is an expected demand for them on the market. Furthermore, ATFs would only be expected to dismantle components when the costs are set-off by respective benefits. Though some stakeholders may have related costs (e.g., loss of business for producers related to manufacture of new parts, repair shops that will have an extra effort to prepare proposals) these are expected to be set off by the environmental benefit of reuse which saves credits related to the manufacture of materials for new production. In so far it is assumed that here the costs are proportionate to expected benefits. For scenario EEC 3, proportionality may depend on the specification of the obligation to dismantle. From the literature, it appears that for some EEC, dismantling of EEC is economically feasible not just for reuse but also for recycling, also providing an environmental benefit. However, this is not always the case and specifying a list of components for obligatory dismantling in lack of sufficient data could affect the proportionality of this measure. As explained earlier in this chapter, the EMPA continues to research this subject in detail in relation to a similar obligation being considered for Switzerland. Results of this study are due for publication at the beginning of 2023 and should be consulted again to allow consideration of the results and a possible alignment with the Swiss obligation.

EPR considerations:

The costs for dismantling of EEC will depend on the components for which this will be obligatory. Some of the specifications proposed in this regard are supported by practices in other sectors (PWBs for WEEE and possibly also PV in the future) and some based on the various studies that have been performed on this subject. However actual costs depend on labour costs of which differ between MS as also on the revenues that can be expected for reuse as also for recycling. In this sense, it is not possible to provide an estimation of possible support that ATFs may need from EPRs to facilitate this practice at this time. That said, the Restrepo et al. (2018) work estimates the time needed for dismantling at 188 minutes for a sub-set of 12 components types expected to contain significant amounts of precious and CRMs. The actual dismantling time may be lower when components are dismantled for recycling in a destructive way (though affecting possible benefits). This provides a reference for the possible costs of dismantling per vehicle, though it can be expected that at least a share of such costs would be set-off by revenues from reused parts and from sales of the EEC fraction for recycling and subsequently, sales of revenues from secondary materials.

3.1.10.1.5 Preferred Scenarios for inclusion in final policy options

It is proposed to include all three measures in the various policy options, these could be combined in different ways, however a combination of all three measures could prove to have the highest relevance as these measures will support both reuse and separate recycling that are both understood to be relevant for EEC. The monitoring measure for reuse is mainly seen as a supporting measure that is necessary in any case and should in any case be considered is the measure for increasing the demand of reused parts. In that sense, the monitoring of reuse could be proposed as a single measure to facilitate better compliance with existing provisions. A more relevant combination would see all three measures applied and a possibility for further ambition would be to consider different options for the list of EEC to be dismantled. The combinations to be considered are thus formulated as follows:

- Monitoring of reuse
- Monitoring of reuse +Measures to promote the demand of reused and remanufactured parts + Obligatory dismantling of the following EEC: printed circuit boards with a surface area greater than 10 square centimetres, photovoltaic components with a surface area of 0.2 square meters, inverter, drive control unit, start-stop-control unit, oxygen sensor, transmission control unit, side assistant sensor, distance and near distance sensors, airbag controller, engine controller, multifunctional display, navigation system GPS, radio CD, speedometer
- Monitoring of reuse +Measures to promote the demand of reused and remanufactured parts + Obligatory dismantling of the EEC listed above in addition to: ABS Block, alternator, starter, window raising motor (front and rear), radiator fan motor, wind wiper motor (front and rear)

It should further be considered whether to extend the list after publication of the EMPA study and in consultation with the obligatory dismantling list for EEC in Switzerland.

To summarise, the following table contains recommendations, in some cases referred in the various sources and in some cases a result of the analysis prepared in this study:

Components	Materials of relevance	Proposed approach - recommendation based on literature conclusions if not specified otherwise - see source in adjacent column	Related source
Actuators in ABS Block, alternator, starter, window raising motor (front and rear), radiator fan motor, wind wiper motor (front and rear)	REE	Part of the Restrepo sub-set: If only copper is targeted: require dismantling in cases that advanced shredding and PST are not applied to enhance removal of copper (beneficial for purity of Fe and AL scrap as well as for copper recycling) If REE targeted, make dismantling obligatory and further investigate if magnets should be disassembled before dedicated shredding of EEC batches.	Restrepo et al.

Components	Materials of relevance	Proposed approach - recommendation based on literature conclusions if not specified otherwise - see source in adjacent column	Related source
airbag controller, engine controller, multifunctional display, navigation system GPS, radio CD, speedometer	Other CRMs	Part of the Restrepo sub-set: GPS (navigation systems) recommended for obligatory dismantling	Restrepo et al.
Printed wiring boards in control devices. Most relevant are: control units for the engine and infotainment, display and control unit, control panel, airbag control and auxiliary stop light	Precious metals	The consultant recommends adapting the WEEE approach of requiring dismantling of PWB with a surface area greater than 10 square centimetres	Groke et al.
Inverter, oxygen sensor, side assistant sensor, distance and near distance sensors		Only components relevant for economically feasible dismantling in countries with high labour costs	Arnold et al. (2021)
Photovoltaic panels		The consultant recommends adapting the WEEE approach of requiring dismantling of PV with a surface area of 0.2 square meters	
Engine components: heating fan and generator		Recommended for dismantling as considered to be economically feasible	Groke et al.
Controller components: engine/gear control unit, inverter, drive control unit, start-stop-control unit		Recommended for dismantling as considered to be economically feasible	Groke et al.
Alternator		Recommended for dismantling as considered to be economically feasible	Groke et al.
Transmission control unit		Recommended for dismantling as considered to be economically feasible	Groke et al.
Heating fan, alternator, inverter, engine control unit, transmission control unit, drive control unit, start/stop engine and oxygen sensor		Recommended for dismantling as considered to be economically feasible	Groke et al.

3.1.10.1.6 Reporting and monitoring requirements

Reporting requirements are explained earlier in the section. For the monitoring of reuse, a new methodology will be developed, requiring a more detailed reporting of the type of components sold for reuse and their respective weights. This monitoring is to replace the currently voluntary reporting on reuse that is not sufficient to allow understanding the actual level of reuse on the various MS. Thus, such monitoring will be necessary for both of the reuse measures proposed here.

To monitor the compliance with the dismantling obligation, possibly the easiest method of monitoring would be to require ATFs to report on amounts of EEC sold for further treatment. This shall also increase transparency as to how such fractions are recycled (what type of recyclers). Understanding expected amounts of EEC to be dismantled and sent to recycling will be difficult as the number of components can vary between vehicle models as can also the weight. However, the reuse monitoring could provide some insight to allow for a better understanding in the future.

3.1.11 Analysis of measures addressing the treatment of vehicles at EoL: vehicle level

Five measures were shortlisted for at the vehicle level, including the following measures:

Title	Chapter
2.3.e) Establish provisions to support the market of used spare parts composed of steel	2.1.5.3.5
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing of steel components	2.1.5.3.6
2.4.a) Align definition of 'recycling' with the WFD to prohibit the backfilling	2.1.5.4.1
2.4.b) Making it mandatory to remove certain copper parts before shredding to encourage high quality steel/aluminium and high quantity copper recycling as well as mandatory removal of selected parts/components that contain aluminium	2.1.5.4.2
2.4.c) Set material-specific recycling targets for a selection of materials	2.1.5.4.3
2.4.d) Regulate shredder/post shredder facilities to ensure high quality/quantity of materials obtained for recycling and to improve final treatment process	2.1.5.4.4
2.4.e) Increase (?) current re-use and recycling targets and/or ban disposal or landfilling of waste from ELVs	2.1.5.4.5

Colour code: Red – discarded, Yellow – premature, Grey – supporting measure

The measures above are relevant for the reuse/remanufacturing and recycling addressing the treatment of vehicles at end-of-life. All of the above-named measures were already considered in the various material level analysis and their outcomes discussed in the previous sub-chapters. The aim of this analysis is to gain better understanding of impacts for various assumption on the vehicle level. Thus, a combination of selected scenarios for materials were combined to perform analysis on the vehicle level. The intention was to select scenarios so they will be as much as possible in the line with the analysed policy options. Below table with the selected material scenario allocated to new overall scenarios on vehicle level.

Table 3-58 Routes of treatment for complete vehicle under the various scenarios

	Baseline Overall ELV	Scenario 1 Overall ELV	Scenario 2 Overall ELV	Scenario 3 Overall ELV	Scenario 4 Overall ELV
Steel, Copper, Aluminium, Other materials	Baseline	Scenario 1 (monitoring reuse)	Scenario 2 (support reuse)	Scenario 3 (mandatory dismantling)	Scenario 4 (regulate shredder/PST)
Glass	Baseline	Scenario 1 (alignment WFD)	Scenario 1 (alignment WFD)	Scenario 2 (mandatory dismantling)	Scenario 3 (material-specific target)
Plastic	Baseline	Baseline	Baseline	Scenario 3 (landfill ban)	Scenario 2 (material-specific target)

Source: Oeko-Institut: own assumptions

3.1.11.1 Results of qualitative analysis

The results of qualitative analysis of all scenarios were already introduced in the analysis performed for various materials, thus will not be duplicate here and instead please refer to relevant parts of the document:

- Implementation of reuse/recycling measures: please refer to e.g., 3.1.5.3.
- Implementation of "calculation point": please refer to e.g., 3.1.8.1.4.2.
- Mandatory removal of certain parts: please refer to e.g., 3.1.8.1.3.
- Requirements on deliverable from shredder/PST together with landfill ban: please refer to e.g., 3.1.5.3.

3.1.11.2 Results of quantitative analysis

The following table are calculated routes of treatment for all materials in collected ELVs in 2035 based on the estimated routes of treatment for individual material.

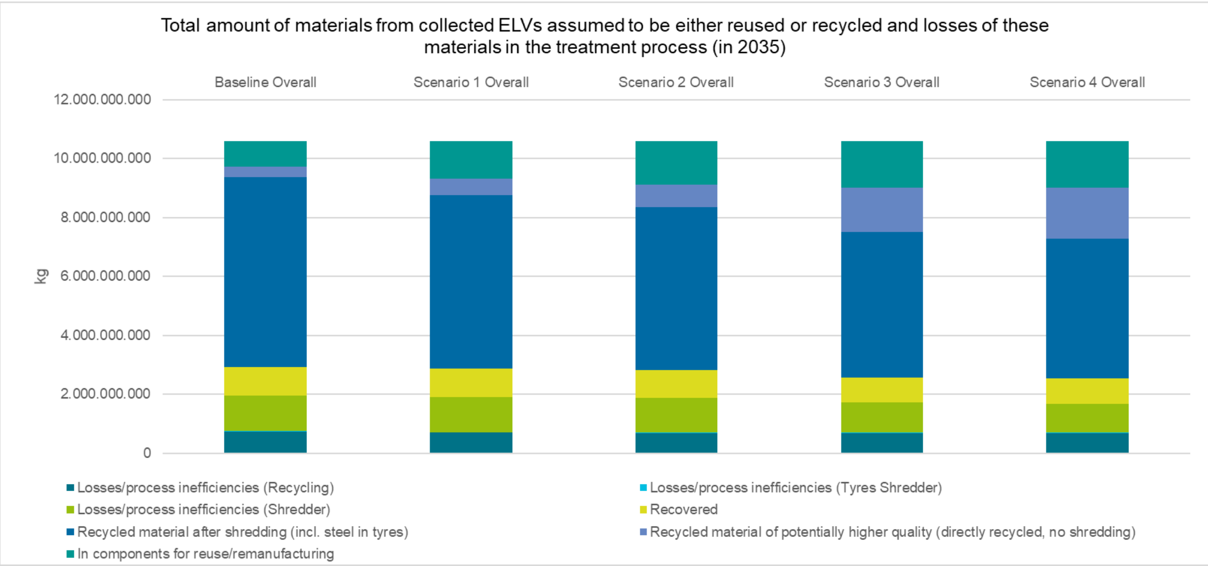
Table 3-59 Calculated routes of treatment for all materials in collected ELVs under the various scenarios

	Baseline	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Dismantled -> reused/remanufactured	8%	12%	14%	15%	15%
Dismantled -> recycled (no shredding)	3%	5%	7%	14%	16%
Dismantled -> shredded -> recycled	2%	5%	8%	8%	8%
Shredded -> recycled	58%	50%	43%	39%	36%
Recovered	9%	9%	9%	8%	8%
Losses/process inefficiencies	18%	18%	18%	16%	16%

Source: Oeko-Institut: own calculations

Figure 3-22 introduces the calculated amounts of materials from collected ELVs in 2035 that could be reused/remanufactured as well as recycled pre- and post-shredder. The total mass of these materials in EoL vehicles is assumed to be about 10,655 Mt in 2035.

Figure 3-22 Tonnes of materials from collected ELVs assumed to be either reused or recycled and losses of the material in the treatment process (in 2035) (kg)



Source: Own illustration

Together with the introduction of new measures the level of common reuse and recycling target will change. The rather significant impact on this level will be the introduction of "calculations point" since from the reported data all the losses have to be discarded and the adjustment of the recycling definition to the WFD due to the fact that backfilling will not account anymore towards recycling rate. In view of the considered measures under Scenario Overall, certain assumptions have been made in the calculations, for instance the high of reuse/remanufacturing is up to 20% of dismantled materials (steel, wrought and cast aluminium, copper, glass, plastic), part of remaining parts/components are treated in shredder/PST and other parts are after dismantling send directly to the recycling. All losses in both routes are excluded in the calculation as well as vehicle's battery weight. Towards reuse and recycling, the weight of aluminium treated together with steel is also considered. In a result, the recovery and recycling rates achieved in the different scenarios range between 80% and 83% and the reuse and recycling rates between 70% and 74%

Table 3-60 Obtained rates for reuse and recycling and rates for recovery and recycling for complete vehicle under the various scenarios

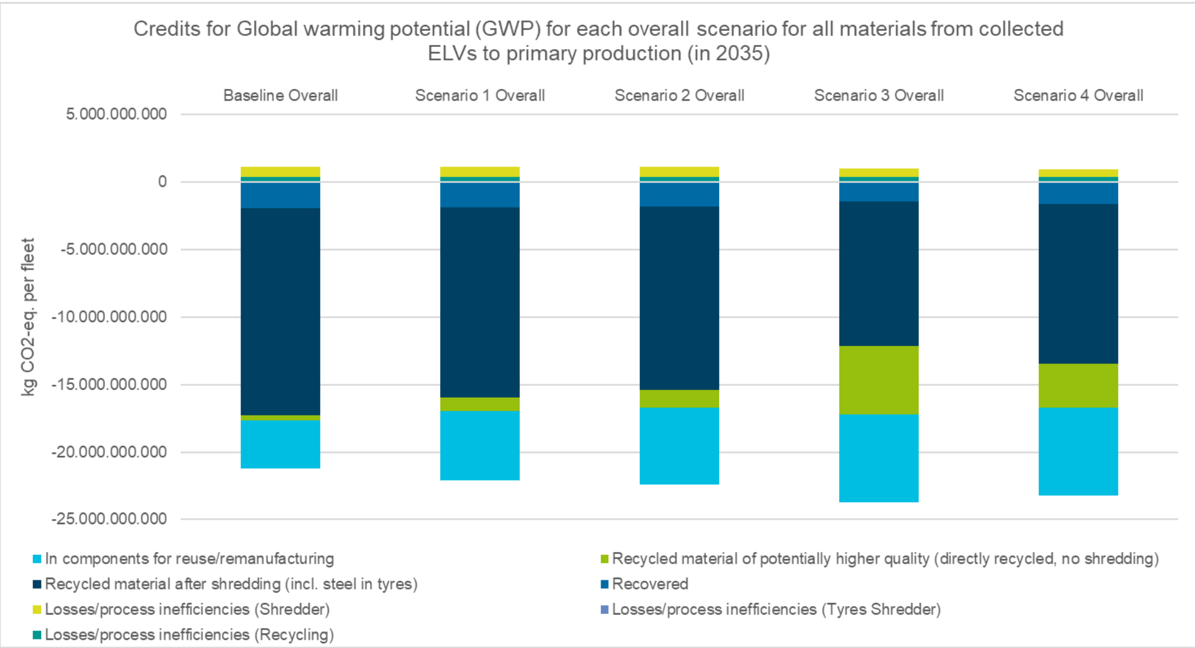
	Baseline Overall ELV	Scenario 1 Overall ELV	Scenario 2 Overall ELV	Scenario 3 Overall ELV	Scenario 4 Overall ELV
reuse and recovery rate	80.4%	85.6%	82%	87.3%	86.8%
reuse and recycling rate	70.6%	75.9%	76.2%	78.9%	77.9%

Source: Oeko-Institut: own calculations

3.1.11.2.1 Environmental impacts

The following figure shows credits in GWP for various scenarios based on the shares specified in Table 3-59 for the whole fleet in 2035. The highest GWP credits per kg material has recycling of materials followed by credits for components for reuse/remanufacturing. Benefit of recycling route without shredder (direct recycling) are more visible in Scenario 3 Overall, where for majority of materials scenario with mandatory removal was analysed. Visible environmental credits are also visible for Scenario 4 Overall. Here significant rule plays also dismantling in order to reach thresholds on the Cu-content in steel scrap as well as on metal content in PST residues.

Figure 3-23 Credits for Global warming potential (GWP) for scenarios for the whole fleet compared to primary production – calculated for all ELVs collected in 2035 (tCO_2eq)

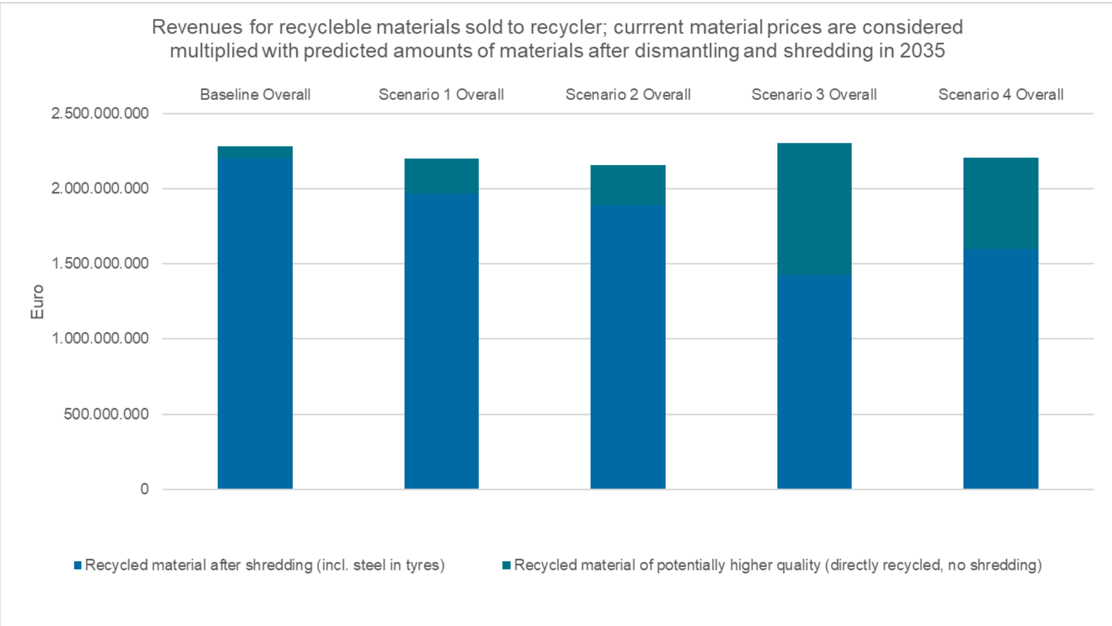


Source: Own illustration

3.1.11.2.2 Economic impacts

Economic impact was also addressed in higher detail under each of sub-section on various materials thus will be not considered on the vehicle level. However, in general, it can be said that dismantling costs are not competitive towards other ways of treatment. Thus, for several materials, it is recommended to consider developing of EPR scheme that could cover potentially higher costs by this scheme. (e.g. also described in detail in other sub-chapter with analysis for various materials). Since the dismantle time (i.e., dismantle costs) varied for different components the calculation of dismantling cost was not performed, however it is possible to refer to previous sub-chapter to get familiar with the calculations for various materials. The following figure shows summed up revenues obtained from recycling of considered materials. Caution, this calculation does not include the revenues from sold components for reuse/remanufacturing, since they vary among the components and the introduced calculation based on the material and not components. The calculations base also on the current prices for materials for recycling and recovery, however the fleet is from 2035.

Figure 3-24 Total revenue from materials for recycling or recovery in Euro – calculated for all ELVs collected in 2035 (1000 Euro)



Source: Own illustration

Here again the intensive dismantling and direct recycling promoted under Scenario Overall 3 and 4 for various materials, shows impact of the revenues for these separately recycled materials on the total revenue. Prices for some materials variate, depending on the quality of material for recycling, i.e., secondary wrought aluminium can have a price of primary wrought aluminium and this current price was considered in the calculations.

Currently, under the reporting format, the steel scrap is to be reported for recycling, recovery, and disposal. These values are nowadays mainly provided by shredders/PSTs. Together with introduction of a “calculation/measurement point” in the reporting, recyclers will also be involved in the reporting (more about it in another chapter). This will also increase the reporting costs also in regard to calculate/assume/obtain data for reporting on all losses (in shredder/PSTs and in recycling processes) in order to derive the actual amount of steel scrap ready for use.

An implementation of the broader reporting scheme, which will embrace also reporting by recyclers, has farther economic impact, which has been assessed with the use of existing model for assessment of administrative costs. The crucial finding that was calculated on the overall ELV level (due to similar approach for all materials) are introduced in Table 3-61. The reporting schemes varied among MS, since its structure is defined by each MS by itself, thus the estimations done for the calculation of administrative costs are rather rough.

Table 3-61 Yearly Admin. Costs (AC) for the Waste management sector and MS related to reporting (~12 000 ATFs (Elliott et al. 2019), 500 shredders and recyclers[278])

Activity	Type of obligation	Days of work	Total AC (€)
ATF Reporting to MS authority on dismantled parts/components for reuse/remanufacturing	Submission of (recurring) reports	1*	1.976.395
MS Reporting on treated ELVS to Eurostat	Submission of (recurring) reports	1*	2.223
Repair shops	Types of obligation	52**	108.392.924
MS Reporting on treated ELVS to Eurostat	Inspection on behalf of public authorities	3	25.014
ATF Reporting to MS authority on mandatory dismantled parts/components either for reuse/remanufacturing or for recycling	Submission of (recurring) reports	1*	1.482.296
MS Reporting on treated ELVs to Eurostat	Submission of (recurring) reports	1*	1.668
Reporting obligation on PST capacities	Submission of (recurring) reports	1	57.645
MS Reporting on treated ELVs to Eurostat	Submission of (recurring) reports	1	11.117
Recycler reporting on quality of smelted steel batches	Submission of (recurring) reports	12	123.525
MS Reporting quality of steel recyclates to MS	Submission of (recurring) reports	1	11.117
Reporting obligation on the quality of residues (POP content)	Submission of (recurring) reports	1	57.645
MS Reporting on treated ELVS to Eurostat	Submission of (recurring) reports	1	8.338
Waste operators/EPR reporting on treated ELVs to MS authorities ("calculation point")	Submission of (recurring) reports	1***	12.451.290
MS Reporting on treated ELVS to Eurostat ("calculation point")	Submission of (recurring) reports	1***	3.127

Assumption: (*) reporting effort assumed similar to baseline, with increasing additional effort per scenario due to changes in format and need to review additional documentation of waste management operators. (**) additional effort for ATFs due to reporting. (***) increased reporting effort due to complexity of reporting on material specific target and related calculation point. Further assumptions in Annex.
Source:

Table 6-17 (Annex I).

[278] According to (Mc Kenna 2014) a total of 352 "automotive shredders" were operating in the EU-28 and Norway in 2014, however this includes 47 UK shredders. 300 automotive shredders were assumed to be active in the EU in 2035 and 200 more recyclers relevant for this material.

3.1.11.2.3 Social impacts

Together with higher dismantling costs it is to be assumed that there shall be an increase in the number of jobs needed to perform dismantling work. The potential additional jobs were introduced under the sections for the specific material analysis and are not reproduced here to avoid double counting.

3.1.12 Comparison of the options

Based on the results of the material/component specific analysis above, the policy options initially compiled under Section 3.1.2 were revised and specified so that in each policy option includes measures to address the various materials/components and the vehicle level.

Three revised options are proposed and detailed in the following table in terms of the measures included and materials and components addressed:

- The better compliance PO,
- The increased harmonisation PO, and
- The advanced implementation PO.

Table 3-62 Options for comparison of circularity objective

	PO 1 - Better compliance	PO 2 - Increased harmonisation (preferred)	PO 3 - advanced implementation
Production	Adaptation of 3R to the new Framework Regulation + definition of vehicle type 2.1.d) Review of standard for calculation of 3R rates + 2.1.e) life cycle data 2.1.i) OEM Provision of dismantling information to ATFs 2.2.b) OEM Hazardous substance declaration 2.1.c) OEM Circularity strategy	Adaptation of 3R to the new Framework Regulation + definition of vehicle type 2.1.d) Review of standard for calculation of 3R rates + 2.1.e) life cycle data 2.1.i) OEM Provision of dismantling information to ATFs 2.2.b) OEM Hazardous substance declaration 2.1.c) OEM Circularity strategy 2.1.g) Recycled content declaration	Adaptation of 3R to the new Framework Regulation + definition of vehicle type 2.1.d) Review of standard for calculation of 3R rates + 2.1.e) life cycle data 2.1.i) DPP: OEM Provision of dismantling information to ATFs 2.2.b) DPP: OEM Hazardous substance declaration 2.1.c) OEM Circularity strategy 2.1.g) Recycled content declaration
Design	2.2.a) Restrictions and exemptions remain under ELV	2.2.a) Hybrid: 4 Heavy metals + exemptions under ELV, further prohibitions under REACH 2.1.g) High recycled content targets for plastics 25% in 2030 and 30% in 2035, 25% of which closed loop	2.2.a) Restrictions and exemptions moved to REACH 2.1.g) High recycled content targets for plastics 30% in 2030 and 35% in 2035, 25% of which closed loop
Reuse	2.3.a) Reuse definitions 2.3.b) Remanufacturing definitions 2.3.f).Reuse monitoring	2.3.a) Reuse definitions 2.3.b) Remanufacturing definitions 2.3.e) Reuse support of market 2.3.f).Reuse monitoring	2.3.a) Reuse definitions 2.3.b) Remanufacturing definitions 2.3.e) Reuse support of market 2.3.f).Reuse monitoring

	PO 1 - Better compliance	PO 2 - Increased harmonisation (preferred)	PO 3 - advanced implementation
Recycling	2.4.a WFD definition, excluding backfilling 2.3.e) introduce calculation point 2.3.f) Reporting requirements	2.4.b) Obligatory dismantling: glass windows, wire harness, EEC (PWBs with a surface area > 10 cm^2, PV panels with a surface area >0.2 m^2, controllers), Mono-material aluminium components with a weight above 10 kg. 2.3.e) Ban of disposal or landfilling (non-inert) 2.3.e) Introduce calculation point 2.3.f) Reporting requirements Assumed to contribute to a level of 0.2% copper impurities in steel scrap	2.4.a WFD definition, excluding downcycling 2.4.b) Obligatory dismantling: engines, wire harness and large mono material copper, EEC (PWBs with a surface area > 10 cm^2, PV panels with a surface area > 0.2 m^2, controllers, engine motors), Mono-material aluminium components with a weight above 5 kg, NdFeB magnets*, non-recyclables. 2.4.c) Material specific targets: glass 70%, plastic 30% 2.4.d) Shredder operation requirement + PST to reduce metallic content + deflagration requirements + PST reporting 2.3.e) introduce calculation point 2.3.f) Reporting requirements Assumed to contribute to a level of 0.1% copper impurities in steel scrap

**Review of NdFeB not part of this study – impacts not assessed so far.*

The following table summarises the main costs and benefits of each of the three policy options on this basis. The period calculated for is 2035 and the calculation is based on the number of collected ELVs expected to derive in that year. In most cases such calculations are based on all ELVs, in specific cases (as explained in the sections above, the calculations may have considered only the share of EVs or may have made different assumptions for the different vehicle categories (ICE, EV, hybrids and plug-in hybrids).

In terms of environmental impacts, global warming potential is referred to in terms of environmental credits and burdens related to various scenarios and the baseline. The scope of this analysis considers the amounts of gained materials in reused spare parts, amounts of materials recycled and/or recovered for each scenario and for the baseline. These amounts are considered as environmental credits. As well, the obtained CO_2-eq refer to environmental burdens from treatment processes, i.e. final treatment of recycling losses.

Hazardous substances avoided are referred to in relation to scenarios in which the prohibitions of such substances are affected.

Finally, the table also refers to impacts in terms of the difference in tonnage of recycled materials obtained from various scenarios and the baseline. Though it can be argued that this reflects also GWP differences and may thus be a form of double counting, the intention is to allow a better understanding of how the scenarios contribute (or not) to the objectives of circular economy. Averting from primary materials to secondary ones can also be considered to have environmental benefits that are not reflected on the GWP indicator: Mining and processing of new materials are often associated with changes of the natural environment and in some cases also with pollution of the environment, when substandard practices are applied. Mining activities can also have a social impact when performed in countries where e.g., children labour is still common. Such impacts could not be quantified and thus the reference to increases in secondary materials provides an indication of their relevance, while also showing the contribution of policy options to the objective of circularity. Furthermore, the different environmental impacts are not referred to additively as the units differ – thus avoiding the risk of double counting.

Some of the measures target an improvement in the quality of materials recycled from vehicles and not just an increase in quantity. Subsequently, under the different policy options, for some materials the table refers not just to the total quantity, but to the shares of material recovered at low, moderate and high quality. This method of notation is used here for simplicity and also for unification, whereas the sections dealing with the analysis at the material specific level give an indication of what types of quality may result from the waste management under different scenarios. Generally, high quality represents vehicle grade and equivalent and refers to a level that can be used for manufacture in vehicles. Low quality is used when the material is downcycled significantly. The moderate level may be relevant only for some materials, where levels exist in between these two extremes (not always the case). For example, glass recycled after the shredder can currently only be applied for uses considered as downcycling. This is referred to as low quality. When glass is dismantled it can be separated and used for manufacture of container glass. This is considered moderate quality as it is currently not feasible to recycle such glass so that it could be used for manufacture of window glass in vehicles, considered as high quality. For steel in contrast only two levels are distinguished.

The different recycling qualities have a financial significance which is captured in the calculation of revenues from recycled material. From an economic perspective, an increase in quality also has an importance for reducing the dependency of the EU on other countries for the production of resources, however at present it is not possible to quantify such impacts. This difference can also be considered to have an environmental significance, as where recycled materials cannot be used, primary ones would need to be produced. However, where there is not a surplus of low- or moderate-quality materials, primary materials would need to be used anyway (i.e., where their supply is matched with the demand). For example, in the case of moderate quality steel that can be used on construction as is but that would need to be diluted with primary steel for vehicle manufacture), as long as there is demand for moderate quality steel in construction, primary steel will need to be produced anyway and could be used in the vehicle sector. Respectively there is limited LCA data that reflect the environmental differences between different qualities of material (very small difference). Thus, the indication of quantities is used to also indicate related impacts that cannot be quantified, i.e., in terms of various secondary steel qualities with higher or lower carbon content.

In the table below, when referring to monetary impacts, the minus symbol is used when a cost is referred to (a negative monetary impact) and a plus when a benefit is referred to (a positive monetary impact). In a few cases, certain values appear more than once in the table. For example, the revenues from sales of recovered material are considered a benefit of recyclers, but also appear alongside the tonnage values that are referred to under the category “envi. Secondary materials”, as they provide an indication for the level of benefit in monetary terms. In the latter case, the values thus appear in red. In other words, whenever values appear more than once, repetition will be in red. For the case that the values under each scenario are to be aggregated, red values should be disregarded to avoid double counting.

Table 3-63 Compiled results of comparison of the options for comparison of circularity objective

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
Envi: GWP and other	Non-recyclables	CO2 eq. emissions: no change expected but benefit of non-recyclables in use phase ensured Recycling credits similar to baseline Negligible	CO2 eq. emissions: -/- Recycling credits: Similar to baseline Negligible	CO2 eq. emissions: -/- Recycling credits: In the mid- to long-term, recycling will lead to increase in credits and circularity +
	Steel	Increase in credits from reuse/rem.: ~570 Mt CO2-eq. ++	Increase in credits from reuse/rem.: ~581 Mt CO2-eq. ++	Increase in credits from reuse/rem.: ~589 Mt CO2-eq. ++
	Copper	Increase in credits: ~65 Mt CO2-eq. ++	Increase in credits: ~130 Mt CO2-eq. ++	Increase in credits: ~67 Mt CO2-eq. ++
	Aluminium	Increase in credits from reuse/rem.: ~693 Mt CO2-eq. ++	Increase in credits from reuse/rem.: ~1,990 Mt CO2-eq. ++	Increase in credits from reuse/rem.: ~1,307 Mt CO2-eq. ++
	Glass	Increase in credits from recycling: ~4,000 t CO2-eq. (negligible)	Increase in credits from recycling: ~126,000 t CO2-eq. ++	Increase in credits from recycling: ~126,000 t CO2-eq. ++
	Plastic		Additional 758 thousand tonne in credits Moderate decrease in hazardous substance emissions related to plastics	Additional 661 thousand tonnes in credits Moderate decrease in hazardous substance emissions related to plastics
	EEC	For inverter: Moderate increase in credits of 11% (15,000 tonnes CO2 eq) in comparison to baseline scenario For sub-set of components: increase in environmental credits – unknown range +	Benefits in a range between the other two scenarios ++	For inverter: Larger increase in credits of 26% (36,000 tonnes CO2 eq) in comparison to baseline scenario For sub-set of components: increase in a rage of 49-120% in environmental credits +++
	Hazardous substances	Benefits for the substances already prohibited under ELV have already incurred for the most part. Benefits expected for future restrictions, depending in range on applications in which substances to be restricted in the future are applied, as well as on the difficulty or ease of their substitution.	Benefits for the substances prohibited under ELV have already incurred for the most part. Benefits expected for future restrictions under REACH, depending in range on applications in which substances to be restricted in the future are applied, as well as on the difficulty or ease of their substitution.	Benefits for environmental health are expected if the future regulation of substances in vehicles enables the prohibition of additional hazardous substances, depending in range on applications in which substances to be restricted in the future are applied, as well as on the difficulty or ease of their substitution
Envi: secondary materials	Vehicle level design	Small increase in the share of vehicle that comply with the 3R, raising the reuse and recycling level	Small increase in the share of vehicle that comply with the 3R, raising the reuse and recycling level	Small increase in the share of vehicle that comply with the 3R, raising the reuse and recycling level a bit

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
		a bit above 4% in comparison to baseline Between + and ++ Decrease in the use of resources for manufacture of new parts due to increased reuse Between + and ++	a bit above 4% in comparison to baseline Between + and ++ Decrease in the use of resources for manufacture of new parts due to increased reuse Between + and ++ Small increase in circularity in the long run Between 0 and +	above 4% in comparison to baseline Between + and ++ Decrease in the use of resources for manufacture of new parts due to increased reuse Between + and ++ Small increase in circularity in the long run Between 0 and + Benefit related to declaration not expected n.a
	Non-recyclables		Changes considered negligible	Increase in SRM in moderate- to long term where recycling technologies develop +
	Steel	Copper impurities in scrap < 0.4% Decrease in availability of secondary steel (- 46 thousand €) due to increase in reuse -	Copper impurities in scrap ≤ 0.2% Decrease in availability of secondary steel (- 45 thousand €) due to increase in reuse -	Copper impurities in scrap ≤ 0.1% Decrease in availability of secondary steel (- 45 thousand €) due to increase in reuse However, the secondary steel is of high-quality ++
	Copper	Decrease in availability of secondary copper (-4 thousand €) due to increase in reuse -	Increase in availability of secondary copper (+3 thousand €) thanks to higher dismantling +	Increase in availability of secondary copper (+2 thousand €) thanks to better sorting ++
	Aluminium	Decrease in availability of secondary aluminium (-44thousand €) due to increase in reuse -	Decrease in availability of secondary aluminium (-40 thousand €) due to increase in reuse -	Decrease in availability of secondary aluminium (-64 thousand €) due to increase in reuse ++
	Glass	Small increase in availability of secondary glass for high-quality applications 4.4 thousand tonnes	Large increase in availability of secondary glass for high-quality applications 131 thousand tonnes	Large increase in availability of secondary glass for high-quality applications 131 thousand tonnes
	Plastic		Total additional SRM = 130 thousand tonnes SRM from dismantling (higher quality assumed) = 54 thousand tonnes	Total additional SRM = 160 thousand tonnes SRM from dismantling (higher quality assumed) = 67 thousand tonnes
	EEC	Moderate increase in availability of secondary precious metals for manufacture and in the availability of reused parts, benefiting ATFs and indirectly repair shops and consumers +	Benefits in a range between the other two scenarios ++	Large increase in availability of secondary precious metals for manufacture and in the availability of reused parts, benefiting ATFs and indirectly repair shops and consumers +++
ATFs	Vehicle level design	Some costs for additional dismantling but assumed to be set-off by benefits for selling components for reuse and scrap for recycling Between + and ++	Some costs for additional dismantling but assumed to be set-off by benefits for selling components for reuse and scrap for recycling Between + and ++ Indirect benefits from OEMs strategies in the long term, as vehicles become more circular +	Some costs for additional dismantling but assumed to be set-off by benefits for selling components for reuse and scrap for recycling Between + and ++ Indirect benefits from OEMs strategies in the long term, as vehicles become more circular + Benefit related to declaration not expected n.a

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
	Non-recyclables	n.a - no dismantling assumed	n.a - no dismantling assumed	Increase in costs for dismantling of CFRP - Possible set-off when/where CFRP can be recycled, moderate- to long-term Between 0 to +
	Steel	7 million € costs due to additional dismantling (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+60 mln €) --	48 million € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+131 mln €) --- / +	31 million € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+181 mln €) --- / +
	Copper	zero costs due to additional dismantling (comparing to the baseline) Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+104 mln €) -- / +	104 million € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+424 mln €) --- / +++	98 million € costs due to additional dismantling (comparing to the baseline) Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+264 mln €) -- / ++
	Aluminium	7 million € costs due to additional dismantling Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+43 mln €) --	48 million € costs due to additional dismantling Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+309 mln €) --- / +	31 million € costs due to additional dismantling Additional investment cost in dismantling technologies Additional revenues for dismantled parts/comp. for reuse/rem. and separate recycling (+122 mln €) --- / +
	Glass	Additional dismantling costs of 0.76 million € due to additional dismantling Additional revenues for dismantled glass cullet for reuse recycling (+0.04 mln €) -	Additional dismantling costs of 23 million € due to additional dismantling Additional revenues for dismantled glass cullet for reuse recycling (+1.3 mln €) - - -	Additional dismantling costs of 23 million € due to additional dismantling Additional revenues for dismantled glass cullet for reuse recycling (+1.3 mln €) - - -
	Plastic	n.a	Additional costs for dismantling ≥ -4.3 million € (depends if PST requirements suffice to support closed loop recycling)	Additional costs for dismantling of -5.4 million €
	EEC	-38 million € additional dismantling costs, benefits from reuse related revenues unclear but expected to set off costs Between 0 and +	Dismantling costs and benefits form sales for reuse in a range between the other two scenarios (calculated average -93 million €)	-147 million € additional dismantling costs, benefits (revenues for reuse) unclear but expected to set off at least 26 million € of dismantling costs Between - and +
Shredders/PST	Vehicle level design	Possible decrease in shredder inputs where more dismantling takes place -	Possible decrease in shredder inputs where more dismantling takes place - Unclear impact of strategies, depending on how	Possible decrease in shredder inputs where more dismantling takes place - Unclear impact of strategies, depending on how vehicles become more circular

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
			vehicles become more circular -/-	-/- Benefit related to declaration not expected n.a
	Non-recyclables	Shredders/PST operators may need to develop some form of treatment to ensure targets are complied with, expected in the long term if at all Between 0 to +	Non-recyclables assumed to be sent to recovery or backfilling with non-recoverable plastics - no special treatment, n.a	Non-recyclables dismantled, n.a
	Steel	Loss of shredding material (loss of revenue) Decrease in revenues for steel scrap (-140 mln €) -	Loss of shredding material (loss of revenue) Decrease in revenues for steel scrap (-209 mln €) --	Loss of shredding material (loss of revenue) Additional investment costs in separation technologies and hand picking Assuming the price for high-quality secondary steel the same as for the cast steel, there will occur decrease in revenues for steel scrap (-259 mln Euro). However, the secondary steel is of high-quality and potentially of higher price (higher revenues) --- / +++
	Copper	Loss of shredding material (loss of revenue) Decrease in revenues for copper scrap (-129 mln €) -	Loss of shredding material (loss of revenue) Significant decrease in revenues for copper scrap (-408 mln €) --	Loss of shredding material (loss of revenue) Additional investment costs in separation technologies and hand picking Increase of secondary copper However, still decrease in revenues for copper scrap (-252 mln €) ---
	Aluminium	Decrease in revenues for material scrap (-78 mln €) -	Decrease in revenues for material scrap (-296 mln €) --	Additional investment costs in separation technologies and hand picking Decrease in revenues for material scrap (-164 mln €) --- / +++
	Glass	Loss of shredding material set-off by lower maintenance costs (0.3 million € additional revenues) negligible	Loss of shredding material set-off by lower maintenance costs (loss of 1 million € revenues) between 0 and -	Loss of shredding material set-off by lower maintenance costs (loss of 1 million € revenues) between 0 and -
	Plastic		Additional operation costs at least 8.4 million € (depends on PST requirements suffice to support closed loop recycling)	Additional operation costs of 10.2 million €,
	EEC	Loss of shredding material (loss of revenue) -	Loss of shredding material (loss of revenue) in a range between the other two scenarios	Loss of shredding material (loss of revenue) --
Recyclers	Vehicle level design	Possible increase in revenues where dismantling for separate recycling increases Between 0 to +	Possible increase in revenues where dismantling for separate recycling increases Between 0 to + Unclear impact of strategies, depending on how vehicles become more circular-/-	Possible increase in revenues where dismantling for separate recycling increases Between 0 to + Unclear impact of strategies, depending on how vehicles become more circular -/-

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
				Benefit related to declaration not expected n.a
	Non-recyclables	Possible investments in CFRP recycling capacities (one time investment) expected in the long term. However, then set off by revenues between 0 and +	Possible investments in CFRP recycling capacities (one time investment) expected in the long term. However, then set off by revenues Between 0 and +	Non-recyclables dismantled, n.a
	Steel	Copper impurities in scrap < 0.4% Small decrease in business, due to loss of steel scrap (-79 mln €) However, increase in higher quality material (dismantled prior shredding) +	Copper impurities in scrap ≤ 0.2% Small decrease in business, due to loss of steel scrap (-78 mln €) However, increase in higher quality material (dismantled prior shredding) +	Copper impurities in scrap ≤ 0.1% Small decrease in business, due to loss of steel scrap (-78 mln €) However, huge increase in higher quality material (dismantled prior shredding), thus potentially lower processing costs to obtain steel of high quality ++
	Copper	Small decrease in business, due to loss of copper scrap (-25 mln €) However, increase in higher quality material (dismantled prior shredding) +	Slightly increase in business, due to increase of copper scrap (+16 mln €) However, increase in higher quality material (dismantled prior shredding) +	Slightly increase in business, due to increase of copper scrap (+12 mln €) However, huge increase in higher quality material (dismantled prior shredding), thus potentially lower processing costs to obtain steel of high quality ++
	Aluminium	Small decrease in business, due to loss of material scrap (-36 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of material scrap (+13 mln €) However, increase in higher quality material (dismantled prior shredding) +	Small decrease in business, due to loss of material scrap (-41 mln €) However, increase in higher quality material (dismantled prior shredding) ++
	Glass	Small increase in business (0.08 million €), due to glass fraction available for high-quality recycling +	Small increase in business (2.4 million €), due to glass fraction available for high-quality recycling ++	Small increase in business (2.4 million €),, due to glass fraction available for high-quality recycling ++
	Plastic		Additional compounding costs of at least -3.41 million € and additional revenues of 52 million € (depends on PST requirements suffice to support closed loop recycling)	Additional compounding costs of at least -12.3 € and additional revenues of 64 million €
	EEC	Higher decrease in business due to less reuse --> less secondary material for recycling – however impact is only delayed -	Benefits for recyclers in a range between the other two scenarios +	Benefits for recyclers of Fe and Al as copper impurities will decrease, increasing quality of secondary materials. Benefits for EEC recyclers in terms of higher amounts of secondary material (copper and precious metals). In both cases higher revenues expected ++
Waste management investments	Plastic		One-time investments in waste management of 151.5 million €	One time investments in waste management of 159.9 million €
OEMs	Vehicle level design	Costs for calculation revision assumed to be low and mainly transitional Between 0 and -	Costs for calculation revision assumed to be low and mainly transitional Between 0 and -	Costs for calculation revision assumed to be low and mainly transitional Between 0 and -

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
		Admin costs of about half a million € for implementing dismantling tests Costs from provision of data unknown Between - and ---	Admin costs of about half a million € for implementing dismantling tests Costs from provision of data unknown Between - and --- Administrative costs for developing and revising strategy and for implementation in the mid-long term Between - and -- Administrative costs for declaring rate of recycled content, possibly negligible: Between 0 and -	Admin costs of about half a million € for implementing dismantling tests Costs from provision of data unknown, possibly higher if DPP is required Between - and --- Administrative costs for developing and revising strategy and for implementation in the mid-long term Between - and -- Administrative costs for declaring rate of recycled content, possibly negligible: Between 0 and -
	Non-recyclables	Costs for preparing and submitting life cycle data based evidence Negligible	Costs for ensuring treatment if required by EPR (see below): it could be considered to compensate e.g., to allow shredder/PST operators that separate the non-recyclable fraction to require the OEM to collect and treat the material independently and at no cost to the ATF	Costs for ensuring treatment / take-back of non-recyclables if required by EPR: it could be considered to compensate e.g., ATFs for storage costs, or to allow ATFs (or shredder/PST operators) that separate the non-recyclable fraction to require the OEM to collect and treat the material independently and at no cost to the ATF
	Plastic		Additional production costs for use of recycled content 64 €/vehicle OEMs may have costs for declarations/certification; however these are understood to be very small	Additional production costs for use of recycled content 64 €/vehicle OEMs may have costs for declarations/certification; however these are understood to be very small
Vehicle owners	Vehicle level EoL	As the market demand for reused/remanufactured parts is expected to increase, consumers will have reduced costs for repairs where they apply such parts. +++	The obligatory dismantling of components could support more reuse where demand exists, consumers will have reduced costs for repairs where they apply such parts. +	The obligatory dismantling of components could support more reuse where demand exists, consumers will have reduced costs for repairs where they apply such parts. +
Jobs	Vehicle level design	Increase in type approval service provider and ATF/shredder employment of around 4 jobs for dismantling tests + Increase in Type approval authority and EC employment, estimated at less than one job Between 0 and + Increase in ATF employment due to additional dismantling – level unknown Between + and ++	Increase in type approval service provider and ATF/shredder employment of around 4 jobs for dismantling tests + Increase in Type approval authority and EC employment, estimated at less than one job Between 0 and + Increase in ATF employment due to additional dismantling – level unknown Between + and ++ Increase in employment at OEMs for developing and implementing circularity strategy Between + and ++	Increase in type approval service provider and ATF/shredder employment of around 4 jobs for dismantling tests + Increase in Type approval authority and EC employment, estimated at less than one job Between 0 and + Increase in ATF employment due to additional dismantling – level unknown Between + and ++ Increase in employment at OEMs for developing and implementing circularity strategy Between + and ++ Increase in employment due to declarations negligible -/-

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
	Non-recyclables	Increase in employment for preparing life cycle data based evidence	Possible increase in employment for new PST capacities (expected in long term) Between 0 and +	Increase in employment for dismantling and new recycling capacities +
	Steel	Increase in jobs in ATF (~86) ++	Increase in jobs in ATF (~582) ++	Increase in jobs in ATF (~383) Increase in jobs in shredder facilities (~360) +++
	Copper		Increase in jobs in ATF (~1,195) +++	Increase in jobs in ATF (~1,195) Increase in jobs in shredder facilities (see steel) ++
	Aluminium	Increase in jobs in ATF (~86) ++	Increase in jobs in ATF (~582) ++	Increase in jobs in ATF (~383) Increase in jobs in shredder facilities (see steel) +++
	Glass	Increase in jobs (ca. 20)	Increase in jobs (ca. 645)	Increase in jobs (ca. 645)
	Plastic		Significantly more than 1795 jobs (waste sector)	More than 6,530 jobs (OEMS) and somewhat more than 1,795 jobs (waste sector)
	EEC	Increase in jobs (~7) for the inverter and in 466 additional jobs for the component sub-set +	Increase in jobs in a range between the other two scenarios between + and ++	Increase in jobs (~29) for the inverter and in 1,801 additional jobs for the component sub-set ++
	Hazardous substances	This requires a total of two, new full-time-equivalent (FTE) temporary-agent staff (AD 5-7) at the ECHA (average cost EUR 144 000/year over 7 years and beyond). In addition, one FTE contract agent (CA FG III, average cost EUR 69 000/year over 3 years) will be necessary to increase the knowledge base, and to facilitate an informed priority setting and work plan.		
SMEs	Vehicle level design	Inefficient provision of information assumed to have a larger impact on small and independent ATFs who would be discouraged from using data.		
	Non-recyclables	SMEs are understood to be common among waste operators, so any costs for these (ATF, shredder, PST, recycler) could have a heavier burden for SMEs	For ATF SME, the dismantling obligation (scenario CFRP 2) will likely result in higher costs. SMEs are understood to be common among waste operators, so any costs for these (ATF, shredder, PST, recycler) could have a heavier burden for SMEs	
	Steel	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities.		
	Copper	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities. This may depend on the type pf copper components that must be dismantled		
	Aluminium	Small ATFs would probably have higher costs than larger ones. With higher dismantling costs the profitability of the business for the ATFs might be questionable and possibly the activities of these facilities might shift to illegal activities - this may depend on threshold level of Al components to be dismantled		
	Glass	Small ATFs would probably have higher costs than larger ones Costs for dismantling and separate recycling may be higher where the distance to recycling facilities is significantly >150 km		
	Plastic		Small operators may have higher logistics costs assuming they have less storage space, need to send plastic scrap batches more often and thus also in smaller batches	
	EEC	Small ATFs will have higher costs than larger ones		

Impact category	Material/ Vehicle	Option 1 - Better compliance	Option 2 - Increased harmonisation (preferred)	Option 3 - advanced implementation
Administrative burden	Non-recyclables	Increased costs for OEMs where LCA data submitted to type-approval process and for authorities for reviewing such data	n.a	n.a
	Hazardous substances	Reduced admin costs for EC/ECHA as only one legislation needs to be maintained. Member States will have greater clarity and lower administrative burden by dealing with the technical and socio-economic assessment of the proposals for restrictions under one single common assessment framework	The hybrid is considered to be similar to the baseline and should not change the administrative burden.	Most stakeholders involved in prohibition process follow REACH in any case. Elimination of ELV will reduce burden of legal compliance. Reduced admin costs for EC/ECHA as only one legislation needs to be maintained. No admin costs for MS related to transposition.
	Vehicle level EoL	Additional burden or ATFs in the order of (-1.97) mln € for reporting on components removed for reuse. Additional burden for repair shops for providing proposals referring to reused parts in the order of (-108) mln €. Additional burden for MS for reporting on reuse in the order of (-27,000) € Additional burden for reporting on targets by EPR/waste operators in the order of (-12.4) mln € Additional burden of reporting on targets for MS in the order of (-3,000) € High increase in administrative burden for reporting for regulators and waste management ---	Additional burden for ATFs in the order of (-1.48) mln € for reporting on dismantled components. Additional burden for MS for reporting on reuse in the order of (-1,700) € Additional burden for EPR/PST operators for reporting on the quality of residues (POP content in plastic) in the order of (-57,600) € Additional burden for MS for reporting on treated ELVS to Eurostat (disposal ban) in the order of (-8,000) € Additional burden for reporting on targets by EPR/waste operators in the order of (-12.4 mln €) Additional burden of reporting on targets for MS in the order of (-3,000) € Moderate increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies --	Additional burden form reporting obligation on PST capacities for EPR/PST operators, in the order of (-57,000) € MS Reporting obligation on treated ELVs to Eurostat in the order of (-11,000) € Additional burden for recyclers reporting on quality of smelted steel batches, in the order of (-123,000) € Additional burden for MS reporting on quality of steel recyclates to EUROSTAT in the order of (12,000) € Additional burden for reporting on targets by EPR/waste operators in the order of (-12.4) mln € Additional burden of reporting on targets for MS in the order of (-3,000) € Moderate increase in administrative burden for reporting for regulators and waste management and developing of improvement strategies --
Other	Hazardous substances	There is an expected social benefit because reference to human health protection is added to the ELVD and will be considered for future restriction of substances in vehicles.		
Targets	reuse and recovery rate	82%	87.3%	86.8%
	reuse and recycling rate	76.2%	78.9%	77.9%

…

**For EEC, results are given for "sub-set" of components unless otherwise specified*

*** For non-recyclables under scenario 1: Vehicle placed on the market, no special treatment requirements (i.e., life cycle evidence supports type approval)*

Total materials reused/recycled/recovered:

Steel - reused	489,000	489,000	489,000
Steel – recycled pre-shredder	323,000	699,000	968,000
Steel – recycled post-shredder	-746,000	-1,118,000	-1,385,000
Copper - reused	10,000	12,000	12,000
Copper – recycled pre-shredder	17,000	67,000	42,000
Copper – recycled post-shredder	-21,000	-65,000	-40,000
Aluminium – reused	62,000	99,000	99,000
Aluminium – recycled pre-shredder	37,000	266,000	105,000
Aluminium - recycled post-shredder	-81,000	-306,000	-169,000
Aluminium – recovered (>steel)	-9,000	-30,000	-18,000
Glass reuse	0	0	0
Glass – recycled pre-shredder (high quality)	4,000	131,000	131,000
Glass – recycled post-shredder (low quality)	-5,000	-131,000	-131,000
Plastic reuse	0	71,000	71,000
Plastic recycled pre-shredder (high quality)	0	54,000	67,000
Plastic – recycled post-shredder (low quality)	0	76,000	93,000
Plastic - recovered	0	-149,000	-220,000
EEC recycled separately	787	in between	7,220

The impacts compiled for the three options in the table above are based on the analysis performed in the sections above and the impacts specified therein.

3.1.13 Conclusions and the preferable option

In some cases, some overlaps or synergies may exist, for example, measure 2.3.e (Ban of disposal or landfilling (non-inerts)) would require development of PST facilities in the EU where they are not available and in some cases their improvement or expansion. In this case, such facilities would have a focus on the recovery and recycling of plastic fractions, however the fact that PST technologies are developed and improved can also be assumed to have an effect on measure 2.4.d, which specifies shredder operation requirements with an aim to reduce metallic content.

The same is true for example for measures addressing the dismantling of EEC, which often contains copper but also other base metals like steel and aluminium. Dismantling and recycling of such components will also have an effect on the recovery of steel, copper and aluminium. In cases, where multiple measures would lead to the same treatment route (e.g., dismantling of copper-based EEC in copper measures or its dismantling under EEC measures) an overlap is assumed, meaning that should the impacts be summed, they would be expected to represent a bit of an overestimation due to double counting. In other cases, like in the first case of the different measures affecting the capacities of PST, some post shredder technologies could improve plastic sorting, some could improve metal sorting, and some could improve both. Thus, here in some cases synergies may exist but also some overlap. For this reason, an attempt to sum the impacts is not undertaken. Instead, the impacts have been colour coded so that it is more apparent in which cases the costs are highest (darker red) and in which case the benefits are the highest (darker green) and vice versa.

The comparison shows that it is difficult to distinguish between PO 2 and PO 3, both showing higher benefits but often also higher costs and differing from each other for various materials or impact categories. Both of these policy options are considered to be effective in terms of achieving the objectives to a large degree. PO 1 is considered less effective, as though the costs are usually low, the benefits achieved are also quite under-reaching in comparison.

Since at present the ELVD sets out an annual common (for all materials) recycling target based on the average weight of the vehicle, not all the materials used in vehicles are subject to the same high standard of recycling. While high-quality recycling can often be technically feasible and environmentally beneficial (e.g., of glass, selected plastics, electronic components), it is not performed in cases with low or lacking profitability.

In general, the higher availability of recyclables on the EU market will lower the dependability of the EU on extra-EU sources (primary but also secondary in some cases). With the current war in Ukraine and lacking clarity on further geo-political developments, this reduction in dependency is not only an advantage for the EU in general but could also reduce supply risks for the European automotive industry (or other manufacturers). This has already become clear at the beginning of the war in regard to the supply of copper from the Ukraine which delayed assembly where wire harnesses were not available. This is an important motive not just for recycling in general but also for the options that lead to increases in the quality of recyclates.

For example, looking at the analysis for steel and copper, whereas for many categories both PO 2 and 3 show a similar relation of costs and benefits, it seems that PO 2 leads to higher credits, meaning that in general this PO is more effective for copper. However, looking at steel, PO 3 is assumed to lead to higher benefits as the quality of steel scrap shall improve and increase the range of applications for which it can be used significantly. This may not be as important at present, as steel scrap can be used where cast steel is needed, however in the future, a surplus of cast alloys is expected and this means that actual benefits will be more significant in the long run, even if on the surface the levels are similar.

For aluminium, it is clear that measures are relevant. Despite the fact that one of the PO may show higher benefits than others, data is still missing to consider how such measures should be characterised in detail.

For glass, though PO 2 and PO 3 deliver benefits in the same order, main differences are expected in favour of PO 2 due to the reduced complexity of monitoring.

For plastics, GWP impacts are not so high, however the benefits in term of SRM would feed into the manufacture of vehicles and allow reducing the dependency on primary materials and thus solving the current market failure. Though POC 3 may suggest higher benefits, it will also have higher costs. Whether this is justified or not is hard to say, but it could also be considered to use the elements of PO 2 and PO 3 to develop an increasing ambition over time.

For EEC, it is logical that the longer the list of components to be dismantled, thus also the higher the benefits can be expected to be, in terms of GWP but more importantly in the contribution to SRM of precious and critical materials. The main question here will be of the level of costs that is to be considered feasible for the sector to support, either due to the expected returns form reuse or recycling or if needed, in relation to the level of compensations needed from EPR to ensure the economic feasibility of operations for ATFs. For REE from magnets, it is possible that a dismantling obligation alone will not suffice to promote recycling and thus will not result in increased REE availability on the European market. If the REE cannot to be sorted and sufficiently recovered from fractions after dismantled parts are subjected to dedicated shredding of EEC (separate from other equipment) it could be relevant to perform deep dismantling of certain EEC to disassemble e.g., magnets prior to shredding operations.

Decisions on which EEC components are to be dismantled depend on the objective. If the main objective is to improve the removal of copper impurities from Fe and Al scrap (also increasing copper recycling amounts), the dismantling can be considered as an alternative for cases where advanced shredding and PST is not applied (giving the waste management more flexibility how to achieve related targets, e.g., choosing between technology or labour-intensive approaches). When the objective is also to improve the recycling of precious and critical materials, the importance of dismantling of EEC prior to shredding increases and in some cases certain sub-components (e.g., magnets) should also be considered to ensure their sufficient recovery. Though for some materials this has an environmental relevance, for others it may be more of a geopolitical decision related to the dependency of the EU for supply of certain materials

A further economic aspect is related to the expected administrative cost of reporting. Under the baseline, Commission Decision 2005/293/EC, which specifies the current reporting rules, already requires MS to report on the “metal components” arising from depollution and dismantling in the required format. However, it is required to report a sum of all depolluted and dismantled materials and reporting on separately listed materials is voluntary. Some of the measures will require adjustment of the reporting format as well as changing the reporting from voluntary to mandatory. This adjustment is assumed to result in additional economical costs for public administration as well as for ATF that report on removed parts/components.

3.1.14 Reporting and monitoring requirements

To be able to monitor the measures proposed in the chapter above, it will also be necessary to consider how the reporting requirements for MS are revised. For several aspects, Oeko-Institut developed a proposal for an amendment of the reporting format in Commission Decision 2005/293/EC and this proposal was shared with the Member States for comments accordingly. The feedback of the Member States is available to the contractor and a report was provided to the EC on 23 May 2019 accordingly[279]. Many of the Member States appreciate most of the proposed amendments, but some also question if the mandate in the ELVD covers all proposed amendments.

With regard to future reporting obligations, it should therefore be examined which mandate would have to be laid down in the ELVD in order to allow for the necessary amendments to Commission Decision 2005/293/EC. For instance, mentioning / defining terms like 'post shredder technology (PST), reporting on the number of (certified) ATFs, shredders and PST plants and their input/ output. First issues are mentioned in section 0.

However, a broader and more detailed consolidation of the mandate for the reporting forms is depending on the new measures proposed for implementation. If for instance new (material specific) recycling targets shall be introduced, this should also be reflected in the reporting requirements.

Some of the areas analysed above also provide insights as to aspects that should be addressed in the revision of Commission Decision 2005/293/EC and of any reporting obligations of the ELVS.

The issue of reporting on the changes in the vehicles fleet (PoM, import/export of used vehicles, import/export of ELVs, final cancellation of registrations, CODs issued and temporary de-registrations) is addressed in section 2.2.5.1.9 at page 166.

[279] Mehlhart, G.; Hay, D. (2019): Assessment of the comments of the Member States in relation to the draft proposal for the amendment of Commission Decision 2005/293/EC Amendment to contract No 07.0201/2015/723374/ETU/ENV.A.2; Darmstadt, 23.05.2019

3.2 Missing vehicles

3.2.1 Baseline

The baseline reflects what would happen under a "non-policy-change" scenario without new policy intervention, and assuming realistic implementation of existing legislation.

For the aspect of missing vehicles and illegal export the situation and problem were manyfold discussed with the Member States at different level for instance it was continuously a topic in the working group meetings, respectively the TAC meeting for the ELVD. Diverse topics were discussed with the Member States like inspection campaigns in UK and Denmark; different registration regimes like in Denmark, Norway and the Netherlands; examples how to make use of international data exchange on re-registration of vehicles; fraudulent use of registration documents for stolen vehicles and last but not least the relevant studies commissioned by the EC.

A report was commissioned by the European Parliament to evaluate the effectiveness of the ELV Directive and it detected the issue of the missing vehicles too. (Schneider et al. 2010).A report was commissioned by the European Parliament to evaluate the effectiveness of the ELV Directive and it detected the issue of the missing vehicles too. (Schneider et al. 2010).

Regarding the distinction between used vehicles and ELV the correspondents to the Waste Shipment regulation established the Correspondents' guidelines No 9, which applies from 1 September 2011.

Guidelines for the reporting were published by Eurostat for the first time in 2010, last updated in 2019[280], also addressing the problem on missing vehicles and how to overcome it. This guidance also includes the identification of sources for a more detailed national assessment of the whereabout of national ELVs.

The EC launched an analysis in 2010 on the European second-hand car market analysis (Mehlhart et al. 2011) which tried to calculate the vehicle balance and the whereabouts of ELVs from different available sources – but this approach failed and demonstrated that under the given conditions it is by far not possible to demonstrate that all ELVs are treated according the requirements of the ELVD.

The most recent study commissioned by the EC, focussed on the assessment on the end of life vehicles of unknown whereabouts and discussed proposals how to overcome the identified shortcomings of the current legislation with the Member States and in an open public consultation with other stakeholders (Mehlhart et al. 2017). This study identified several measures which might be established at national level as well.

However, the EC tried for a decade to reinforce the implementation of the ELV Directive without legislative changes. However, this approach is, as demonstrated, not successful. For the baseline scenario it is estimated that the situation of 30% to 40% missing vehicles (3 to 4 million vehicles will persist, without any principal changes).

As some Member States[281] are aiming to implement national specific legislation, we consider that the Baseline (for the entire EU) will improve regards the missing vehicles marginally only.

[280] How to report on end-of-life vehicles according to Commission Decision 2005/293/EC, Revision by Eurostat: 17 December 2019

[281] E.g. France announced to establish an EPR regime which includes the obligation to collected abandoned vehicles.

3.2.2 Policy Options

3.2.2.1 Identification of discarded measures

With the aim to have a shortlist of measures for further assessment, all measures are checked for legal or technical feasibility and effectiveness. This step is not to be confused with the impact assessment itself and therefore does not include all categories of impact assessment (economic, social and environmental).

The details of this check for feasibility and effectiveness are displayed in section 6.6.1 in Annex I. In result the following measures are discarded and not shortlisted for the detailed assessment:

- MS to demonstrate implementation of Incentives, Level B (2.2.5.1.1)
- Establish a collection target based on the reporting obligations on the national vehicle market (2.2.5.1.10)
- Exchange on MS best practice on national implementation and enforcement incl. sector inspection campaigns (2.2.5.2.1)
- Voluntary campaigns on export of ELVs with a focus on the current waste shipment correspondents' guidelines No9 on distinction between ELVs and second-hand vehicles (2.2.5.2.2)
- European-wide deposit refund scheme for vehicles supervised by a single European body (2.2.5.2.4)
- Promote international non-binding actions at the international level (through UN Environmental and road safety programmes) to address the issue (2.2.5.3.1)
- Promote enforcement actions by MS through EU funding and EU enforcement actions against environmental crime (2.2.5.3.2)

The remaining measures are shortlisted and grouped for policy options in following sections.

3.2.2.2 Policy option 3A: Enhanced reporting & enforcement

The policy option 3A is relying on enhanced monitoring and reporting requirements to demonstrate the whereabout of used vehicles and ELVs. The primary responsibility **on how** to achieve that the whereabout of vehicles can be demonstrated remains with the MS, while the MS retain a large degree of flexibility on the types of measures to be taken to address the problem of missing vehicles. It is expected that this option would raise the least amount of concerns related to subsidiarity. Policy option 3A includes the following measures:

No	Title	Chapter	Effective by
3A1	Reporting by Member States on the current vehicle market and the ELVs on their territory	(2.2.5.1.9)	2025
3A1	Reporting and exchange of best practice on incentives in force to strengthen the effectiveness of the CoD	(2.2.5.1.1) **Level A**	2025
3A1	Requirements for Member States to **report** on penalties	(2.2.5.2.7) **Level A**	2025
3A2	Obligations for dismantlers /recyclers to check and report on ELVs/ CoDs	(2.2.5.1.5)	2025
3A3	Definition of minimum requirements for sector inspections	(2.2.5.2.6)	2025
3A4	Action at international level to support that roadworthiness (and others) become criteria for export of used vehicles.	(2.2.5.3.1)	ongoing

3.2.2.3 Policy Option 3B: Interoperable national registers and harmonisation

This option is aiming to improve collection by:

- setting a harmonised approach between the Member States for some aspects linked to the national registration of vehicles and the definition of binding criteria on the distinction between used vehicles and ELVs (building on existing non-binding guidelines), as well as
- requiring that the national registrations systems be made interoperable.

Compared to option 3A, this option may reduce MS flexibility by harmonising national definitions for “temporary deregistration” and terms on registration documents, as well as setting binding criteria to distinguish used cars and ELVs (for export and accident cars).

Policy option 3B includes the following measures:

No	Title	Chapter	Effective by
3B1	Interoperability between national registration authorities including obligation for MS to provide reasons for de-registration.	(2.2.5.1.6)	2025
3B2	Alignment of the terms of the ELV Directive with the terms of Directive 1999/37/EC	(2.2.5.1.2)	Upon entry into force of new legislation
3B2	Introduction of new definition: “temporary de-registration”	(2.2.5.1.3)	Upon entry into force of new legislation
3B3	Requirements for Member States to **establish** penalties	(2.2.5.2.7) **Level B**	2025
3B4	Binding criteria for a distinction of used vehicles / ELVs	(2.2.5.2.5)	Upon entry into force of new legislation
3B5	Effective Deposit Refund Scheme (voluntary)	(2.2.5.2.3)	n.a.

3.2.2.4 Policy Option 3C: EU wide vehicle registration and export controls:

This option consists in fully harmonising the elements of the current national registrations systems relevant for the tracking of vehicles by transferring them into an EU system. In addition, this option includes the establishment of new criteria regulating the export of used vehicles (which are not ELVs), to ensure better traceability and sustainability of these exports. More strict (extra-EU) export criteria, including the mandatory use of the VIN number in export documents, based on combined roadworthiness, age, emission level criteria set at EU level.

No	Title	Chapter	Effective by
3C1	EU vehicle registration database-system	(2.2.5.1.8)	2027
	EU wide harmonised registration procedures for vehicles:	(2.2.5.1.4)	2027
	a) conclusive list of conditions for permanent cancellation of the registration	(2.2.5.1.4)	2027
	b) regulations for how to apply “temporary de-registrations”	(2.2.5.1.4)	2027
3C2	(Extra-EU) Export restrictions for used cars linked to roadworthiness, and taking into consideration rules on age and emission level of vehicles entitled to be imported in certain countries	(2.2.5.3.3)	2025/2030
3C3	Include Vehicle Identification Number (VIN) in customs declaration/control system	(2.2.5.1.7)	2027

3.2.2.5 Overview Policy Options

Table 3-64 Overview Policy Options and related measures sorted by Objectives

The numbers refer to the chapter where the potential measures are described

Red italic letters = discarded measure
Green box = Policy Options 3A
Yellow box = Policy Option 3B
Amber box = Policy Option 3C

Objective 3.1: Ensure that all ELVs are treated in accordance with the requirements of the ELV Directive	**Objective 3.2: Reduce levels of illegal dismantling and illegal export of ELVs**	**Objective 3.3: Enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards**
1.1a **Reporting** and exchange of best practice on Incentives (Level A)	*2.1 Exchange on MS best practice*	3.1 Action at international level to support that roadworthiness (and others) become criteria for export of used vehicles.
*1.1b MS to **demonstrate** implementation of Incentives (Level B)*	*2.2 Voluntary campaigns on export*	*3.2. EU funding for enforcement*
1.2 Alignment of terms	2.3 Effective Deposit Refund Scheme (Voluntary for MS)	3.3 Export restriction linked to roadworthiness; respect rules of receiving countries regards age and emission level
1.3 Definition of temporary deregistration	*2.4 EU wide Deposit Refund scheme*	
1.4 a Conclusive list of conditions for permanent cancellation of the registration	2.5 Better definition of ELVs	
1.4 b Management of temporary deregistration	2.6 Minimum requirements for sector inspections	
1.5 ATFs and shredders to check and report on ELVs / CoDs	2.7a MS are **encouraged** to establish fines and penalties for illegal activities of owners and operators of treatment plants	
1.6 interoperability of national registers	2.7b MS are **required** to establish fines and penalties for illegal activities of owners and operators of treatment plants	
1.7 VIN in customs declaration		
1.8 EU vehicle registration data base-system		
1.9 Reporting obligation on the current vehicle market		
1.10 Collection target		

3.2.3 Methodology

It is difficult to assess the impacts of measures and policy options addressing the aspect of missing vehicles as is has manyfold reasons and diverse stakeholders are affected. On top it is not known which of the main reasons, either unreported extra EU export or unreported / illegal dismantling within the EU (regardless of whether transferred between MS) is dominating the current situation.

However, it is important to derive quantitative assessment for a number of aspects. As far as the impacts are not directly detectable / derivable, we established a model, describing the shifts between diverse categories of whereabout as outlined below

3.2.3.1 Model for the shift of numbers of whereabouts

The model considers the following categories of whereabouts:

- A) ELVs directed to ATFs and subsequently to shredders and reported by ATFs and MS (ATF, reported)
- B) ELVs directed to ATFs and subsequently to shredders but not reported (ATFs, not reported)
- C) ELVs directed to non-ATFs and subsequently to shredders, not reported (non-ATF)
- D) Used Vehicles exported (extra EU) and reported accordingly (Export, reported)
- E) Used Vehicles exported (extra EU) but not reported (Export, not reported)
- F) ELVs exported (extra EU), not reported (ELVs export, not reported)
- Missing vehicles

The distinction of these measures is relevant as a shift from one to another has different impacts on different stakeholders. Some examples:

A shift of F) and E) to D) has no effects on the environment nor the economy in the EU but improves the quality of reporting and possibly demonstrating the achievement of the collection target.

While a shift of F) and E) to either A), B) or C) does have a physical effect on environment and economy but if directed to B) and C) not on the statistics.

A shift from B) to A) has currently a statistical effect only, but in the future, in combination with more challenging settings regards circularity this might change.

A shift of D), E), F) to A), B), C) has several effects: a) physically changes for the recycling industry in EU (more vehicles) with related environmental and economic impacts and economic impacts on those stakeholders who are involved in the extra EU export which will lose parts of their business.

The table below demonstrates how these shifts are introduced to the model. The yellow cell indicates for instance a shift of 0.25 percent points of the total Number of ELVs from category E (Export, not reported) to category D (Export, reported), the red cell displays the reverse (redundant information). The total displays the change in percent points for the entire category. For instance, category D (Export, reported) receives in total 0.5 percent points more vehicles in the given year compared to the year 2019 where (at least for some of the categories) data is available.

	Szenario							
			shift to					
	Schift from		A	B	C	D	E	F
		A		-0.25%	-0.25%	0.00%	-0.25%	-0.25%
		B	0.25%		0.00%	0.00%	0.00%	0.00%
year		C	0.25%	0.00%		0.00%	0.00%	0.00%
		D	0.00%	0.00%	0.00%		-0.25%	-0.25%
		E	0.25%	0.00%	0.00%	0.25%		0.00%
		F	0.25%	0.00%	0.00%	0.25%	0.00%	
		total	1.00%	-0.25%	-0.25%	0.50%	-0.50%	-0.50%

Source: own calculations

Regards the situation in 2019 (=starting point of the model) the data for A) and D) and G) are considered as explained in the section "current situation" of this report. However, the share of B), C), E) and F) cannot be derived in exact figures from existing data and literature. Instead Mehlhart et.al. (2017) assumed for the EU, that 50% of the missing vehicles are illegally treated domestically in the EU and 40% are illegally exported. Miljøstyrelsen (2016)[282] reports for Denmark the assumption that 50% are illegally treated domestically and 40% are illegally exported and 10% are left on public or private ground. Umweltbundesamt (2022)[283] assumes for Germany that 80% are illegally treated domestically and 20% illegally exported. In fact, the details of the whereabout for the categories B), C), E) and F) are not known, in particular not at the national level.

For the purpose of the model, we considered that the share between illegal/unreported dismantling within the EU should be compared to the unreported extra-EU export is 50 % of the unknown vehicles each. As both include two distinct categories B/C and E/F we further consider an equal share for each category. Thus, for each category B/C/E/F we consider 25 % of the missing vehicles in 2019 as a starting point for 2019.

For the interpretation of effects, the following aspects needs to be considered:

- A shift from B or C (both non reported treatment) to A reduces the number of missing vehicles
- A shift from E or F (both non-reported export) to D reduced the number of missing vehicles.
- A shift from A to D or vice versa does not change the number of missing vehicles, while such shift between A and D has effects on ELVs available for recycling as addressed later in the Impact assessment.

[282] Udredning af skrotningsgodtgørelsens incitamentsstruktur; Udgiver: Miljøstyrelsen; Redaktion: Deloitte Consulting; Udredning; September 2016 [Investigation of the incentive structure of the scrapping premium; Publisher: Danish Environmental Protection Agency; Editing: Deloitte Consulting; Study; September 2016

[283] Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, Publisher: Umweltbundesamt, Dessau, Germany, Publication in preparation

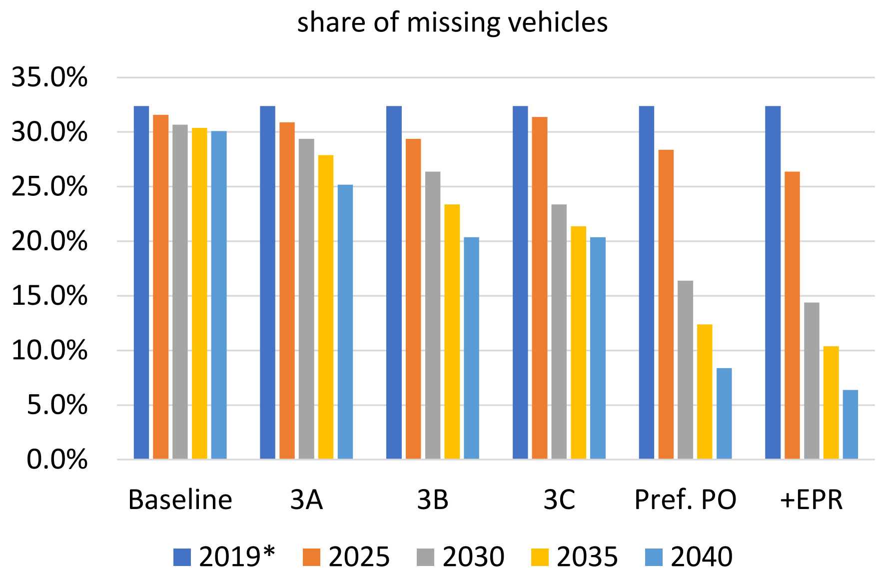
3.2.3.2 Results from model calculations for the share of missing vehicles

It is important to be aware that the assumptions were made for the purpose of estimating magnitudes and are far from being accurate "model" forecasts. The shifts considered for calculating the impacts of the policy options are more of an expert estimate than a correct calculation.

For the different policy options the detailed assumptions for the shift between the categories and the impacts on the share of missing vehicles is displayed section 6.6.2.2 in Annex I.

Figure 3-25 displays as one result of the model calculations the changes in the number share of missing vehicles caused by the different policy options.

Figure 3-25 Model calculations for the change in missing vehicles due to the effects of the different policy options



Source: own calculations

Note: For the purpose of easier reading, the preferred Policy Option and the preferred Policy Option including the effects of the rules for EPR are displayed here and in the subsequent figures too. The description of this Option and the combined impacts with EPR rules will follow later in chapter 3.2.9.

As mentioned above we expect for the **baseline** marginal effects only as we have experienced in the past – with a lot of attention by the EC – effectively no general change on the number of missing vehicles at EU level. To be not too pessimistic we consider a limited shift from category B,C, E, F to category A and also a slight shift from E and F to D. In result the share of missing vehicles declines by 2.4 percent points from 32.4 % in 2019 to 30.1 % (2040).

The policy **option 3A** is relying on enhanced monitoring and reporting requirements to demonstrate the whereabout of used vehicles and ELVs. It includes inter alia obligation for reporting on the changes in the vehicle fleet with the aim that such reporting shall prove that all ELVs are directed to ATFs. The MS have full flexibility to choose the measures to achieve this target either with an adjusted registration system or with penalties or with incentives or other means.

The main shortcoming of this options is that a single Member State alone has not all means at hand to complete the reporting form and thus can argue that he is by external reasons not able to fulfil his obligations. And might even hide with this argument his non-action in fields where the Member State would have opportunities to act and improve.

Main missing aspects with this regard is the alignment definition of terms (e.g. for temporary deregistration) and the obligatory exchange of information of vehicles dismantled in another Member State as it was last registered and last not least the missing introduction of a more detailed/applicable definition of the term ELV.

We expect a few more Member States to take action regards their registration system and also regards incentives/penalties. This will cause step by step a shift to the categories A and D (both decreasing the number of missing vehicles) and also a small shift from category E to F.

According to our assumptions the share of missing vehicles will continuously decline by 7.2 percent points from 32.4% in 2019 to 25.2% (2040). Due to the shortcomings mentioned above it is very likely that the Policy Option 3A is at risk to fail in generating substantial improvements regards the share / number of missing vehicles.

The **Policy Option 3B** aims to improve collection by:

- requiring that the national registrations systems be made interoperable.
- a harmonised approach between the MS regards national registration of vehicles
- requirements regard incentives and penalties
- binding criteria on the distinction between used vehicles and ELVs

Compared to option 3A, this option reduces the flexibility of MS.

However, it does not include the reporting obligation on the changes in the vehicle fleet (as in Policy Option 3A) which is an important tool to prove that all ELVs are directed to ATFs.

Policy Option 3B provides the tools for cooperation between the MS but a clear method for the calculation of the change in the vehicle fleet is missing. Therefore, the current problem that a comparable performance monitoring by country regards missing vehicles is not possible will persist and cause limited incentive to improve the overall situation on missing vehicles.

However, as by the interoperability the tools are available for complete balance of the whereabout of vehicles we expect some frontrunners of the Member States to make use of it and seek to improve their performance regards missing vehicles. Other measures regard permits and incentives will support this change.

Overall, the effect of Policy Option 3B is considered as more effective than Policy Option 3A, while the missing national reporting on the performance regards missing vehicles is a major gap to generate full effectiveness of this policy option.

Policy Option 3C consists in implementing interoperability of national registrations systems relevant for the tracking of vehicles and for getting relevant information on export restrictions like the status of the roadworthiness certificate.

In addition, this option includes the establishment of new criteria regulating the export of used vehicles (also those which are not explicit ELVs), to ensure better traceability and sustainability of these exports. Criteria for extra Export, including the mandatory use of the VIN number in export documents, requiring demonstration of a valid roadworthiness certificate are included too.

The limitation of (extra-EU) export to vehicles with valid roadworthiness certificate will have massive effects on the extra EU export. The limitation of the export will have a sudden effect by the date of enforcement. Most likely exports of older vehicles (without valid certificate) to non-EU Member States will even increase ("last chance") in the period before the restrictions enter into force. For the assumptions regards the shifts between the categories we take into consideration that the enforcement date will be 2027 and the adverse effects will become effective in 2025 and the intended effects become visible in 2030.

The adverse impacts in 2025 on the number of missing vehicles are caused by the shift from treatment in ATFs to the export (Cat. D, E, F) and as we considered the unreported export to increase too, the number of missing vehicles increased for the year 2025.

3.2.4 Selection of potential impacts

According BRG Tool #18 the impact assessment potential impacts "should be screened objectively in order to identify all potentially important impacts – considering both positive/negative, direct/indirect, intended/unintended as well as short/long-term effects. Some of the categories are cross-cutting and can be analysed from different angles (for example employment, income distribution, impacts on consumers or environmental impacts). A (well-justified) choice should then be made on the most significant impacts to be retained for a more thorough analysis. The full list of key impacts to screen is displayed in section 6.6.2.5 in Annex I. In the next chapter the affected stakeholders are identified and secondly the most significant impacts are assessed considering the list mentioned in BRG Tool #18.

3.2.5 Economic Impacts

3.2.5.1 Identification of affected stakeholders

The following list provides an overview of the affected stakeholders.

- Vehicle owners
- Garages
- ATFs
- Shredders
- Used car dealers
- Insurances
- Customs Services
- National vehicle registers
- Producers
- Industries involved in processing/recycling of waste arising from ELVs treated in the EU

3.2.5.2 Vehicle owners / consumers

Vehicle owners might receive less compensation for their ELV if all ELVs are directed to ATFs and less vehicles are exported as less stakeholders are involved in the business with ELVs (e.g. specific exporters are kicked out and illegal dismantlers are reduced). The level of the compensation depends on the brand, age and condition of the ELV. The German study[284] considers an average pay out to the last owner of 80 Euro per ELV.

Vehicle owners might be affected if they must follow more strict obligations to report on the status of the owned vehicles and possibly experience fines or continuing fees if they do not report the change in ownership or the scrapping of the vehicle or do not provide a CoD to the registration authority.

Different concepts of DRF schemes have different impacts during the use phase of the vehicle.

A DRS can be established by two options:

- It is included in the first sale
- It is collected during the use phase of the vehicle

A levy charged on the sale of new cars would increase the cost of new cars, as well as used cars, because the prices of old used cars would also include the premium payment as a markup on the market price. Thus, no "losses" apply to the first owner when selling a vehicle.

An annual levy will increase step by step the value of the used car. As the last owner will at least get the premium from the ATFs. However, it is not benefit to the last owner as has paid the mark up to the used vehicle and also added the levy during his use phase.

If it is collected during the use phase and no import fee is charged, such a system has adverse effects for countries importing a relevant number of end-of-life vehicles. The table below demonstrate the effects of different national market characteristics when the premium payment for ELVs is levied during the lifetime of the vehicle and no levy applies for imports of used vehicles.

Table 3-65 Effects of import / export of used vehicles on the level of a yearly DRS fee

The import / export quote is the only variable						
Premium per ELV	300 €	300 €	300 €	300 €	300 €	300 €
Average age of ELVs	18	18	18	18	18	18
share of used cars imported ("-" indicates export)	-50%	-25%	0	25%	50%	75%
average age of imported	6	6	0	6	6	6
Effect: Annual levy for the collection of the premium	12.50 €	15.00 €	16.67 €	17.86 €	18.75 €	19.44 €

Multiple variables apply, reflecting the typical situations in the MS						
Premium per ELV	300 €	300 €	300 €	250 €	200 €	150 €
Average age of ELVs	18	18	18	22	24	28
share of used cars imported ("-" indicates export)	-50%	-25%	0	25%	50%	75%
average age of imported	4	6	0	4	6	8
Effect: Annual levy for the collection of the premium	13.64 €	15.00 €	16.67 €	11.79 €	9.09 €	6.10 €

Source: own calculations

[284] Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, Publisher: Umweltbundesamt, Dessau, Germany; publication in preparation

For the prices of (very) old used cars the premium becomes relevant for the price of that car as a mark up to the current market price.

3.2.5.2.1 Problematic effects of import and Export of used vehicles on the EPR fees

On the one hand, the total EPR costs of manufacturers are caused by the degree of EPR ambition and country-specific treatment costs, which are also influenced by wage rates. On the other hand, they correlate with the number of end-of-life vehicles produced on the territory of the country.

EPR schemes in a county exporting more than halve of the vehicle fleet before it is becoming ELVs need to collect less than half of the compliance cost compensation (Country A below). EPR schemes in a county importing more than halve of the vehicle fleet as used vehicles need to collect more than double of the compliance cost compensation per new vehicle PoM (Country B).

In consequence Country C might decide to collect a contribution to the EPR scheme when a used vehicle is imported respectively registered for the use on public roads in the country of destination.

As the table below shows, a transfer of the EPR fee from exporting country A to importing countries would be fairer. In this case, country A would have to collect the full amount of €200 million and transfer half of it to the destination countries, which would then not have to charge an import fee for used vehicles. Under real conditions, it becomes more complicated, as compliance costs vary from country to country, e.g. due to different wage rates.

A secondary effect might be relevant too: Often, the countries importing a relevant share of used vehicles have lower wages. For instance, labour cost for the NACE sector E (Water supply; sewerage, waste management and remediation activities) vary in 2020 between 5.2 € per hour in Bulgaria and 44.7 € per hour in Denmark. The average EU27(2020) is 23.0 € per hour[285]. Therefore, we added in

Table 3-66 below a calculation in the last column where the compliance costs are only half of the compliance cost compared to the exporting country.

Table 3-66 Exemplary effects of import and export of used vehicles on the EPR fees Organisations identified

	Unit	Country A	Country B	Country C	Country D
New Vehicles PoM	1000 vehicles	2 000	500	500	500
Export of used vehicles	1000 vehicles	1 000	-/-	-/-	-/-
Import of used vehicles	1000 vehicles	-/-	500	500	500
ELVs	1000 vehicles	1 000	1 000	1 000	1 000
Compliance cost offsetting per ELV	€ per ELV	100	100	100	50
Required budget	Million €	100	100	100	50
Fee per new vehicle	€ per ELV	50	200	100	50

[285] Source: Eurostat (lc_lci_lev), extracted: 16.2.2022

Fee per imported used vehicle	€ per ELV	-/-	-/-	100	50

Source: own calculations

3.2.5.3 Garages

Garages might be affected if they cannot make use of spare parts of used vehicles / ELVs without being an ATF.

In consequence they might opt

- to register as an ATF. As the number of ELV treated might remain small (e.g. 10 – 15 ELVs per year, this might cause unproportional additional administrative burden to those with small numbers of ELVs treated.
- to continue with the dismantling of valuable spare parts (which would be illegal) and seek how to direct the partially dismantled vehicles to ATFs or shredders.

To some extend it is expected that Garages might continue with their business to make use of spare parts and bypass legislation as enforcement in detail is difficult. Some specific measures (minimum level of sector inspections, monitoring / reporting on illegal activities) might reduce this bypassing.

The level of the economic effects is unknown.

3.2.5.4 ATFs

ATFs will be affected under the different scenarios by more ELVs directed to ATFs and also by new restrictions regards the export of (old) used vehicles. ATFs selling/ exporting such (old) used vehicles would incur losses in turnover and profit due to the restrictions. At the same time, it is expected that ATFs as a whole would benefit from more ELVs directed to ATFs.

Beside this ATFs might be affected due to more (or less if online procedures apply) administrative burden by issuing a CoD and demonstrating the source of spare parts sold.

Additional profits due to increasing number of ELVs directed to ATFs

Germany prepared a study on the „Illegal treatment of end-of-life vehicles – Assessment of the environmental, micro- and macro-economic effects”.[286]

The study provides model calculations distinguishing between 6 types of legal dismantling concepts and 4 types of illegal dismantling.

Legal dismantling types:

- **Baseline:** ATF with a throughput of 500 ELVs per year, ELVs are equipped with combustion engines, treatment is in accordance with the minimum legal requirements: depollution, dismantling, logistics but without dismantling of plastics and glass
- **Plastics:** Baseline + dismantling of large plastics components: front and rear bumper, wheel arch closures
- **Glass**: Baseline + dismantling of vehicle glass: Laminated safety glass: windscreen glass, door glass. Toughened safety glass: fixed side windows, rear screen glass
- **Spare Parts + Metal**: Baseline + dismantling of spare parts by ATF staff + dismantling of metal components: engine, starter motor, gear box, axles; alternator; copper components
- **Electric vehicles**: Baseline, but exclusively electric vehicles instead of conventional ELVs: mainly: battery instead of fuel tank, no catalytic converter, no engine oil, less gear box oil
- **Gas vehicles**: Baseline, but exclusively CNG/LPG instead of conventional ELVs gas tank instead of fuel tank

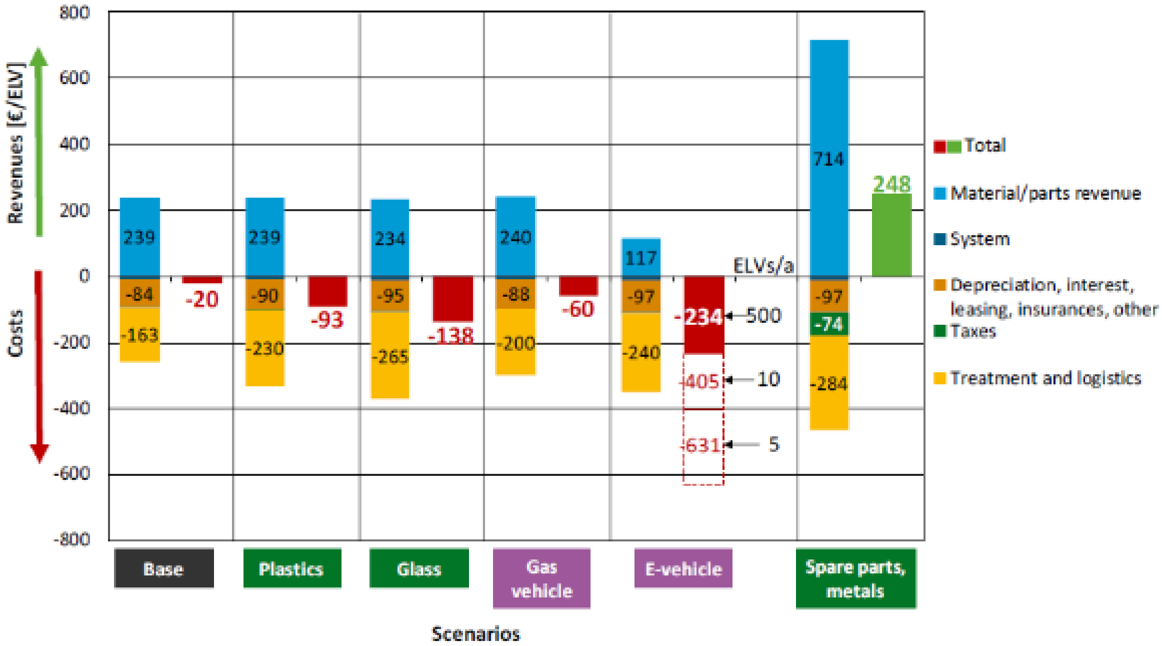
Illegal dismantling

- **Type 1:** Private actors such as private person, hobbyists, collectors and DIY auto repair communities and similar clubs.
- **Type 2:** Actors with registered businesses and good equipment such as workshops/ garages which occasionally dismantle vehicles.
- **Type 3:** Actors with registered businesses and partly under-equipped such as workshops/ garages with poorer standards, spare parts dealers etc.
- **Type 4:** Actors with registered businesses and largely without suitable equipment and inadequate dismantling practice such as used car or tire dealers.

The Figure 3-26 displays the costs and revenues for the different concepts of the legal sector. It displays that the baseline (the minimum effort for compliance) does not generate a profit but the scenario which includes the revenues from dismantling of spare parts and metals the profit is about 248 €/ELV. Th study displays an additional scenario (not displayed in the graph below) for the dismantling of spare parts but without dismantling of metals, which generates a profit of 222 €/ELV. The cost for the treatment of EV depend much on the turnover in numbers of EV as much upfront investment in staff and equipment is needed.

[286] Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, Publisher: Umweltbundesamt, Dessau, Germany; publication in preparation

Figure 3-26 Cost and revenue of ELV treatment in German ATFs

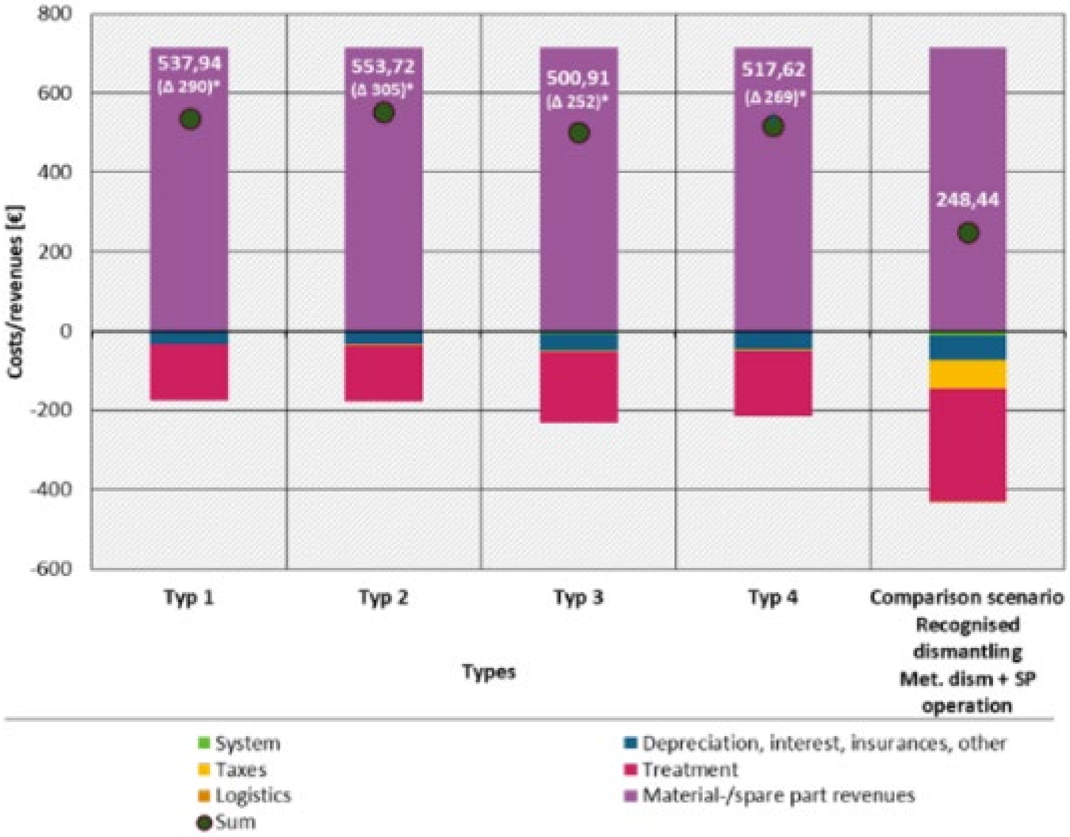


Cost per ELV, throughput of 500 ELV/a, average prices 2019 / 2020

Source: Zimmermann et.al (2022)

The Figure 3-27 displays the results of the investigations in the sector costs and revenues for the illegal and the legal sector per vehicle compared to the treatment in an ATF (scenario Baseline + dismantling of spare parts and metals). The delta, the difference between the (best) legal scenario and the different illegal scenarios is between 252 €/ELV and 305 €/vehicle.

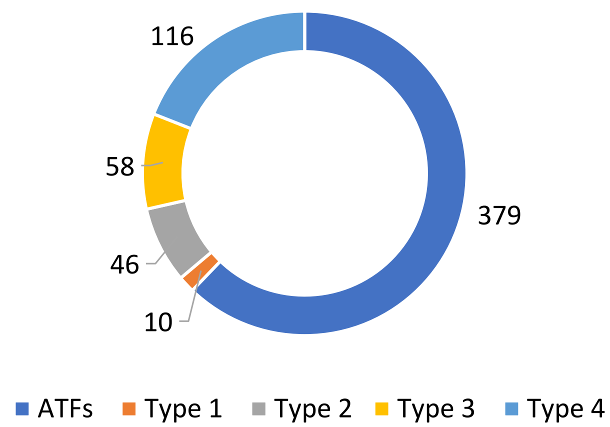
Figure 3-27 Cost and revenue situation of the illegal dismantling per ELV



Source: Zimmermann et.al (2022)

Using the figures in table 67 of the study, it is possible to calculate the total revenues for the legal and the illegal actors as displayed in Figure 3-28 below. The turnover of selling (very) old used vehicles to third countries is not included.

Figure 3-28 Model calculations for the revenues from dismantling activities in Germany for ATFs and different illegal actors (in Million €)

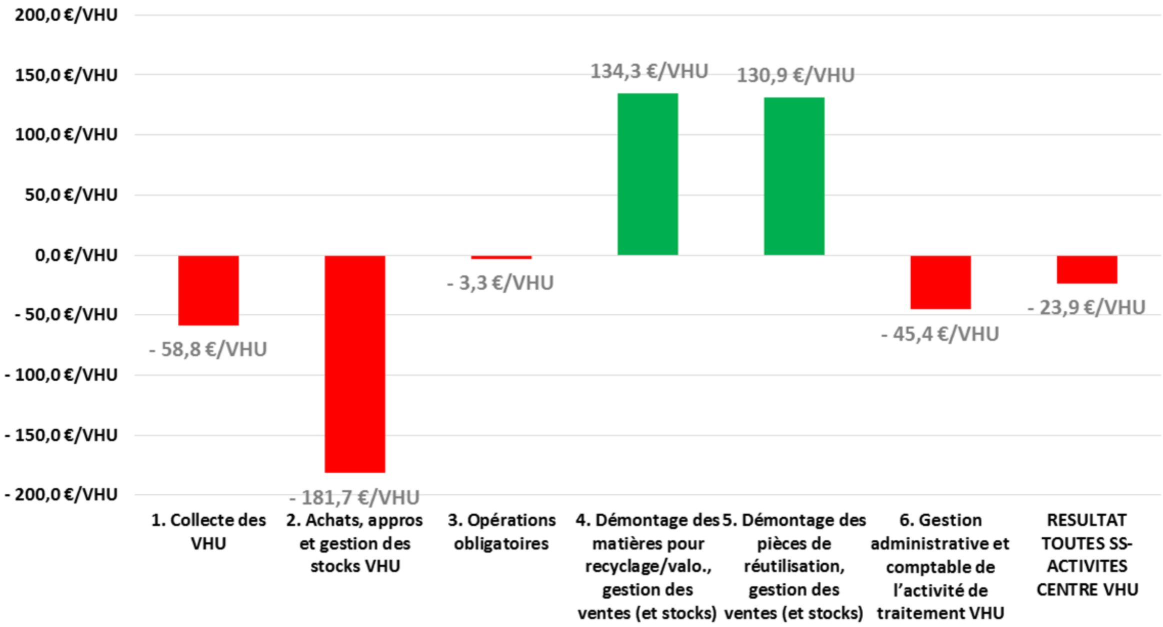


Source, own calculations based on data in Zimmermann et.al. (2022)

As demonstrated by the studies published by ADEME (2015)[287] and UBA (2022)[288], the operation of ATFs focusing on revenues for recyclables is not profitable.

Based on very detailed questionnaire, completed by 24 selected ATFs for the reference year 2012, the ADEME (2015) report concludes that the business is not profitable (on a weighted average) even if the spare parts separation activities are included. The ADEME report shows a weighted economic loss of 23.9 €per /ELV as displayed in the figure below. The average weighted turnover according to the same figure is 265.2 €/ELV.

Figure 3-29 Résultat d'exploitation par sous-activité (moyenne pondérée de l'échantillon 24 centres VHU)



Source: ADEME (2015)

It is important to note that the results for the 24 ATFs included in the study range from a negative result of -225.2 €/ELV to a maximum profit of 109.8 €/ELV. One of the main effects to distinguish. The ADEME report examines in detail whether patterns can be identified to distinguish which ATFs generate losses and which generate profits. An important aspect seems to be whether the treatment of end-of-life vehicles is the main activity or whether the business is dominated by other activities such as car trade or repair shop: "We note that the result in €/ELV is positive for the ELV centres whose % ELV turnover is greater than 75% of total turnover. This probably reflects a concern to optimise costs and margins on the main activity. The average operating profit in € for all activities combined of ELV centres whose ELV turnover is less than 75% of total turnover is positive. The margin of these companies is therefore achieved from activities other than that of the approved ELV centre."[289]

[287] ADEME (2015): TERRA SA – DELOITTE – BIOIS - EVALUATION ECONOMIQUE DE LA FILIERE DE TRAITEMENT DES VEHICULES HORS D'USAGE – 2015 – Synthèse. 40 p.

[288] Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, Publisher: Umweltbundesamt, Dessau, Germany, Publication in preparation

[289] ADEME (2015), Volume 1, page 67

In contrast to the ADEME (2015) report (referring to a survey) the UBA (2022) report developed model calculations for different operations concepts as mentioned above. For the operation concept including the separation of spare parts UBA (2022) reports a positive result of 222 €/ELV[290]. For the operation concept including the separation of spare parts and the separation of metals UBA (2022) reports a profit of 248 € per ELV. The turnover reported in UBA (2022) for the same operation concepts are 656 €/ELV respectively 714 €/ELV (the last including separation of metals).

The German average profit (revenue - cost, including the cost of purchasing ELVs) per ELV may not be representative for the EU as a whole, as the profit depends on the revenues of shredder steel scrap, catalytic converter scrap and aluminium scrap (all of which fluctuate over the time series, but do not differ that much within the EU) and depends also on transport distances, investment in equipment and wage levels, and last but not least on the demand for spare parts from the ELVs typically treated in the country.

As long as no other economic information is available, we consider as a total profit from the treatment of ELV considering the concept to dismantle spare parts a profit of 200 €/ELV and a turnover of 600 €/ELV.

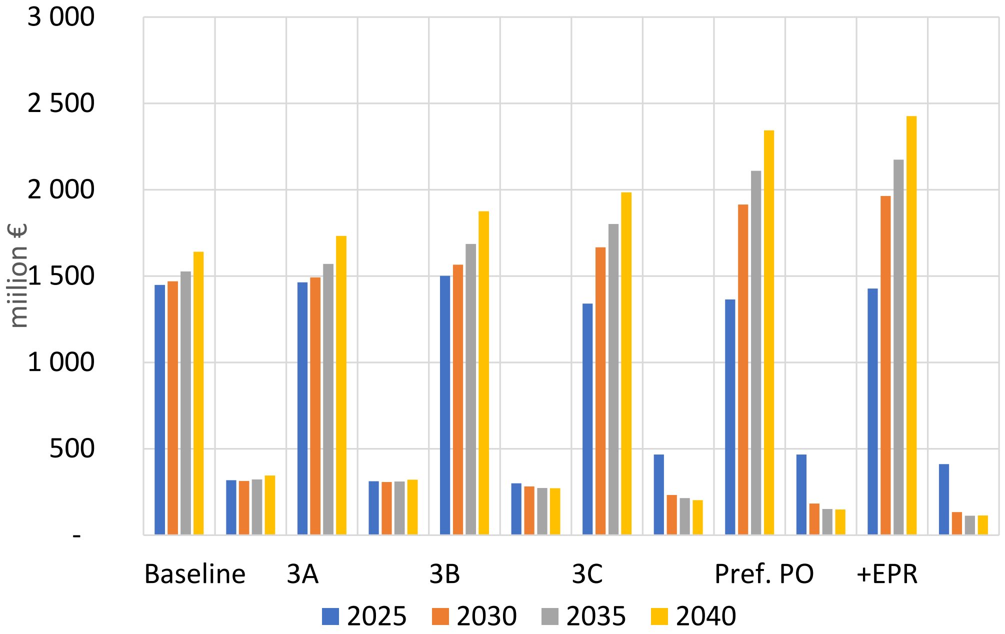
Losses due to limitations in export of used vehicles (similar to ELVs)

We consider that ATFs currently are involved in exporting old vehicles, considered in the EU as ELV but with a positive market value in 3rd countries. As it must be more attractive to export them (or sell them to exporters) we consider that the profit per exported vehicle is about 400 € per vehicle for the ATF. Further we assume that ATFs are involved in 25% of such exports. The different scenarios have different effect to what extend the export is limited and directed to (EU domestic) ELV treatment in ATFs instead.

Figure 3-36 below displays the effects for the Policy Options and the preferred option for both: increased profits due to more ELVs treated in ATFs (displayed in the first 4 bars for the years 2025 - 2040) and the lost profits due to the limitations of the export (second set of the bars for each policy option. The reduced number of treated ELV in ATFS in 2025 in Policy Option 3C (and subsequently the preferred Policy Option(s) is a one-off effect caused in advance to the shortly coming (envisaged for 2027) limitations of exports.

[290] UBA (2022), English version, Table 11, page 54

Figure 3-30 Profits (revenues – costs) for ATFs in EU-27 for the Policy Options: a) profits from ELVs directed to ATFs; b) profits from export of (old) used vehicles



Source: own calculations

Assumptions for the calculations:

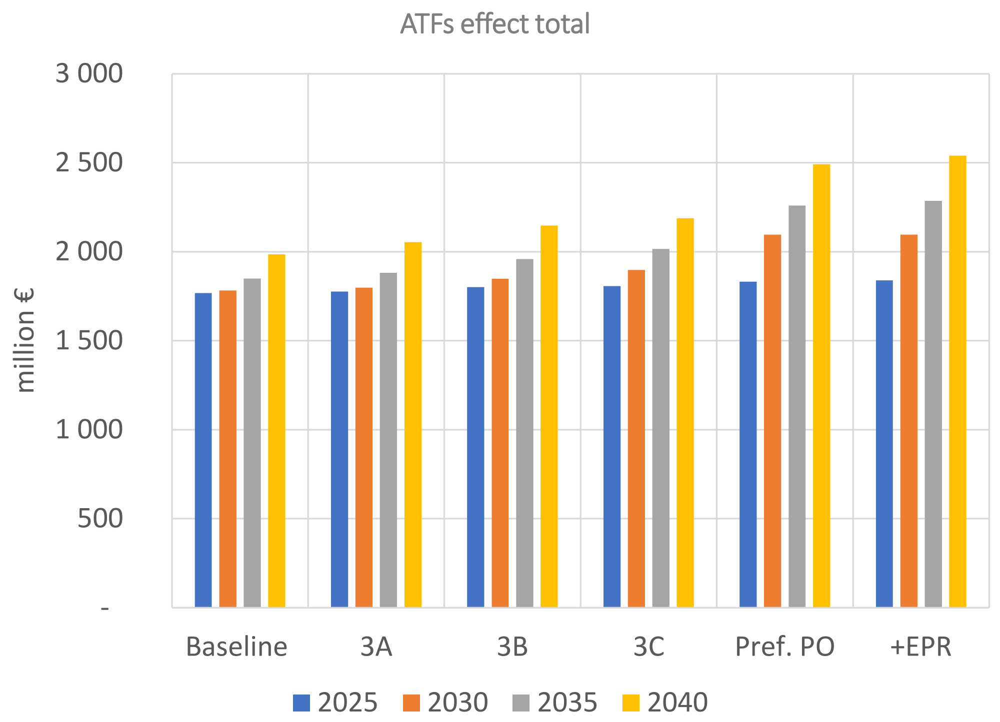
- Dynamic development of ELVs according to the fleet model
- Shift to ATFs (Category A and B) as displayed in Table 6-30 in Annex I
- Profits: 200 € per ELV treated in ATFs
- Profits due to exports to non-EU Countries: 400 € per exported vehicle; assumption that ATFs are involved in 25% of the total export of used vehicles to non-EU-Countries

In PO3C and the preferred Policy Option there might be an on-off effect shortly in 2025, before the limitations for the export enter into force. This is caused by the "alarmed" exporters having a last chance to export such old vehicles which would not get a roadworthiness certificate but meet a demand in the receiving countries. In result the profits from treatment drop and the profits from export increase.

Figure 3-31 below displays the total effects on profits of the combination of a) ATFs treated in EU27 and b) ATFs exported. As a result, the on-off effect will not reduce ATF profits in 2025, and after 2025, the preferred policy option will lead to an increase in profits.

Finally, Table 3-67 displays the profits for the Policy options compared to the baseline.

Figure 3-31 Aggregated change in profits for ATFs in million € for the different Policy Options



Source: own calculations

Table 3-67 Additional profits (revenues – costs) for ATFs in EU-27 for the Policy Options in million Euro compared to Baseline

		2025	2030	2035	2040
	Baseline	1 449	1 470	1 526	1 641
ELV treatment compared to baseline	3A	15	22	44	91
	3B	52	97	159	234
	3C	-109	196	275	344
	Pref. PO	-84	444	583	702
	+EPR	-22	494	647	785
	Baseline	319	313	323	344
Export of used, compared to baseline	3A	-6	-6	-12	-23
	3B	-19	-31	-50	-73
	3C	149	-81	-108	-142
	Pref. PO	149	-130	-172	-197
	+EPR	93	-180	-211	-231
	Baseline	1 768	1 783	1 849	1 986
total ATF compared to baseline	3A	9	16	32	67
	3B	33	66	109	161
	3C	40	115	167	202
	Pref. PO	64	314	411	505
	+EPR	71	314	437	554

Source: own calculations

New administrative burdens to ATFs

At the same time ATFs are exposed to additional administrative burdens caused by the policy options 3A measure 3 requiring dismantlers to check and report on ELVs.

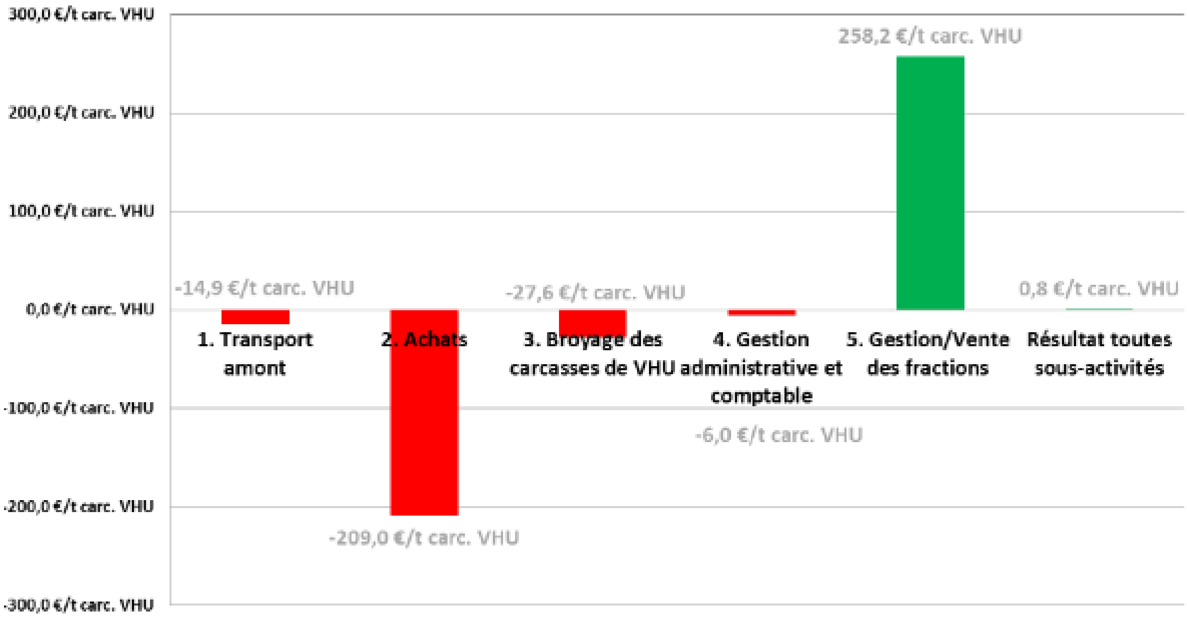
Regards 3A3 the situation does not change much: ATFs should according to the current legislation anyhow issue CoDs on demand. As the measure includes the obligation that the Member States shall establish electronic transfer to authorities, this might cause some one-off effort to some ATFs, but as it might be a simple registration procedure and a simple interface it might even reduce the administrative burden to ATFs. Such burdens might cause a light shift from (very) small business to medium size business simply due to economy of scale.

More challenging is the aspect that shredders shall be enabled to check the VIN number and accompanying CoDs (as it is the case in the Netherlands). This would not allow ATFs to compress the cars to the maximum or to separate components / metal with hydraulic shears. Both might cause increasing transport cost for ATFs to shredder / recycling facility.

3.2.5.5 Shredders

The study of ADEME (2015) selected 7 shredders representing the average situation of shredders in France and these shredders provided economic data for the reference year 2012 (with some deviations depending on the fiscal year). According to the results of ADEME (2015) French shredders work in average with a (marginal) profit of 0.8 €/t (depolluted and dismantled ELV, with a range of maximal losses 29.8 €/t and a maximal profit of 27.2 €/t.

Figure 3-32 Résultat d'exploitation par sous-activité (Moyenne pondérée del'énchantillon 7 broyeurs VHU)

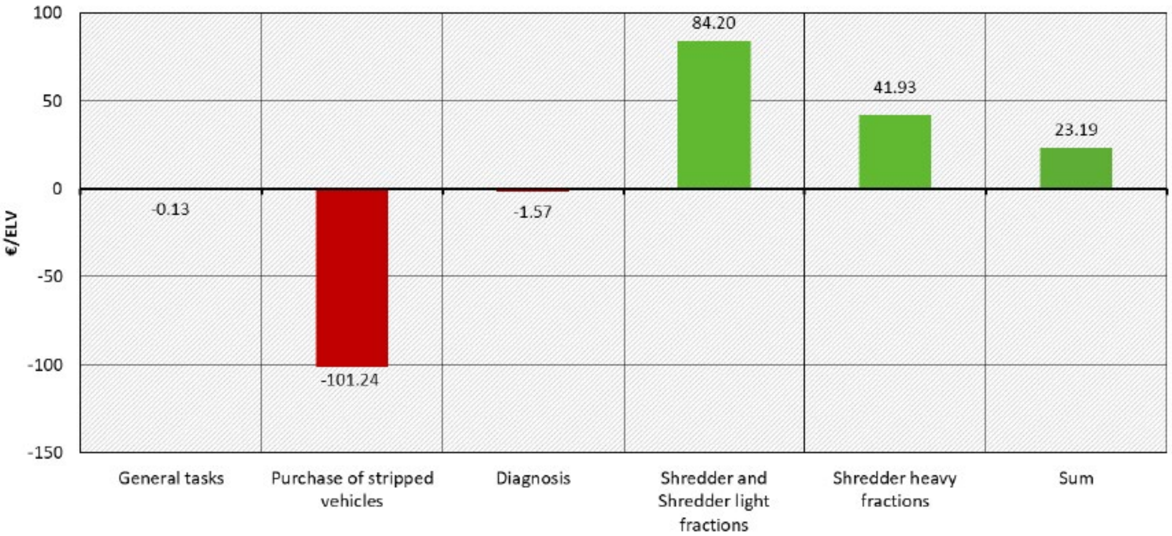


Source: ADEME (2015)

Three of the seven shredders analysed showed a negative operating result for the activity of shredding ELV carcasses. The results of this study are a bit surprising as according to the same study the shredders pay for the incoming depolluted and dismantled ELV between 150.5 and 210.4 €/t. So why should the shredders buy these ELVs if they generate losses?

The UBA (2022) study investigated in the economic situation of shredders too. The assessment is based on 4 shredders in Germany as displayed in the figure below.

Figure 3-33 Cost and revenues of shredding plants per cost type



Source: UBA (2022)

Shredders will have additional turnovers and profits if more ELVs are treated in Europe. For the calculation below we consider that today ELVs treated domestically in ATFs (cat A and B of Model, see section 3.2.3 on the Methodology) and also those domestically treated in illegal (non-ATFs, cat C) are delivered to shredders. Additional mass/profits are generated by the shift from extra EU export (cat D) E) F)) to EU domestic treatment only.

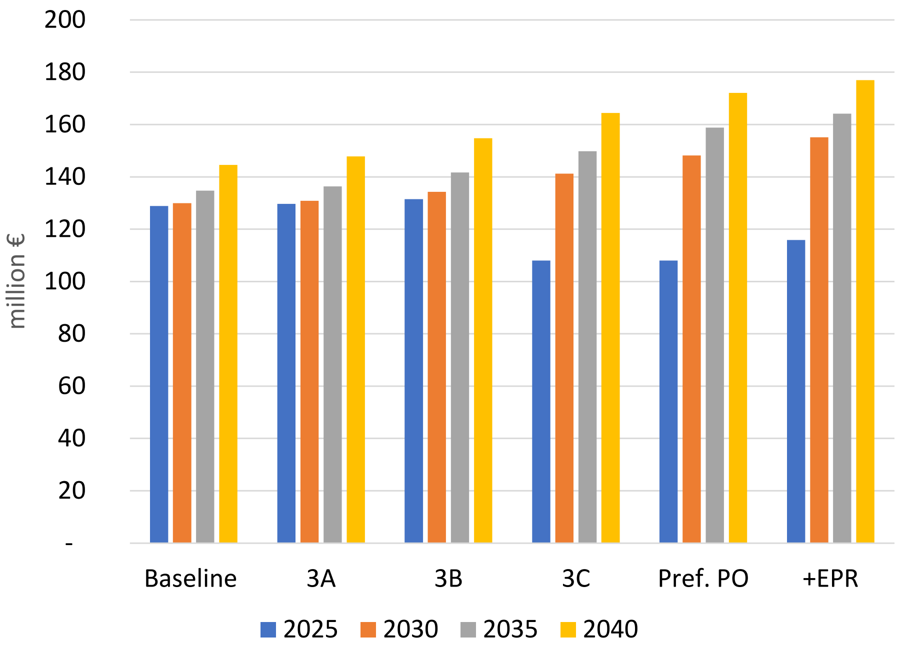
Considering an average 700 kg per dismantled and depolluted ELV the additional feed for shredder will be in maximum 1.5 million tonnes per year which is according to statements of the recycling sector feasible to absorb.[291]

For the calculation of the additional profits, we consider a specific additional profit for shredders of 20 €/t dismantled and depolluted ELV.

Figure 3-34 displays the total profits of shredders from the treatment of ELVs for the different policy options and Table 3-68 displays the additional profits under the policy options compared to the baseline.

[291] The total amount of steel scrap (all qualities) consumed for crude steel production in the EU-27 in 2021 is about 88 million tonnes (Source: Eurofer / BIR; Statista)

Figure 3-34 Profits for Shredders from ELVs in EU-27 for the different Policy Options



Source: own calculations

Assumptions for the calculations:

- Shift from exports (cat D, E, F) to domestic (EU27) treatment (cat A, B, C) as displayed in Table 6-30 in Annex I
- Profit for shredders per dismantled and depolluted ELV: 20 €/t dismantled and depolluted ELV

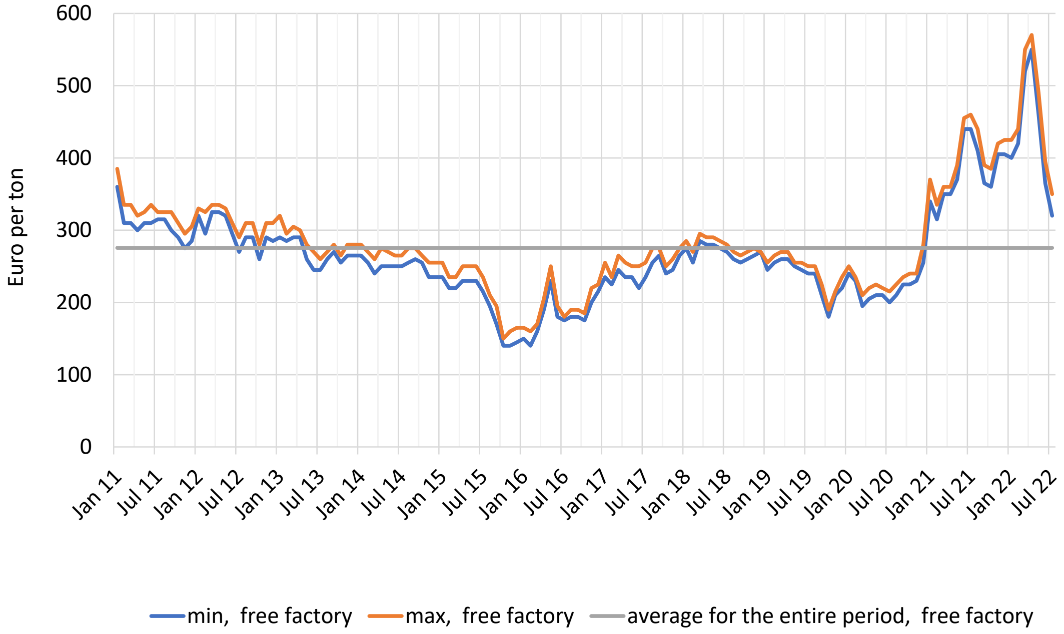
Table 3-68 Additional profits (revenues – costs) for shredders in EU-27 for the Policy Options in million Euro compared to Baseline

	2025	2030	2035	2040
Baseline	129	130	135	145
3A	1	1	2	3
3B	3	4	7	10
3C	-21	11	15	20
Pref. PO	-21	18	24	28
+EPR	-13	25	29	32

Source: own calculations

Sometime stakeholders are of the opinion that the profits of shredder are higher when the prices for the shredder steel (or aluminium) are high as in 2021 (see figure below with peak prices in April 2022). However, the shredders have to buy the steel scrap including the depolluted and dismantled ELVs and the purchase prices for the input increase too.

Figure 3-35 Min / max prices for shredder steel, free factory (Germany)



Source: data: www.euwid-recycling.com, own compilation.

Shredders might be affected by the fact that they must check if the ELVs arriving at their facility were depolluted and dismantled by ATFs and carry the correct CoD. This will require a compacting of the carcass/depolluted/dismantle ELV for transport from ATF to shredder which allows checking the VIN number. This approach is already applied in the Netherland for the ARN network.

3.2.5.6 Industries involved in processing/recycling of waste arising from ELVs treated in the EU

As outlined in the section on environmental impacts (3.2.6) more feedstock for several secondary materials will become available for other stakeholders in the recycling industry too. As for almost all of the materials mentioned in this section the recycling is profitable, additional feedstock will increase the profits of the recycling industry accordingly.

3.2.5.7 Used car dealers

Dealers with used cars might experience more administrative burdens and also higher costs if continuing fees / insurance apply during a temporary de-registration.

Used car dealers often apply for temporary deregistration for the period during which the vehicle is for sale. If a fee of e.g. 5 € per month and vehicle is due during this period, this would amount to 3 000 € per year for a dealer with e.g. 50 used cars to sell. If the average sales period is about 2 months, the additional costs to be covered by the sales prices amount to about 10 € per vehicle.

Dealer with used cars would be affected by new rules restricting the (Extra EU) export of used vehicles.

As outlined for the current situation (see Annex I) the total number of exported used vehicles from EU-27 to non-EU Countries peaked in the past decade in 2012 with 1.4 million, dropped to 680 000 in 2016 and increased to 971 000 in 2019.

The total value of the exported used vehicles to non-EU Countries is € 6.14 billion in 2012 and dropped to € 4.33 billion in 2019. These data refer to the data as provided by Eurostat which is based on statistics from the customs services. As explained earlier we assume an additional share of the "missing vehicles" being exported too, but not reported to the customs services. As outlined in the section methodology we consider for the assessment that 50% of the missing vehicles are treated (but not reported) within the EU and 50% are exported but not declared to the customs services. For 2019 (last available data when the report is prepared) this would represent around 1.7 million used vehicles (also including a share which would be declared within the EU as ELVs). The total export is the sum of reported and unreported 2.67 million used vehicles.

As we have no further sources on the characteristics of the unreported exports, we assume them to have the same characteristics as the officially exported with an average value of around 4 400 €/vehicle. Thus, the total value of the unreported vehicles would be about 11.75 billion Euro.

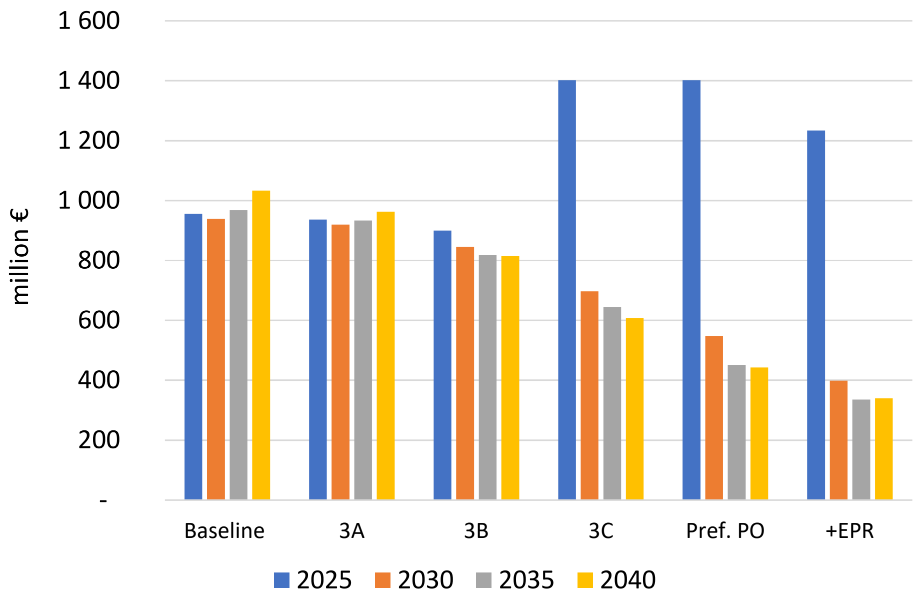
The model calculation is similar to the calculation of the economic impacts on ATFs, involved in export of used vehicles too.

Therefore, we consider the same profit of per exported vehicle of about 400 € per vehicle. Further we assume that non-ATF car dealers are involved in 75% of such exports.

The lost profits for the used car dealers in the different scenarios are displayed in Figure 3-36 below and Table 3-69 displays the (lost) profits compared to the baseline.

The calculation is a kind of worst-case scenario for the sector as we expect a shift of the export activities of car dealers to younger vehicles, which can get easier a roadworthiness certificate.

Figure 3-36 Profits in EU-27 for car exporters of (old) used vehicles for the different Policy Options



Source: own calculations

Assumptions for the calculations:

- Shift from exports (cat D, E, F) to domestic treatment (cat A, B, C) as displayed in in Table 6-30 in Annex I
- Profits: 400 € per exported vehicle (25% manged by ATFs and 75% managed by car dealers) ELV treated in ATFs
- Not realised profits (negative values) due to limited exports to non-EU Countries: 400 € per not exported vehicle; assumption that ATFs are involved in 25 % of the total export of used vehicles to non-EU-Countries

Table 3-69 Additional profits in EU-27 for car exporters for the Policy Options in million Euro compared to Baseline

	2025	2030	2035	2040
Baseline	956	939	968	1 033
3A	-19	-19	-35	-70
3B	-56	-93	-150	-219
3C	446	-242	-324	-425
Pref. PO	446	-391	-516	-591
+EPR	279	-540	-632	-694

Source: own calculations

3.2.5.8 Insurances

Insurances often apply procedures for economic and technical total loss which have the potential to disregard that these vehicles might be waste and shipment regulations for intra EU must apply and export to non-OECD countries might be prohibited. If the definition of ELVs is connected to the definition of “total technical loss” or even “total economic loss”, the insurances might be exposed to higher cost, and this might cause higher cost to consumers too.

For the Netherlands a number of 30 000 total loss vehicles per year is mentioned[292]. This would represent a share of 0.3% of the fleet (approximately 9 million passenger cars in use) respectively a share of 15% of the ELVs reportedly treated (approximately 200 000 per year). Of the 30 000 a share of 10 000 are dismantled and 20 000 repaired[293].

3.2.5.9 National Authorities

- might be affected by
- more inspection/enforcement campaigns
- prepare their registration systems to become interoperable with the systems of other MS
- more administrative efforts to manage extra EU exports.
- New reporting obligations regards the change in national fleet with the aim to demonstrate that all ELV are directed to ATFs and reported to the registers accordingly

[292] E-Mail: H. Nix (EGARA), 7 August 2022

[293] E-Mail: H. Nix (EGARA), 7 August 2022

With regard to this first measure (more inspection/enforcement campaigns): To check 10% of the sectors facilities per year a relevant effort is required. Taking into consideration 12 000 ATFs[294] and 2 times more other facilities (like garages or private places where ELVs are suspected to be stored) relevant for inspection then 10% would account for around 3 000 facilities. Taking into account 3 full days effort per facility in average, multiplies with the average EU labour cost of 29 € per hour[295] this would account for 2.5 million € for the entire EU + plus reporting to the EU of possibly about 10 000€ per MS. In total an amount of 2.8 million €.

Considering the average of new registered passenger vehicles in the EU for the period 2019 – 2021 of 10.9 million vehicles this represents around **25 cent per new vehicle** registered.

In total, including the other efforts we estimate not more than 1 € per new vehicle registered.

With regard to the second measure (making MS registration systems interoperable with the systems of other MS), the impact would be assessed as part of the impact assessment for the "roadworthiness package" which is under preparation by the European Commission[296], as one aim of this package is to move to a full digitalisation of the registration documents and improve the exchange of information between Member States on their registers. As a first indication the envisaged budget of EUCARIS[297] [298] for the year 2022 might serve as a first proxy which is around 1.6 million € for the services provided to its members. The cost is charged separately for different services to the members of EUCARIS. Additional cost applies to the members when making use of the platform. However, the overall cost shall not exceed 1 € per registered vehicle too.

With regard to the third measure (new requirements on export of used vehicles and better enforcement of rules on export ELVs), the impact for national administrations is linked to the need to ensure training of all relevant services on the new controls that need to be performed upon export, to foster cooperation between the different administrations concerned (especially competent authorities in charge of the implementation of the ELV legislation and customs), as well as to set up or upgrade the necessary IT infrastructure allowing for efficient border automated checks (especially in the case where the Vehicle Identification Number of used vehicles need to be included in the customs declaration). In addition, costs of the inspections to be performed by the relevant authorities on export should also be factored in. These costs would remain marginal for Member States which are not exporting or exporting very low quantities of used vehicles or ELVs and would represent a higher amount for other Member States, especially those hosting large ports specialised in export of large volumes of used vehicles/ELVs. It is difficult to provide a quantitative assessment of these costs, but they should remain limited. The measures put in place through the new legislation should actually mitigate some of these costs as they would render the procedures more efficient and targeted, compared to the current situation.

[294] ARGUS (2016): Implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end-of-life vehicles with unknown whereabouts: Summary report on the implementation of the ELV Directive for the periods 2008-2011 and 2011-2014 ("Lot 2"): In this report for EU27 11089 ATFs are listed (while not all MS refer to the same time period, the range of time periods considered is between 2008 - 2015

[295] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Hourly_labour_costs

[296] Vehicle safety – revising the EU's roadworthiness package (europa.eu)

[297] EUCARIS (short for European Car and Driving License Information System) is an information exchange system that provides an infrastructure and software to countries to share, among others, their car- and driving licence-registration information, helping fight car theft and registration-fraud. EUCARIS is developed by and for governmental authorities and is able to support all kinds of transport related information exchange based on treaties, directives, bi- and multilateral agreements.

[298] EUCARISBUDGETPROPOSALFINAL2022VERSION 1.1

With regard to the 4th measure, it is important that the 2nd and 3rd measures are in place and thus the related costs for the implementation and operation of these measures apply for the 4th measure as well. Once the 3rd and 4th measures are implemented, limited additional burdens apply to collect the data from the different sources established.

Again we come to the conclusion that the overall cost for all four mentioned aspects will not exceed the cost of 1 to 2 € per newly registered vehicle.

3.2.5.10 Producers / OEMs

Producers will not be affected by the measures in Options 3A, 3B, and 3C.

3.2.5.11 Overview

The table below gives an overview by measure / policy option and in principle expected economic impacts with the aim to identify relevant stakeholders and measures to be looked at detail and to crosscheck if the assessment above is complete.

The details of the impacts are here consolidated according to the elaborations above the main affected stakeholders are:

- **ATFs** having relevant additional profits due to the handling of more ELVs, depending on the policy option by 3A to 3C from 91 to 344 million € per year in 2040. As ATFs might be involved in the extra-EU export of used vehicles including those vehicle which might not get a valid roadworthiness certificate ATFs might be experience that profits from these activities decrease by up to 142 million € for Policy Options 3C. According to the model calculations, the last should be by far overcompensated by the additional profits mentioned before.
- **Used car dealer** with a focus on extra EU export (and not involved in the ELV management) will experience losses of profits under the different policy Options 3A to 3C due to the limitations of the exports of used vehicles which are not accompanied with a valid roadworthiness certificate of 70 to 425 million Euro per year in 2040. However, it is likely that effect might be overestimated as the exporters of used vehicles to non-EU countries will adjust their business to the new legal requirements and seek to export more (younger?) vehicles with a valid roadworthiness certificate.
  Secondly all used car dealers will experience due to continuing fees during the selling phase (where used vehicles are often "temporary de-registered") additional cost of around 10€ per sold used vehicle.
- **Shredder plants and recycling industry** will experience an increase in turnover, however as the profit per tonne depolluted and dismantled vehicle is limited we expect limited additional profits for shredders of about 3 to 20 million € for PO 3A to 3C.
- **Vehicle owners/consumer** will be not affected by the change in profits for ATFs and used car dealers. However, additional system cost will remain with the consumer of about 10 € for each used car due to increased cost for the dealers (continuing insurance)
- **Public authorities** might be affected by more inspection/enforcement campaigns, prepare their registration systems to become interoperable with the systems of other MS, more administrative efforts to manage extra EU exports and follow up registration. The total effort is estimated to be below 1 € per new registered vehicle.

Table 3-70 Overview economic impacts in 2040

Title	Vehicle owners	Garages	Exporters*	Car dealers	Insurances	ATFs*	Shredders*	National authorities	Producers
Policy Option 3A			-70 M €			+ 91 M € -23 M €	+ 3 M €	< 1 € per new car	
Policy Option 3B			-219 M €			+ 234 M € -73 M €	+ 10 M €	< 1 € per new car	
Policy Option 3C	10 € for car dealers add. effort		-425 M €	Cost of -10 € per used car sold		+ 344 M € -142 M €	+ 20 M €	< 1 € per new car	

*Expressed in profits (not turnover)

	Title	Vehicle owners	Garages	Car dealers	Insurances	ATFs	Shredders	National authorities	Producers
	Policy Option 3A								
3A2	Reporting on vehicle market and ELVs							**AB**	
3A2	Reporting on incentives and fines (Level A)							AB	
3A2	Requirements for MS to establish penalties	AB	AB	AB	AB	AB	AB	AB	
3A3	Dismantlers /recyclers to check and report on ELVs					AB/W	AB/W		
3A4	Minimum requirements for sector inspections					OP	OP	**AB**	
4A1	Implementation and enforcement action regards WFD Art 8/8a					OP		AB	AB
4A2	EPR obligation: Collection of abandoned vehicles					OP			AB
4A2	EPR obligation: collection of all vehicles					OP			**AB:** 50 € per new vehicle
4A3	EPR obligation: Notification system for CoDs					OP			AB

	Title	Vehicle owners	Garages	Car dealers	Insurances	ATFs	Shredders	National authorities	Producers
4A4	EPR obligation: Monitor and report on illegal activities					OP			AB
	Policy Option 3Ax								
	All measures und 3A plus:								
3A1	Establish collection target					OP	OP	AB	
	Policy Option 3B								
3B1	Interoperability between national registration authorities							AB	
3B2	Alignment of terms with Directive 1999/37/EC								
3B2	New definition: “temporary de-registration”							AB	
3B3	Binding criteria for a distinction of used vehicles / ELVs	W	W	W	W	W/OPT	OP	AB	
4A1	EPR obligation: Collection of abandoned vehicles								
	Policy Option 3C								
3C1	EU vehicle registration database including harmonised procedures and definitions					OP	OP	AB	
3C2	(Extra-EU) Export restrictions for used cars linked to roadworthiness, age and emission level)	W	W	W	W	W/OP	OP		
3C3	Include Vehicle Identification Number (VIN) in customs			W		W/OP	OP	AB	
4A1	EPR obligation: Collection of abandoned vehicles								
	Policy Option 4B								
4B1	EPR: Compliance cost off-setting	W							AB
4B2	National DPR schemes (EPR or Public)								
4B3	EPR schemes for intra-EU trade								
4B4	Link CoD to incentives and penalties (**Level B**: choose the options the MS will have to deliver)								

3.2.6 Environmental Impacts

3.2.6.1 Identification of expected environmental impacts

The shift of extra EU export of ELVs and (old) vehicles with similar characteristics to ELVs may cause the following environmental effects:

- Resources available for recycling if treated in the EU (resources not lost)
- In the method of life cycle assessments (LCA) credits are granted for recycling. In this case we can consider the additional recyclables available in Europe from of additional ELVs directed to treatment plants in Europe.
- Less (hz) waste in receiving (extra EU) countries

The shift from illegal (or unreported) treatment within Europe to ATFs may cause the following environmental effect:

- Illegal treatment might not treat all refrigerants from the air conditioning system and all waste oil. If the ELVs are shifted to ATFs less losses of refrigerants from the air conditioning system can occur
- Today, standard dismantling and shredding is in most countries completely self-managed by the recycling sector, without contribution / funding of the EPR systems. It is expected that the illegal ELV treatment is sending the same amounts of steel, aluminium and catalytic converter to recycling and applies the same effort for separation of spare parts. In consequence no change for the case that more ELVs are shifted from illegal (or unreported) treatment within Europe to ATFs.

No other environmental impacts came to our attention or are did not

3.2.6.2 Additional resources available for recycling in EU

If vehicles, used or ELVs with characteristics similar to that of ELVs, are not directed any more to extra EU exports, they will be directed to ATFs (or illegal dismantlers in the EU) and subsequently to shredders and the resources will then be available for recycling. The effects for the available resources are as displayed in Table 3-71 below.

Table 3-71 Additional Resources compared to baseline for intra EU recycling in 2040 for the different Policy Options

		Baseline 2040	3A 2040	3B 2040	3C 2040	Pref. PO 2040	+EPR 2040
Steel	1000 t	6 626	150	468	910	1 264	1 485
Cast Iron	1000 t	761	17	54	105	145	171
Wrought Aluminium	1000 t	585	13	41	80	112	131
Cast Aluminium	1000 t	719	16	51	99	137	161
Copper/Brass	1000 t	196	4	14	27	37	44
Glass	1000 t	0	0	0	0	0	0
Average Plastic	1000 t	287	7	20	39	55	64
Platinum	t	27	1	2	4	5	6

Source: own calculations

The calculation is based on the following assumptions:

- Annex I section 6.9 on Description of the model to calculate the impact assessment:
  - dynamic generation of ELVs
  - split in ICV, HEV, PHEV and BEV
  - Steady state efficiency for the recycling rate respectively loss rate (RR for glass = 0)
- Shift of vehicles from export to intra EU treatment.
- Without consideration of effects of measures to support circularity.

The complete table for all Policy options and the years 2025, 2030, 2035 and 2040 is attached in Annex I, section 6.6.2.5.

3.2.6.3 LCA credits for recycling of additional ELVs

The environmental credits for recycling when calculating the above-mentioned resources available for recycling are displayed in Figure 3-37 below. The credits for the policy options compared to the baseline are displayed in

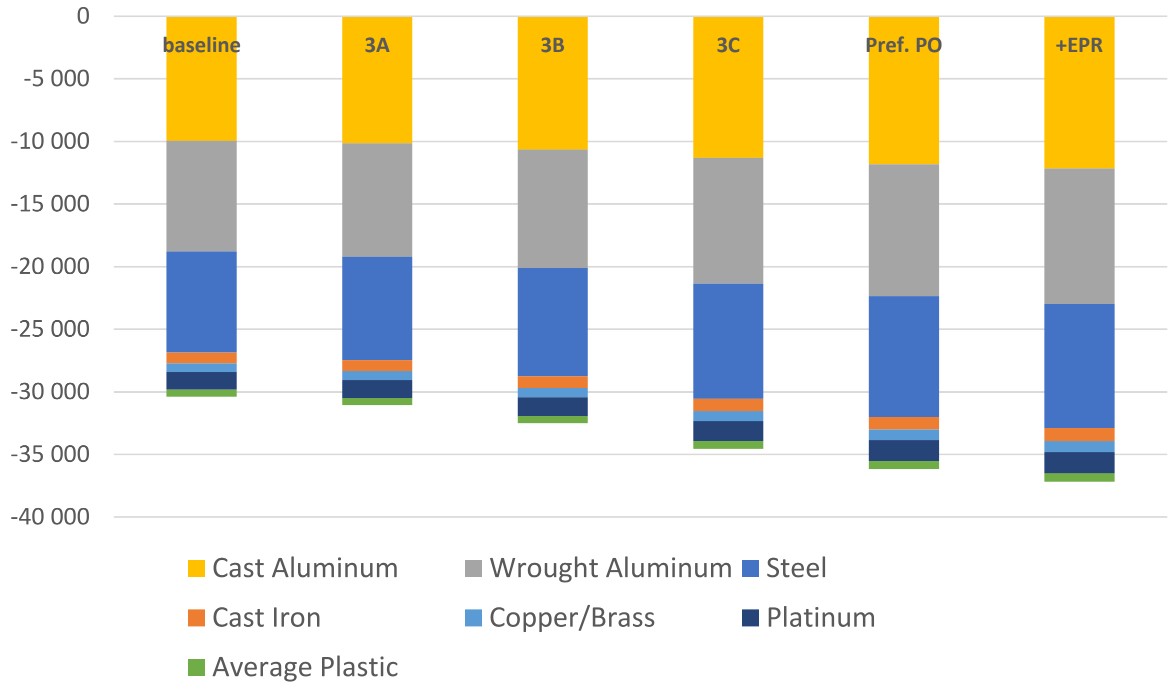
The credits are calculated with the LCA method as explained in the section on circularity.

The calculation is based on the following assumptions:

- Annex I section 6.9 on Description of the model to calculate the impact assessment:
  - dynamic generation of ELVs
  - split in ICV, HEV, PHEV and BEV
  - Steady state efficiency for the recycling rate / respectively loss rate (RR for glass = 0)
  - Credits for recycled material
- Shift of vehicles from export to intra EU treatment.
- Without consideration of effects of measures to support circularity.

The complete set of figures for all Policy options and the years 2025, 2030, 2035 and 2040 is attached in Annex I, section 6.6.2.5.

Figure 3-37 Credits in 2040 for recycling due to shift from export (used and ELVs) to EU domestic treatment; aggregate; LCA unit: GWP 100a [1000 t CO2 eq]



Source: own calculations

Table 3-72 Additional Credits compared to baseline for intra EU recycling in 2040 for the different Policy Options

		Baseline 2040	3A 2040	3B 2040	3C 2040	Pref. PO 2040	+EPR 2040
Steel	1000 t CO2 eq	8 084	183	571	1 110	1 542	1 811
Cast Iron	1000 t CO2 eq	860	19	61	118	164	193
Wrought Aluminium	1000 t CO2 eq	8 844	201	625	1 215	1 687	1 982
Cast Aluminium	1000 t CO2 eq	9 936	225	702	1 365	1 895	2 226
Copper/Brass	1000 t CO2 eq	715	16	51	98	136	160
Glass	1000 t CO2 eq	0	0	0	0	0	0
Average Plastic	1000 t CO2 eq	545	12	39	75	104	122
Platinum	1000 t CO2 eq	1 388	31	98	191	265	311
Total	**1000 t CO2 eq**	**30 373**	**689**	**2 147**	**4 172**	**5 792**	**6 805**

Source: own calculations

3.2.6.4 Losses of refrigerants from the air conditioning system

According to the EU ELV rules, ELV must be depolluted and inter alia the coolants for air conditioning must be separated to avoid that the coolant is discharged to the air. As the coolants are very volatile, this requires special extraction systems. If only a limited number of vehicles is depolluted it is economically not viable to invest in such extraction systems.

To calculate the impact of refrigerant losses, many variables need to be considered:

- The proportion of ELVs with air conditioners treated by non-ATFs and the amount of refrigerant[299] per air conditioner.
- The equipment of these non-ATFs.
- The year of manufacture of the ELV, as it determines the type of refrigerant.

Considering these aspects, the German Umweltbundesamt commissioned a comprehensive study to estimate inter alia the impacts losses of refrigerants from the air conditioning system.[300]: The study assessed the potential impact and concluded that the coolant R12 (with a GWP100 of 10.890 CO2eq), which was phased out the latest 1995, are not relevant anymore. However, the coolant R134a (phased out the latest in 2017) is relevant[300].

As R134a is replaced by R1234yf and R744 (CO_2), the GWP from treatment of end-of-life vehicles in illegal dismantlers will decrease after 2032.

The problematic production of trifluoroacetic acid (TFA) from R1234yf will remain (Zimmermann et.al. 2022).

Table 3-73 Refrigerants in air conditioning of vehicles

Refrigerants	Refrigerants In use for new vehicles	Global Warming potential (CO2 eq)
R12	< 1995	10 890
R134a	1990 bis 2017	1 430
R1234yf	2011 ongoing	4
R744 (CO_2)	2016 ongoing	1

Source: (Zimmermann et.al. 2022)

For the year 2018 the study considered an average volume of 600 gram per air condition and a share of ELVs equipped with air condition of 75% in scenario A and 92.6% in scenario B. For the year 2018 the report refers to a share of 2 % R1234f from ELVs and 98% R134a. For the impact assessment below, we consider that 95 % of all coolants from exported used vehicles / ELVs and ELVs treated in non-ATFs in EU are released to air.

[299] According to source below: Assumption for the calculation below: 600 g per ELV with air conditioning; apparently this value is questioned as a relevant share of air conditioners might be broken and have lost their coolant anyhow, thus it cannot avoided / collected by better collection and depollution.

[300] Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, Publisher: Umweltbundesamt, Dessau, Germany, Publication in preparation

To assess the environmental impacts of the released R1234f the following assumptions apply

1) Vehicles placed on the market and share of new vehicles equipped with R134a.[301] The time series ends in 2021 as the application of R134a is phased out.

Table 3-74 Refrigerants in air conditioning of vehicles

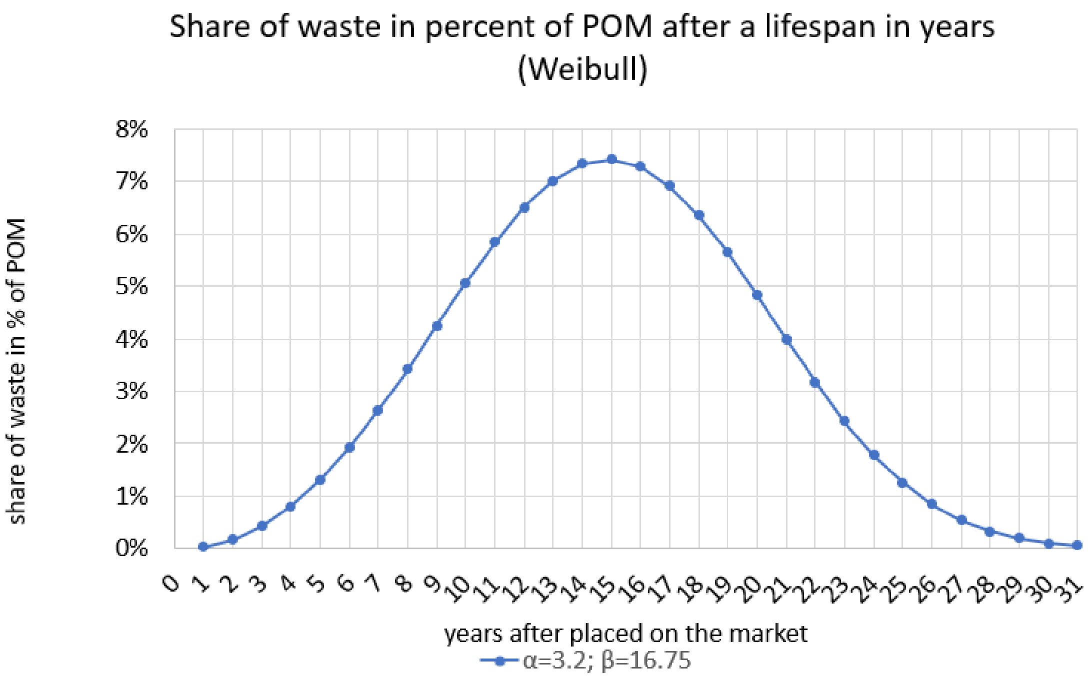
	total M1 + N1 PoM	Share R134a
1991	12,591,233	25.7%
1992	12,701,341	25.7%
1993	10,061,079	25.7%
1994	10,632,622	31.7%
1995	10,687,789	37.8%
1996	11,401,688	43.9%
1997	11,908,142	50.0%
1998	12,852,409	56.1%
1999	13,667,723	62.2%
2000	13,296,470	68.3%
2001	13,126,889	74.3%
2002	12,578,688	80.4%
2003	13,337,197	86.5%
2004	13,613,138	92.6%
2005	13,652,647	94.2%
2006	14,374,710	95.7%
2007	14,474,905	95.8%
2008	13,409,195	95.9%
2009	13,368,260	96.0%
2010	12,667,065	96.1%
2011	12,651,986	96.6%
2012	12,636,906	97.0%
2013	12,621,827	93.7%
2014	12,606,748	90.4%
2015	12,591,668	66.3%
2016	12,283,340	42.1%
2017	11,975,012	22.9%
2018	11,666,683	3.6%
2019	11,358,355	2.3%
2020	11,050,026	0.0%
2021	11,791,238	0.0%

Source: own calculations from different sources

[301] Source: Zimmermann, T.; Sander, K.; Memelink, R.; Knode, M.; Freier, M.; Porsch, L.; Schomerus, T.; Wilkes, S.; Flormann. P. (2022): Auswirkungen illegaler Altfahrzeugverwertung, [Impacts of illegal treatment of ELVs]. Texte 129/2022; Publisher: Umweltbundesamt, Dessau, Germany, November 2022; ISSN 1862-4804;

2) To assess the lifetime of the vehicle the same Weibull function as for the fleet model is applied. The Weibull parameters for the lifetime of a vehicle are displayed in the figure below.

Figure 3-38 Lifetime distribution of vehicles



3) Loss rate for the different destinations of the vehicle

As addressed in other sections (on "missing vehicles") we distinguish different locations where the vehicles become an end-of-life vehicle. We distinguish the following cases:

With

A) ELVs directed to ATFs and subsequently to shredders and reported by ATFs and MS

B) ELVs directed to ATFs and subsequently to shredders but not reported

C) ELVs directed to intra-EU non-ATFs and subsequently to shredders, not reported

D) Used Vehicles exported (extra EU) and reported accordingly

E) Used Vehicles exported (extra EU) but not reported

F) ELVs exported (extra EU), not reported

As outlined in the German report mentioned earlier[300] it is expected that a certain proportion of the coolant from the air-conditioning system of ELVs is not extracted in accordance with the regulations but is released uncontrolled to the air.

Transposing these assumptions to the 6 categories above, we consider for the calculation of the impact that the following share of coolant is not extracted in accordance with the regulations but is released uncontrolled to the air (=loss rate)

Destination where vehicles become ELVs and their loss rate

(A) ELVs directed to ATFs: 10%

(B) ELVs directed to ATFs but not reported: 70%

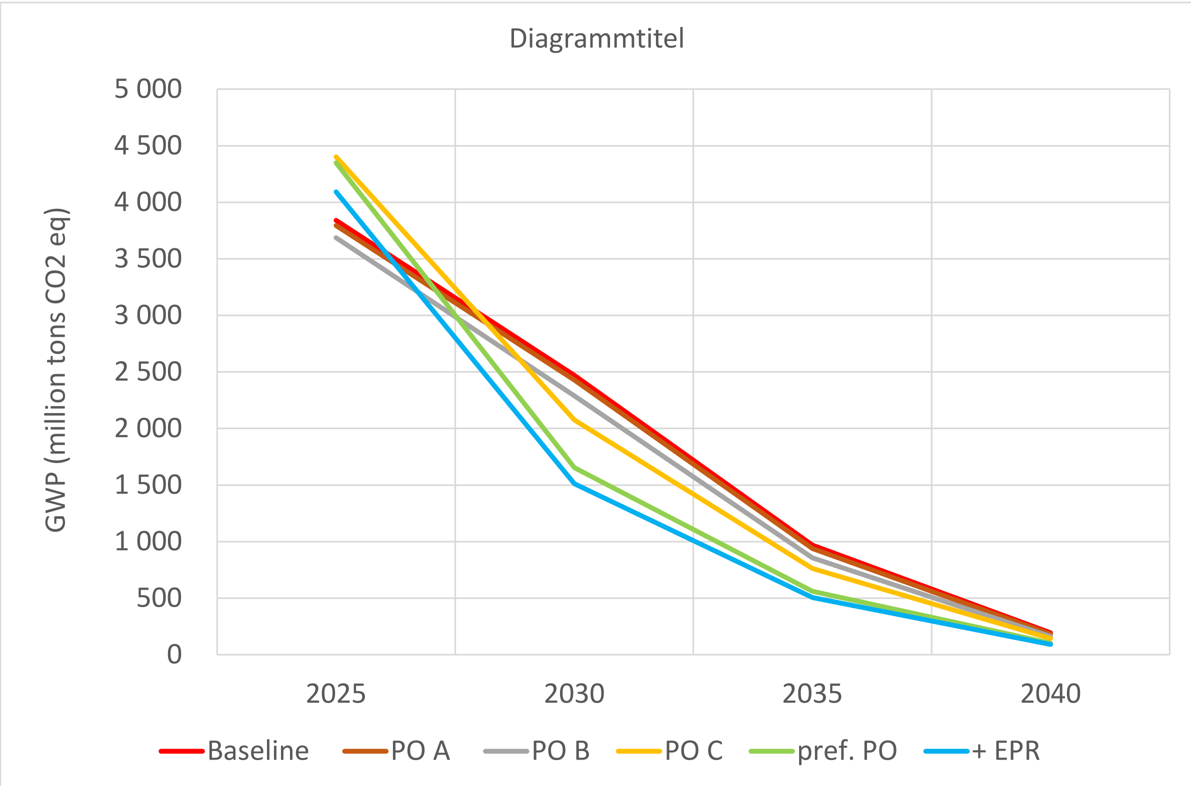
(C) ELVs directed to intra-EU non-ATFs : 70%

(D), (E) and (F): extra EU export: 100%

4) The above-mentioned data / assumptions are finally combined with the total numbers of ELVs directed to the 6 different destinations as calculated for the different scenarios under “missing vehicles”.

The results are displayed in the Figure 3-39 and Table 3-75.

Figure 3-39 GHG Emissions from coolants for the Policy Options



Source: own calculations

Table 3-75 GHG Emissions from coolants in million tons CO_2eq compared to baseline

	Baseline	PO A	PO B	PO C	pref. PO	+ EPR
2025	3 840	-46	-154	562	508	251
2030	2 469	-41	-181	-393	-816	-957
2035	969	-30	-113	-207	-408	-464
2040	194	-12	-31	-49	-91	-103

Source: own calculations

3.2.6.5 Less (hz) waste in receiving countries

If a used car is imported with a similar age as an ELV, e.g. 15 - 20 years, only a reduced service life remains and more waste is generated per kilometre driven, since the old vehicle must be replaced after another 10 years at the latest, for example. Thus, it can only be used for 10 years instead of 30 before it becomes an ELV. As a result, the number of ELVs generated for the same purpose is three times higher in the receiving country. If the import to that country is limited to 5 years old vehicles the vehicle can last longer and less waste is generated per km.

3.2.7 Social Impacts

3.2.7.1 Employment

According to Zimmermann et.al (2022), a shift of 363 000 ELV from the illegal to the legal sector plus a shift of 72 600 ELVs from illegal export to national ATF will cause between 300 to 1200 additional employment subject to social security contributions (Full Time Equivalents, FTE) so 1 to 3 FTEs per 1000 vehicles. For the calculation we consider 1.5 FTE per 1000 vehicles directed to the legal ATFs (category A and B). Whether the on-off effects of increased exports shortly in advance to the implementation (last chance to export old used vehicles without roadworthiness certificate) of the export limitation becomes effective is to be seen or if the employers bridge this period (as they are in parts involved in the export activities and can shift staff.

Table 3-76 Additional employees at ATFs in EU-27 for the Policy Options in million Euro compared to Baseline

	2025	2030	2035	2040
Baseline	14 494	14 696	15 261	16 411
3A	111	168	328	682
3B	390	726	1 195	1 756
3C	-818	1 471	2 062	2 582
pref. PO	-632	3 333	4 374	5 267
+EPR	-167	3 705	4 856	5 886

Source: own calculations

3.2.7.2 Less air pollutant in receiving countries

In the study (UNEP 2020) is a comprehensive section on the aspect of road safety which is below cited in full text:

"Vehicles are among the most rapidly growing sources of pollution and present a major public health risk particularly in regions where growing motorization is not coupled with effective vehicle emission regulations. Vehicles, both gasoline and diesel, emit significant quantities of nitrogen oxides, sulphur oxides, particles, carbon monoxide and hydrocarbon. This cocktail of pollutants and particles are responsible for strokes, chronic respiratory diseases, lung cancer, ischemic heart disease, diabetes, and other non-communicable diseases (HEI,2018). In 2012, the World Health Organisation International Agency for Research on Cancer classified diesel exhaust Particulate Matter (PM) as a Group 1 carcinogen (= causing cancer).

Reducing pollutants emissions from vehicles requires the use of clean vehicles technologies, especially exhaust after treatment technology. Catalytic converters that filter exhaust gasses from petrol vehicles can reduce pollutants by 90 per cent or more. And diesel particulate filters can filter more than 99 per cent of small particulates emitted by diesel vehicles.

Rising levels of carbon dioxide (CO2) in the atmosphere are causing global warming. The global vehicle fleet CO2 emissions are increasing faster than any other sector. Today CO2 emissions from the global fleet are responsible for about one quarter of all energy related CO2 emissions. This is set to go to one-third by 2050. Governments are now introducing strict regulations for the CO2 emissions of vehicles. Further, black carbon (BC), which comprises a substantial portion of small particulates is an important climate forcer, contributing significantly to short-term global warming. To control and reduce emissions from vehicles, countries put in place vehicle emission standards which define the quality of the mixture of exhaust gases at the tailpipe of vehicles. Automobile manufacturers are obliged to adhere to these standards in the territories where they are enforced as it forms part of a vehicle type approval process. Vehicle emission standards have been implemented since the early 90s. Many countries use the EU model of vehicle emission standards called the EURO standards. However, other countries have developed equivalent standards with varying implementation dates i.e. the US, China, Japan, and India have their own vehicles emissions standards comparable with the EURO standards. […] Each of the emission standard is matched by a specified fuel quality that progressively improves with every standard for both diesel and gasoline. The used vehicles imported in low- and middle-income countries often do not meet advanced vehicles emissions standards. This can be because countries import older vehicles that date back from before the introduction of vehicles emissions standards or only meet the earlier, older, standards such Euro 1 to 3. In addition, some used vehicles have damaged or failing emission-control systems. There is a market for old vehicles filters (to recycle precious metals used in these filters) and as a result some of the used vehicles have their filters removed, often illegally, before export. Repair or replacement of vehicle emissions filters can be costly and when these filters are found to be faulty exporters may opt to export the vehicles rather than to invest in fixing the filter. So, there is a share of used vehicles that do not have emissions controls technologies installed, in some cases these systems have failed, in others they have been illegally removed."

While it is not possible to calculate the impacts of the policy options on the emission and immission and early deaths due to strokes, chronic respiratory diseases, lung cancer, ischemic heart disease, diabetes, and other non-communicable diseases, it is obvious that a regulation for the functioning of the emission standard and more general the roadworthiness of the vehicles from the EU is strongly required.

The conclusion of Inger Andersen, the UNEP Executive Director is with this regard more than valid.

"Over the years, developed countries have increasingly exported their used vehicles to developing countries; because this largely happens unregulated, this has become the export of polluting vehicles. … Developed countries must stop exporting vehicles that fail environment and safety inspections and are no longer considered roadworthy in their own countries, while importing countries should introduce stronger quality standards"[302]

At the same time, it is obvious that receiving countries need to improve regulation and control of emission reduction and roadworthiness in their own territories as well. Only a joint effort of exporting and importing countries could succeed in improving the current unpleasant situation.

[302] https://news.un.org/en/story/2020/10/1076202

3.2.7.3 Better road safety equipment of vehicle fleet in receiving countries

In the study (UNEP 2020) is a comprehensive section on the aspect of road safety which is below cited in full text:

"Poor quality used vehicles do not only impact climate change and air quality but also compromise road safety, particularly in low- and middle-income countries which often have "weak" or "very weak" used vehicle regulatory rankings. Road crashes kill an estimated 1.25 million people each year and injure between 20-50 million more. It is the leading cause of death for young people aged 15-29 and the eighth leading cause of death globally (WHO,2018). Ninety per cent of these deaths occur in low and middle-income countries, despite these countries having just 54 per cent of the global vehicle fleet. Africa has the highest road traffic fatality rates with 246,000 deaths occurring each year and this number is projected to increase by 112 per cent, to 514,000 in 2030 (WHO, 2015). This contrasts with the projected reduction in fatalities in Asia-Pacific, Europe, and Central Asia (World Bank, 2014).

Road crashes impose a huge economic toll worldwide, totalling a loss of up to three per cent of the global GDP and up to five per cent of GDP for low and middle-income countries (WHO, 2015). Road traffic injuries are estimated to cost the global economy US$1.85 trillion each year (IRAP, 2015). Road injuries and losses in many countries are not mitigated by adequate insurance coverage or social safety nets, and families can be left with crippling health care costs and the loss of primary income earners. The highest burden of death and long-term disability is on adults in their prime working age. An estimated 12-70 million people are kept in poverty each year due to road traffic injuries and fatalities (iRAP, 2015).

Used vehicles often have compromised roadworthiness and crashworthiness in direct relation to their age, degree of wear and tear and technical design (Cosciug, Ciobanu & Benedek, 2017). The informal character of the used vehicle trade further perpetuates the import of vehicles with mechanical and safety defects. Although there are several factors that influence road safety and reliable data on road traffic injuries is scarce, there is increasing evidence on the links between road safety and used vehicles (Alloweg, Hayshi and Hirokazu 2011).

Studies have shown that passengers of older vehicles with greater wear (e.g. higher mileage, undisclosed crash damages) have an increased risk of injury compared to passengers of younger vehicles. A study by the Monash University Accident Research Centre based on data from New Zealand found that there was an overall increase in vehicle crash risk with increasing vehicle age. The increase in risk with each added year of vehicle age was estimated to be 7.8 per cent (Keall, et al., 2012). Many countries with "very weak" or "weak" used vehicle regulatory rankings such as Malawi, Nigeria, Zimbabwe, and Burundi also have a very high road traffic death rate. Liberia, which has the highest rate of road traffic deaths in the world (35.9/100 000), imports vehicles from the Monrovia port that are up to 10 years old.21 By contrast, Chad, which is one of the few African countries with a 'good' ranking has a 27.6/100 000 road traffic death rate and does not accept vehicles more than five years old."

While it is not possible to calculate the impacts of the policy options on the annual death occurring it is obvious that a regulation for the quality of the vehicles from the EU is strongly required. The conclusion of Inger Andersen, the UNEP Executive Director is with this regard more than valid.

"Over the years, developed countries have increasingly exported their used vehicles to developing countries; because this largely happens unregulated, this has become the export of polluting vehicles. … Developed countries must stop exporting vehicles that fail

environment and safety inspections and are no longer considered roadworthy in their own countries, while importing countries should introduce stronger quality standards"[303]

At the same time, it is obvious that receiving countries need to improve regulation and control of roadworthiness and road safety in their own territories as well. Only a joint effort of exporting and importing countries could succeed in improving the current unpleasant situation.

3.2.8 Comparison of the options

According to BRG Toolkit #11, "the comparison of options should always address the effectiveness, efficiency, and coherence of the options in relation to the specific objectives defined.

- The comparison of options should highlight key **economic, social and environmental** impacts, including when these are not part of the objectives.
- Their **costs** and **proportionality** to the issue at hand.
- The benefit/cost ratio, **cost-effectiveness** or net present value, if available;
- Their **coherence** with other EU policy objectives, including the Charter for fundamental rights, and with other policy initiatives and instruments (coherence) including the SDGs;

The comparison should clearly present trade-offs reflected in the choice of options and the likely uncertainty in the key findings and conclusions and how these might affect the choice of preferred option should be analysed.

Table 3-77 Summarising table for the comparison of the options

	Impact on	Option 3A	Option 3B	Option 3C
Economic	ATFs	Limited positive impacts on profits of ATFs (+ 93 m€ in 2040); main reason: no target. -/- to +	The target causes higher positive impacts on profits of ATFs, mobilising addition profits of 184 m€ in 2040 compared to the baseline, however not the full potential is mobilised. +	Positive impacts to ATFs (230 m€ in 2040), implementation and enforcement hampered by missing target nor strong incentives, the potential is not fully mobilised. +
	Shredders	Limited positive effects on profit (4 m€ in 2040) close to marginal. -/-	Limited positive effects on profit (9 m€ in 2040) close to marginal -/-	Limited positive effects on profit (16 m€ in 2040) near to marginal -/-
	(used) car dealers	No impact -/-	If fees might continue during a temporary deregistration this might cause 10€ per sold vehicle -	Caused by export limitations exporters might experience losses in profits of ~350 m€ in 2040 -
	SME	Currently ATFs are dominated by SMEs. The measures under 3A/B/C have no impacts on the size of the operators. -/- As in the context of stricter EPR rules more administrative structures are expected, we expect slide trend to larger operators but possibly not exceeding the definition of small size operators (<50 employees). -/-		

[303] https://news.un.org/en/story/2020/10/1076202

	Impact on	Option 3A	Option 3B	Option 3C
	OEMs / Producers	Under the Options 3A – 3C the OEMs are not involved -/- but if it comes to EPR (see below the combination with the preferred policy options cost occur for the OEMs / Producers		
	Consumers / Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal -/-		
	Costs / Burden for public administration in MS	Effectively no additional burdens only a few more reporting. -/-	One-off cost occurs for changes in registration procedures and monitoring and the like. However, compared to the current cost marginal. -/-	One-off cost occurs in registration and customs services procedures. The admin workflow shall be fully based on advance IT tools (no case-by-case investigations). If so, the cost will remain marginal. -/-
Environmental	More 2ndary resources available in EU	~0.19 million tons, compared to the baseline +	~0.58 million tons, compared to the baseline +	~1.1 million tons compared to the baseline +
Environmental	LCA credits for recycling in 2040	~0.7 m tons CO2 eq compared to the baseline +	~2.1 m tons CO2 eq compared to the baseline +	~4.2 m tons CO2 eq compared to the baseline +
Environmental	Losses of refrigerants	Currently emissions of 3.5 to 4.5 million tons CO2 eq considered from export of used vehicles and in illegal depollution in EU. Each additional ELV directed to ATFs will improve the situation. + The exact level is difficult to calculate as in parallel new coolants were introduced in 2017 with much lower Global Warming Potential.		
Environmental	Less (hz) waste in receiving countries of export	This impact is difficult to calculate, however longer use phase in the receiving countries will obviously reduce the waste volume in these countries. The Option 3C + is with this regard more effective than 3a and 3B -/-		
Social	Employment in 2040	+ ~550 FTE, close to marginal -/-	+ ~1 250 FTE, close to marginal, -/-	+ ~2 000 FTE, close to marginal, -/-
Social	Benefits for health and safety in receiving countries of export	This impact is difficult to calculate. However, UNEP is asking developed countries to export roadworthy vehicles only.		
Social		9% less used vehicles exported (of the current quality) +	24% less used vehicles exported (of the current quality) +	43% less used vehicles exported (of the current quality) ++
	Cost effectiveness	Costs and burdens are for all options marginal while some economic potential and environmental improvement can be mobilised but not fully realised +		
	Coherence	the measures under the Policy Options are designed to be coherent +		

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

3.2.9 Preferred Policy Option

As demonstrated in the Impact Assessment for the 3 Policy Option above, all three Policy Options have their specific shortcomings and as already mentioned in the study with emphasis on the end of life vehicles of unknown whereabouts with focus on missing vehicles (Mehlhart et al. 2017) and more recently in the context of the stakeholder involvement of this Impact Assessment in 2022, a combination is necessary of measures, addressing the different reasons for the missing vehicles as displayed below in Figure 3-40 under Number 1 to 4.

In consequence the measures as displayed in Table 3-78 are selected for the preferred policy option. Subsequently the impacts of the preferred Policy Option are assessed in detail.

Figure 3-40 Combination of measures is required to reduce the number of missing vehicles, in brackets the reference to the number of the measure)

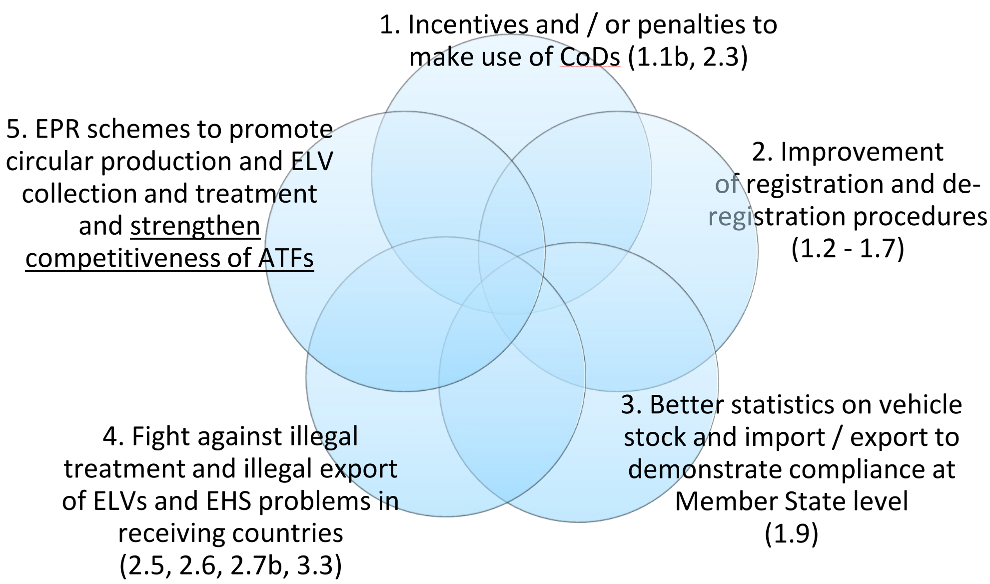


Table 3-78 Summarising table for the comparison of the options

The numbers refer to the chapter where the potential measures are described

Red italic letters = discarded measure
Grey box = not considered for the preferred Policy Option
blue box = preferred Policy Option

Objective 3.1: **Ensure that all ELVs are treated in accordance with the requirements of the ELV Directive**	**Objective 3.2:** **Reduce levels of illegal dismantling and illegal export of ELVs**	**Objective 3.3:** **Enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards**
1.1a Reporting and exchange of best practices on Incentives (Level A)	*2.1 Exchange on MS best practice*	3.1 Action at international level to support that roadworthiness (and others) become criteria for export of used vehicles.
1.1b MS to demonstrate implementation of Incentives (Level B)	*2.2 Voluntary campaigns on export*	*3.2. EU funding for enforcement*
1.2 Alignment of terms	2.3 Effective Deposit Refund Scheme (voluntary for MS)	3.3 Export restriction linked to roadworthiness; respect rules of receiving countries regards age and emission level
1.3 Definition of temporary deregistration	*2.4 EU wide Deposit Refund scheme*	
1.4 a Conclusive list of conditions for permanent cancellation of the registration *1	2.5 Better definition of ELVs	
1.4 b Management of temporary deregistration*1	2.6 Minimum requirements for sector inspections	
1.5 ATFs and shredders to check and report on ELVs / CoDs	2.7a MS are **encouraged** to establish fines and penalties for illegal activities of owners and operators of treatment plants	
1.6 interoperability of national registers *1	2.7b MS are **required** to establish fines and penalties for illegal activities of owners and operators of treatment plants	
1.7 VIN in customs declaration		
1.8 EU vehicle registration data base-system		
1.9 Reporting obligation on the current vehicle market		
1.10 collection target		

*1 might be in parts implemented by other EU Legislations under supervision of DG Move.

For the comfortable reading and less repetition, the detailed impacts for the preferred policy option are displayed together with the calculations for the Policy Options 3A/3B/3C. The overview of the impacts is displayed more blow

3.2.9.1 Interrelations with preferred option regards the EPR

Several of the measures addressing the implementation of the Extended Producer Responsibility (EPR) also have effects on the missing vehicle and are added to Figure 3-40 as Number 5.

Table 3-80 displays the detailed obligations for MS and Producers under the EPR regime. Most of them have a positive impact and might contribute to reduce the number of missing vehicles.

3.2.9.2 Overview of impacts of the preferred policy option and the interrelations with the preferred measures regards the regulation of the EPR

Table 3-79 Overview of impacts of the preferred policy option and the interrelations with the preferred measures regards the regulation of the EPR

	Impact on	Preferred Policy Option "Missing vehicles"	Preferred Policy Option "Missing vehicles" + EPR
Economic	ATFs	ATFs (~500 m€ in 2040; the potential is almost fully mobilised. ++	ATFs (~500 m€ in 2040; the potential is almost not fully mobilised. +++
	Shredders	Positive effects on profit ((~22 m€ in 2040) +	Positive effects on profit ((~26 m€ in 2040) +
	(used) car dealers	If fees continue during a temporary deregistration this might cause (~10€ per sold (used) vehicle -	
		Caused by export limitations exporters might experience losses in profits of ~470 m€ in 2040 --	Caused by export limitations exporters might experience losses in profits of ~550 m€ in 2040 --
	SME	Currently ATFs are dominated by SMEs. The preferred policy option has no impacts on the size of the operators. -/-	As in the context of stricter EPR rules more administrative structures are expected, we expect slide trend to larger operators but possibly not exceeding the definition of small size operators (<50 employees). -/-
	OEMs / Producers	OEMs are not involved in measures under the preferred policy option -/-	When stricter rules for EPR are applied, including compliance cost offsetting, cost occur for the OEMs / Producers (see separate assessments) --
	Consumers / Other	Economic impacts on other stakeholders can be compared to the total cost of vehicles and are considered as marginal -/-	
	Costs / Burden for public	One-off cost occurs in registration and customs services procedures. The admin workflow shall be fully based on advance IT tools (no case-by-case investigations of	

	Impact on	Preferred Policy Option "Missing vehicles"	Preferred Policy Option "Missing vehicles" + EPR
	administration in MS	public staff). If so, the cost will remain marginal. -/-	
Environmental	More 2ndary resources available in EU	~1.6 million tons, compared to the baseline ++	~1.8 million tons, compared to the baseline +++
Environmental	LCA credits for recycling in 2040	~5.8 million tons CO2 eq compared to the baseline ++	~6.7 million tons CO2 eq compared to the baseline +++
Environmental	Losses of refrigerants	Currently emissions of 3.5 to 4.5 million tons CO2 eq considered from export of used vehicles and in illegal depollution in EU. Each additional ELV directed to ATFs will improve the situation. ++ The exact level is difficult to calculate as in parallel new coolants were introduced in 2017 with much lower Global Warming Potential.	
Environmental	Less (hz) waste in receiving countries of export	This impact is difficult to calculate, however longer use phase in the receiving countries will obviously reduce the waste volume in these countries. ++	
Social	Employment in 2040	+ ~3 300 FTE +	+ ~3 800 FTE +
Social	Benefits for health and safety in receiving countries of export	This impact is difficult to calculate. However, UNEP is asking developed countries to export roadworthy vehicles only.	
Social		58% less used vehicles exported (of the current quality) ++	68% less used vehicles exported (of the current quality) +++
	Cost effectiveness	Costs and burdens are for all options marginal while some economic potential and environmental improvement can be mobilised but not fully realised +	
	Coherence	the measures under the Policy Options are designed to be coherent +	

Notes:

-/-: no impact

Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens

Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

(): brackets around symbols if costs, benefits etc. are only potentials or are uncertain. If the costs, benefits etc. is rather uncertain, a broader range is indicated: e.g. ++ to +++ or – to +

n.a.: not applicable

3.2.9.3 Interrelations with preferred option regards the circularity

In general, the interrelation with measures selected to improve design for circularity and measures selected to improved reuse and recycling will have additional positive impacts on the number of missing vehicles.

It is important to note that, if ATFs were subject to additional burdens related to circular economy without adequate compensation, this would clearly challenge the legal sector, and the illegal sector (which avoids unprofitable circular economy obligations) would be expected to increase. Such a combination (higher burden on ATFs / no compensation for compliance costs) would clearly jeopardize the goal of reducing the number of missing vehicles.

3.2.10 Reporting and monitoring requirements

This aspect is addressed in detail in the description of Measure 2.2.5.1.9 Improve reporting obligations on the current vehicle market and the ELVs on their territory. This measure is included in the preferred Policy Option.

3.3 Extended Producer Responsibility (EPR)

3.3.1 Identification of discarded measures

With the aim to have a shortlist of measures for further assessment, all measures are checked for feasibility and effectiveness. This step is not to be confused with the impact assessment itself and therefore does not include all categories of impact assessment (economic, social, and environmental).

The details of this check for feasibility and effectiveness are displayed in Section 6.8.1 in Annex I.

In result the following of the mentioned measures above are discarded. All others are shortlisted for the detailed assessment

2.3b Support / software interfaces to international notification system

4.1 Deposit Refund Schemes (DRF) manged by EPR scheme

The remaining measures are shortlisted

3.3.2 Overview of measures and relation to "missing vehicles" and "circularity"

Table 3-80 Measures in the context of the EPR regime with impact on the aspect of missing vehicles

Red italic letters = discarded measure
*Not considered for the preferred option, see **below** in section 3.3.4, Table 3-81*

1. Specification of general minimum requirements of Art 8/8a WFD: Obligations for the Member States	By when	Relevant for	
		missing vehicles	Circularity
1.1 Obligation for all MS to establish national EPR schemes	+2 ys	X	
1.2 MS to report on implementation and enforcement action regards Art 8/8a WFD and the specifications of EPR in the ELV Regulation	+ 3 ys, + 6 ys	X	
1.3 MS to establish an independent competent authority (clearing house) for monitoring, supervision, moderation of the EPR schemes and publication of rules / specifications for the implementation of the national EPR scheme	+2 ys	X	
2. Specification of general minimum requirements of Art 8/8a WFD: Obligations for Producers to cover cost for			
2.1 Collection of vehicles at holder's premises and abandoned vehicles free of charge for the last holder. → specification of WFD Art 8a(3) point (b)		*X*	
2.2 Awareness raising of last holder to deliver ELVs to ATFs	+2 ys	X	
2.3a Notification/ software / application / system for ELV, CoD and final cancellation of the registration to the national authorities and PROs	+ 2ys	X	
2.3b.Support / software interfaces to international notification system			
2.4 Rules, software and plausibility checks for the monitoring of material flows, with the aim to demonstrate compliance with RRR targets.	+ 2ys		X
2.5 Monitoring and reporting on illegal activities in the sector to responsible authorities (police and environmental inspectorate)	+ 2ys	X	
2.6. Training of staff from dismantling/recycling sector regards necessary technical skills (e.g. for management of EV); training on how to use reporting tools	+2ys		X
2.7 Provision of easy access to harmonised information for new registered vehicles (and for vehicles registered before the ELV regulation entered into force)	+2 ys (+4)		X
2.8 Fee modulation based on circularity features	+4 ys		X
2.9 Compliance cost offsetting	+4 ys	X	X
3. Advanced European EPR			
3.1 EPR schemes for intra EU trade (delegated / implementing act)	+2 ys	Not yet	Not yet
3.2 European EPR for the EU market (feasibility study)	+2 ys	Not yet	Not yet
4. Advance economic incentives			
4.1 Deposit Refund Schemes (DRF) manged by EPR scheme			
4.2 Green Public Procurement	+2 ys		X

3.3.3 Methodology

Extended Producer Responsibility Schemes are not an objective by itself compared to the reduction of "missing vehicles" or the more advanced "circularity". Instead, the EPR is developed to ensure that producers become responsible for the end-of-life management of their products. The legal requirements, as elaborated in the chapter "circularity" and "missing vehicles", define the compliance level for the end-of-life management and also include measures which are addressing the design for circularity (with the aim to reduce the end-of-pipe effort for the Producers). The definition of obligations for Member States and Producers are therefore inevitable measures (as the "compliance cost compensation") or supportive ones (as training or reporting) which should help the ATFs and shredder to operate most efficient.

Therefore, the economic, environmental and social impacts are not elaborated in the same methodology as for the other sectors as these impact relay more on the defined level of compliance under "circularity" and "missing vehicles" and less on the structure of the EPR.

Nevertheless, it is important to assess the direct (often administrative) effort connected to the obligations under the EPR for both Member States and Producers as done in this section.

Regards ATFs it is worth to note that, if the (increasing) compliance cost for circularity will be not compensated, it is most likely that more vehicles will be directed to illegal treatment, disregarding the requirement for circularity.

3.3.4 Administrative effort / burden of measures for different stakeholders

Table 3-81 Initial assessment of measures to identify discarded and short-listed measures

Measure	Effectiveness
1 Specification of general minimum requirements of Art 8/8a WFD: Obligations for the Member States	
1.1 Obligation for all MS to establish national EPR schemes	Administrative effort for Producers: Purely administrative effort to demonstrate a "zero cost network" is about 1 to 3 € per new vehicle placed on the market (see section 6.7.2 in Annex I)
1.2 MS to report on implementation and enforcement regards EPR	Two reports in year + 3 and +5 required. Limited one-off effort demonstrating implementation. No explicit data collection but focussing on legal implementation.
1.3 MS to establish an independent competent authority (clearing house)	Advanced MS and also smaller MS establish "cover authorities" for more than on EPR only. Under such roof the effort should be limited. However, when it comes to negotiation of compliance cost compensation or fee modulation it might easily need one FTE high experienced staff + 2 FTE support staff (at least for the larger countries, smaller countries might refer to lessons learned in larger ones.
2 Specification of general minimum requirements of Art 8/8a WFD: Obligations for Producers to cover cost for	

Measure	Effectiveness
2.1 Collection of vehicles at holder's premises and abandoned vehicles free of charge for the last holder. à specification of WFD Art 8a(3) point (b)	Free collection at last holders' premise might cause average cost of 38 € per new vehicle[304], free collection of abandoned ELVs might cast (because of the limited number) 1.4 € per new vehicle[305]. Such regulation might worsen the attitude of last holders to offer/ deliver the vehicles to collection points / ATFS and instead dump more ELVs illegally in the environment with the attitude that the costs are anyhow covered by the Producers. The current system that the last holder delivers the ELV to the collection point or ATF is considered sufficient (in combination with other measures addressing "missing vehicles". In consequence this measure is not considered for the preferred option.
2.2 Awareness raising of last holder to deliver ELVs to ATFs	While the task is important the budget is considered as limited with 0.04 per inhabitant and year, respectively <1 € per new and used car first registered [306]
2.3a Establishment of a notification system for ELV, CoD and final cancellation	Based on indication from Belgium (febelauto), Netherlands (ARN) and Ireland (ELVES) we conclude that the effort for this task is less than 1 € per new and used car first registered
2.3b.Support / software interfaces to international notification system	*Discarded before (see section 6.8.1 in Annex I)*
2.4 Monitoring of material flows and compliance with RRR targets	Based on indication from Belgium (febelauto), Netherlands (ARN) and Ireland (ELVES) we conclude that the effort for this task is between less than 1 € and in maximum 5 €per new and used car first registered
2.5 Monitoring and reporting on illegal activities in the sector	As the PRO / producer must activate a kind of whistle-blower functionality, forwarding the information to the responsible authorities only the effort to establish and maintain this functionality is marginal.
2.6 Training for staff of ATFs (and shredders)	Training for the handling of batteries up to 1 € per new vehicle sold[307]. Other training (less costly) to add.

[304] The obligation to collect all ELVs on demand at the premise of the last holder can cause high costs to the Producers. E.g. the service of a towing service for a distance of 30 km easily cost 100 to 200 € per vehicle. In average (considering one might assume cost of 100 € per ELV. Considering further that 4 million holders per year make use of this opportunity it will sum up to 400 m€ per year, respectively (with 10.9 million new vehicles in average) around 38 € per new vehicle.

[305] Considering that few end-of-life vehicles are left in the environment (e.g. 1% of 10 million) and the average cost of €150 per collection, this would amount to €15 million per year for the EU as a whole. With an average number of 10.9 million newly registered passenger cars in the EU for the period 2019-2021, this corresponds to about €1.4 per newly registered vehicle.

[306] See e.g. Ireland where the PRO conducts comprehensive effort for awareness raising: ELVES (2022): Annual report 2021: total expenditures 1.9 m€; 11% on advertising, marketing and PR = 0.2 m€: about 4 cent per inhabitant and year, respectively (considering 250 000 new and used cars registered for the first time in Ireland) less than 1 € per new and used car first registered

[307] Considering that each of the 12 000 ATFs will sooner or later need training in handling EV and traction batteries (high-voltage battery handling training), such training, including missed work time, easily costs ATFs more than €5,000, which would add up to € 60 million for the entire EU. Considering that such training needs to be completed in a period of 5 years and taking into account 63 million new passenger cars registered in the previous 5-year period (2017 – 2021) this would account for around 1 € per each new vehicle in that period. Other trainings to be added.

Measure	Effectiveness
2.7 Provision of easy access to harmonised information	The current cost (e.g. for IDIS) are estimated by ACEA at 3 m€/a[308]. The effort to provide easier accessible information in a harmonised manner (e.g. via photo of VIN number, directly accessible to the tablet) and more information (not obligatory dismantling only, but on valuable components for reuse, remanufacturing, recycling as well)[309] the effort might double but remain < 1 € per new vehicle registered.
2.8 Fee modulation	The fee modulation will not change the total fee. The effort for the stakeholders (producers, dismantlers, shredders) associated with the fee adjustment is the negotiation process to adjust the modulation (including studies to prove one's own position) and the effort for the (public) clearinghouse to moderate this process.
2.9 Compliance cost offsetting	The cost for the producers to offset compliance costs depends on the level of compliance requirements (see measures addressing circularity) and the revenues which can be achieved for the distinct compliance operation. More details giving an indication on the level of required cost compensation for the proposed measures are displayed in the circularity sections in which measures are analysed at the material level. See for example section 3.1.8.1.5 on “Comparison of scenarios for glass” or section 3.1.9.1.4 on “Comparison of scenarios for plastic”.
3. Advanced European EPR	
3.1 EPR schemes for intra EU trade (delegated / implementing act)	So far cost for EC occur for staff and study occur to prepare (if any) delegated / implementing act (~ € 350 000) in total.
3.2 European EPR for the EU market (feasibility study)	So far cost for EC occur for staff and study occur to prepare the feasibility study (~ 250 000) in total.
4. Advance economic incentives	
4.1 Deposit Refund Schemes (DRF) manged by EPR scheme	*Discarded before (see section 6.8.1 in Annex i)*
4.2 Green Public Procurement	Cost to EC to develop the criteria (~ 250 000) in total Cost for the Member States to comply with the advanced requirements: unknown: to be assessed in the process of the definition of the criteria above.

3.3.5 Conclusion

The producers / OEMs will be exposed by the introduction EPR schemes and new obligations under the EPR to additional costs:

- The obligation to collect ELV at the premise of the last holder might cost up to 40 € per new vehicle and might cause even adverse effects (more abandoned vehicles in the environment). Therefore, this measure is not included in the preferred policy option.

[308] COMMISSION SWD(2021) 60 final: Evaluation of Directive (EC) 2000/53 of 18 September 2000 on end-of-life vehicles

[309] Like the advance software of k.p.u.t.t gmbH: https://kaputt-gmbh.de

- The offsetting of compliance cost depends on the level of compliance requirements and the economic viability of these measures. The level is not discussed here but under the section “circularity”
- Other new obligation under EPR schemes might have marginal cost for each but might add up in total to 10- 20 € per new vehicle.

3.4 Extension of the vehicle categories in scope of the ELV Directive

The study focusses on expanding the scope of the ELV legislation to the following type-approved road vehicles[310]

- L vehicles, type approval regulation for the motor vehicles through REGULATION (EU) No 168/2013
- Type approval regulation through REGULATION (EU) No 2018/858 (M vehicles, N vehicles, and O vehicles.)

See reasons for not considering the inclusion of non-road vehicles under the scope of ELVD in section 6.1.1.

3.4.1 Baseline

The baseline scenario is that no provisions on vehicles which are not yet in scope of ELVD are added to the Directive (or related Directives, i.e., type approval and 3R Directive). As a consequence, in the baseline, no new vehicles enter the scope of any regulation. The share of vehicles not covered under the ELVD relates to nearly 17% by unit, ~ 47 million, or 33% by mass, 159 million tons (see Table 6-2).

Generally, it is assumed that the total number of all type-approved vehicles in Europe increases (fleet stock number, see Figure 2-32). Another general trend is expected: It is assumed that material variety increases whereas recyclability with given recycling technology decreases within type-approved vehicles. As for the waste management, it is assumed that parts from ELVs will be removed and sold for reuse and that vehicles will be recycled. However, though there are MS-specific regulation in place (see section 2.4.3.1), in the baseline, there are no EU-wide requirements on the waste management of such vehicles (e.g., depollution) nor on the conditions of such facilities as well as no targets such as mandatory removal of components or recycling targets. As depollution requirements do not exist, respective wastes such as fluids and oils may not be removed, affecting the share of the vehicles that can be recycled and the quality of obtained secondary materials. From the stakeholder interviews, it is understood that the reuse rate is higher for lorries, PTW and buses, however this may be performed more often by private owners (common for motorcycles) or by non-authorized facilities. Overall, it is expected that the design of vehicles currently not in scope of ELVD would not change substantially, e.g., no recycled content and no effort to increase recyclability. As well, no major achievements are expected at the end-of-life of these vehicles, e.g., higher reuse or recycling rates.

One will not be able to monitor certain indicators, e.g., current recycling rates and potential upcoming achievements in the end-of-life treatment of these vehicles due to missing monitoring scheme. This means, in the baseline, the particular contribution of vehicles which

[310] with the exemption of vehicle category T (agricultural tractors)

are not yet in scope of ELVD to the goals of set out the Circular Economy Action Plan and the European Green Deal cannot be identified.

However, as consumers are requesting more and more sustainable products, it can be assumed that there is a natural shift to more sustainable manufacturing practices. However, the particular way and dimension of sustainable practice is not foreseeable. Given the fact that often, when it comes to vehicles, recyclability and a reduction of carbon emissions during use phase are inevitable trade-offs, the contribution of a natural shift towards sustainable manufacturing practices to overall environmental, economic and social goals is unclear.

Material quantities from ELVs for baseline

In 2020, material quantities from waste lorries, buses and PTW (these sums do not include material from trailers[311]) added up to 822,0 - 3825,4 Mio tons in total. This splits into the materials as indicated in the table below.

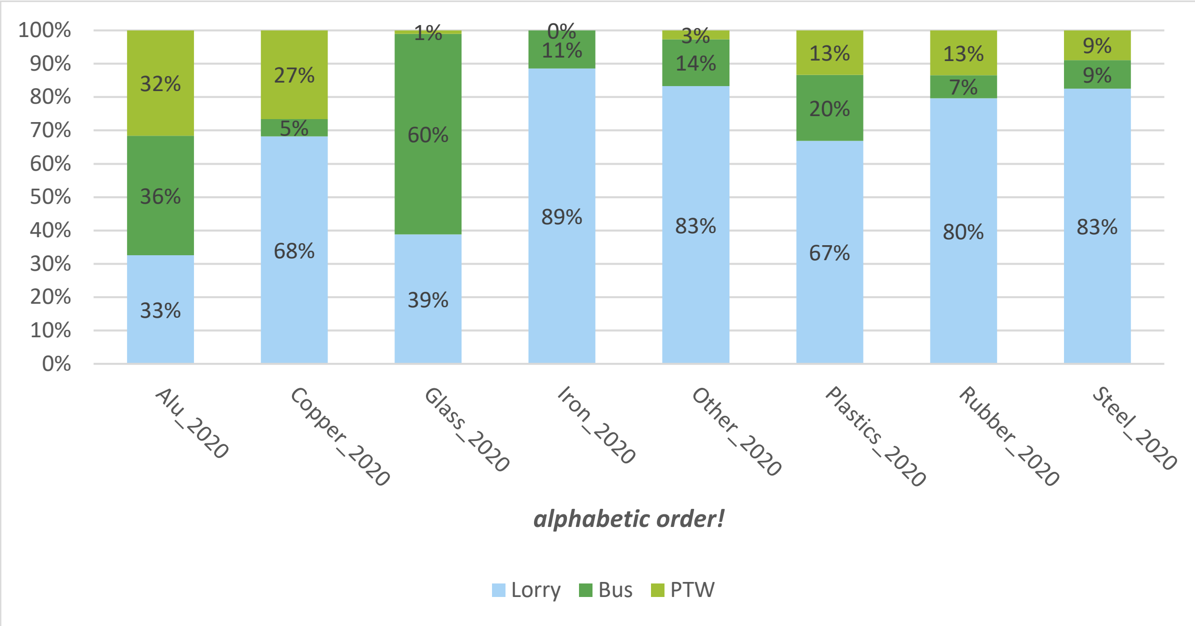
Table 3-82 Material quantities from waste lorries, buses and PTW in 2020

	Range_min	Range_max	%_lorry	%_bus	%_PTW
Alu_2020	136,3	293,1	33%	36%	32%
Copper_2020	7,0	21,9	68%	5%	27%
Glass_2020	13,5	17,7	39%	60%	1%
Iron_2020	61,8	362,9	89%	11%	0%
Other_2020	87,9	369,1	83%	14%	3%
Plastics_2020	99,4	237,8	67%	20%	13%
Rubber_2020	29,8	213,3	80%	7%	13%
Steel_2020	386,4	2309,7	83%	9%	9%

Source: Calculation based on expected ELVs and material compositions per vehicles.

[311] (Semi-)Tailers have a high variety in total weight and material composition. It was not possible to obtain generalized data or to assume their material composition due to the high variability in the vehicles. See examples for the weight of trailers in the Annex (6.1.1).

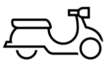
Figure 3-41 Shares that vehicle categories have in the total sum of material quantities from waste lorries, buses and PTW



Source: Data in Annex I, Table 6-13

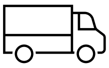
As can be seen from Figure 3-41, lorries have a share of ~80% in the total sum of steel, iron, rubber and other material from waste vehicles in 2020 with the rest split between buses and PTW, except for iron which cannot be found in PTW. At aluminium, copper, glass and plastics, one has to look individually. The share that lorries have in the total sum of aluminium and glass is below 40% each which is little compared to the other materials. In both of these material categories, buses have a high contribution to the total sum. For aluminium and copper, PTW have a higher share in the total sum compared to other materials.

Specifically for the vehicle categories it is assumed that:



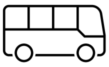
In the case of PTW, in the baseline it is expected that repair and reuse will be high (reuse quota for motorcycle dismantlers and hobbyists found to be 60-95% and ~10% at car dismantling facilities in Finland, SMOTO 2021), though a lot of regionally scattered, individual and small operators continue to exist that conduct the dismantling and repair. It is unclear, to which extend this covers illegal operations. Another aspect is that PTW will continue to be subject to different waste management laws in different countries and one will not be able to follow the developments, as the statistical indicator of the number of ELVs is not readily available, nor any EoL market overview.

In the baseline, recycling of PTW will continue to be low by amount of material (‘never seen one’, ACEM), and if PTW are recycled, it’s that car dismantlers have a PTW in their input stream. Costumers of PTW will expect to be able to repair their vehicles, this will drive the market to follow their high focus on reuse, reused parts and repair. It is expected that Design-for-recycling in particular does not play an important role in material choices for PTW. In the baseline the number of exported (or imported) used vehicles is not known, nor the number of ELVs. However, the general number of PTW is expected to increase given that stock statistics show an increase of ~ 2.0 Mio motorcycles (Eurostat is not consistent with L-type approval nomenclature).



Lorries are an important means of transport goods and will continue to be in Europe and other parts of the world. Small signs indicate that the extra EU export market of used lorries might turn around, i.e., either stagnating or declining (Typically, between ~157 000 used lorries were exported per year, this relates to ~74% of expected ELVs). The top 5 importing countries of used lorries are Jordan, Ukraine, Afghanistan, Serbia and Saudi Arabia. Export of new lorries is a viable business as well. Looking at the list of importing countries, low waste management infrastructure can be expected associated with negative environmental consequences, like the leakage of liquids or low-efficiency exhaust gas emissions in waste treatment plants.

In the baseline, it is continuously in the interest of the business-to-business customers using lorries in the transport of goods and leasing companies, that the fleets consist of long-lasting, robust vehicles that are easy to repair. On the other hand, seeing the high awareness of the climate impact of road vehicles, it is expected, to serve the demand of reduction of CO_2 emissions from road transport, that an increase of light-weight material can be seen. This will lower the CO_2 emission associated with the transport of goods. It is expected that Design-for-recycling in particular does not play an important role in material choices for lorries. One will not be able to follow the developments, as the statistical indicator of the number of ELVs is not available, nor any EoL market overview.



The number of buses that reach their EoL per year is little, compared to the other vehicles that are looked at. The amount of material in one vehicle is high as well as the material composition which is special compared to the other vehicles. It is expected that in the baseline not much changes in these respects. However, one will not be able to follow the developments, as the statistical indicator of the number of ELVs is not available, nor any EoL market overview. In relation to exports, numbers for buses do not show the same developments as other export figures, it is expected that the number of exports continue to be ~10.000 buses per year. Environmental problems associated with such exports cannot be quantified.

For trailers, the information on the whereabout and treatment at EoL is currently relatively unknown, except for the fact that around 75,000 (semi-)trailers are extra-EU-exported per year. Also, general materials used in trailers suggest that they are highly recyclable, sometimes being made from steel only. In the baseline, without intervention, there is no increase of knowledge expected.

To sum up, it is expected that in relation to the problems identified,

- The contribution to CE of a large share of vehicles cannot be quantified, nor described properly hindering the evaluation of the actual contribution to circularity of those vehicles and the decision for the need for and feasibility of EU action. The situation of the market, e.g., numbers of operators and their in- and output, is not known.
- Export of lorries, buses and trailers into countries with poor waste infrastructure continues, for PTW the situation will be unknown. Also, no information will be available on intra-EU transboundary shipment of vehicles not in scope of ELVD. Potential measures taken to tackle the same problems for M1 and N1 vehicles cannot be applied to other vehicles.
- For vehicles not in scope of ELVD, there will continue to be no legal incentive available to design vehicles for circularity.

- For vehicles not in scope of ELVD, there will be member states with individual regulations, e.g., (voluntary) EPR systems for PTW in France or the Netherlands, requirement to dismantle in ATFs in countries like Italy and Czech Republic, or general waste provisions like in Germany. But there will be MS as well without having rules for waste vehicles other tan M1 and N1, like Greece and Ireland.
- Inefficiencies between scopes of ELVD and 3R Directive identified (Annex II) continue to exist, and
- An increase of the total amount of vehicles is expected that adds to the above-mentioned problems.

3.4.2 Policy Options

3.4.2.1 Identification of discarded measures

None of the measures was discarded.

3.4.2.2 Policy Options Overview

The baseline as well as three options (A, B, C) represent the scenarios between which impacts shall be compared in the detailed assessment. To start, under options A, B and C, additional vehicles would be phased-into the legislation on end-of-life vehicles (and related legislation such as 3R Directive) through an extension of the scope, namely type-approved vehicles of categories Le1-Le7 (motorcycles), M2 and M3 (buses), N2 and N3 (lorries) and O1-O4 (trailer and semi-trailer)). To be precise, special purpose vehicles[312] and multi-stage build[313] vehicles of category M2,3, N2,3, and O (considered not relevant for L-type-approved vehicles) or such vehicles built in small series[314] are covered by the measures.

Setting legal requirements to solve the problem for M1 and N1 (chapters 2.1 & 0) supports the fact that the intervention should be through legislation and that ELV legislation is considered the right place, as problems for M1 and N1 apply to other types as well. Thus, except for the baseline, in all options the scope of the ELV legislation (and related legislation) shall be expanded. In the grouping of the measures to build the options proportionality was decided as the most important factor. In that respect, Option A is the extension of scope, however, only reporting and information requirements shall apply to new vehicles in scope. Option B is the extension of scope plus an additional set of basic requirements chosen as they target specific problems, e.g., collection, or are expected to be implemented easier than others at least for some vehicle categories, e.g., within the context of hazardous substances the restriction of the four heavy metals.[315] Finally, the scope extension with full applicability of all current and future ELVD is Option C to be able to reach maximum benefits but possibly leading to disproportionate effects.

[312] According to Regulation 2018/858/EU: 'special purpose vehicle' means a vehicle of category M, N or O having specific technical features that enable it to perform a function that requires special arrangements or equipment, and characterised through Regulation 2018/585/ EU, Annex 1, Part A, point 5.

[313] as referred to in Regulation 2018/858/EU. The multi-stage procedure (described in article 22(1) of the mentioned Regulation) is a procedure where "one or more approval authorities certify that […] an incomplete or completed type of vehicle satisfies the relevant administrative provisions and technical requirements" (Regulation 2018/858/EU, article 3(8)).

[314] In the Regulation 2018/858, the general type-approval regulation in force today, the annual limits per Member State are 500 units for O1, O2, and 250 for M1, M2, M3, N1, N2, N3, O3, O4. The EU-wide annual limits are 1 500 for M1, N1, N2, N3, and 0 for other categories.

[315] With regards to hazardous substances, Article 4(2) of the ELVD stipulates the restriction of the four heavy metals lead, mercury, cadmium or hexavalent chromium and the exemption mechanism for specific cases.

Figure 3-42 Scenarios addressing objective 1 addition to the baseline

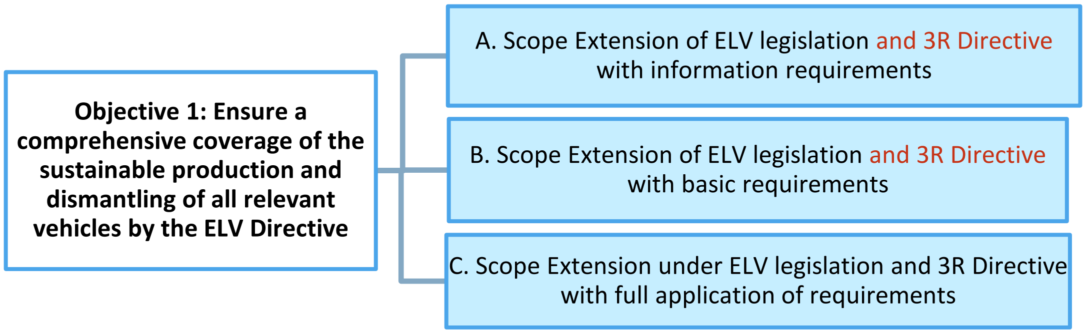
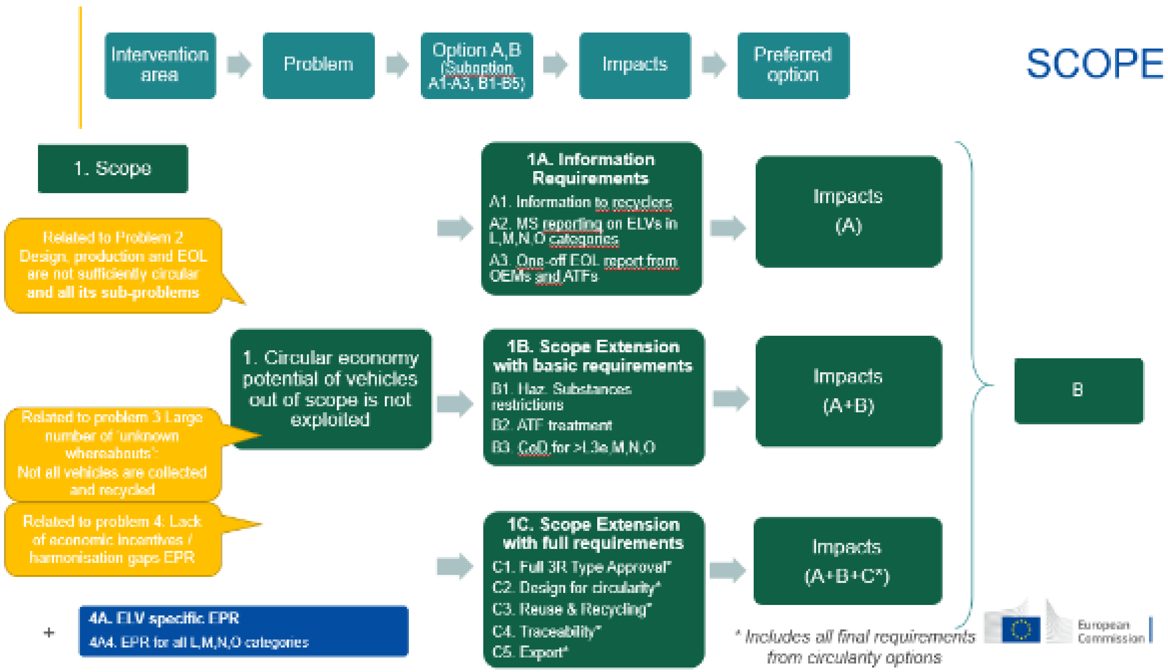


Figure 3-43 Overview of policy options



A. Scope Extension of ELV legislation and 3R Directive to all type-approved L, M, N and O vehicles with information requirements

The intention of this option is to gather more comprehensive information on the waste management of vehicles currently not in scope of ELVD before taking the decision on the ambition level and intensity of regulation. Most of the requirements shall not apply to new vehicles in scope immediately after their inclusion under the ELV future legislation. It thus stands to reason that the reporting for such vehicles would differ from passenger vehicle reporting for the transition period until potential additional end-of-life requirements, e.g., 3R type approval, may apply.

The Option A consists of the following measures:

No.	Title	Chapter	Effective by
1A1	Information to recyclers	2.4.5.1.1	*2025*
1A2	MS reporting (via Eurostat) on ELVs newly added to the scope by nr.	2.4.5.1.2	2025
1A3	OEM and ATF to EC: One-time reporting oblig. on EoL	2.4.5.1.3	2025

Mainly, measures in this policy option contribute to the solution of the problems described above by generating knowledge for building the basis for further decisions in relation the problems that cannot be solved by pure information requirements. Information to recyclers (A1) might be the first step in the direction of ATFs and recyclers being able to take decisions what to dismantle for reuse (in addition to what they dismantle for reuse already).

The vehicle types in scope of the new ELV legislation shall be defined based on the vehicle categories set out in Regulation (EU) 2018/858 and Regulation (EU) 2013/168. It is expected that differentiating between various types of powered two or three wheeled vehicles, i.e., including Le3-Le7 but excluding Le1 (light two-wheel powered vehicle) and Le2 (three-wheel moped), or different rules for lorries or semi-trailer tractors (both category N) would increase the complexity for end-of-life treatment facilities, e.g., for sorting what is in scope and what is not as a basis for reporting.

Based on a report from the European Commission, within four years of entry into force of the legislative framework for ELVs the Commission shall make a proposal on which and how requirements of those politically agreed on for the ELV legislation shall be applied to vehicles new in the scope of ELV legislation and related legislation[316].

B. Scope Extension of ELV legislation and 3R Directive to all type-approved L, M, N and O vehicles with basic requirements

To come to terms with the limited information on the end-of-life treatment of such vehicles at the on-set of this option, only selected obligations would apply to new vehicles in scope. However, some measures seem proportionate to address the above-mentioned problems: Measures in this option have been in place for M1 and N1 type approved vehicles since ELVD came into force – though there might be fine tuning for one or the other, generally, all of the measures B1-B3 (below) can be attributed to the catalogue of measures under the objectives to improve collection/traceability and circularity.

On top of the options in policy option A, the following provisions are added to all vehicles in scope of the future legislative framework of end-of-life vehicles, however, providing new vehicles in scope a transition period until they must comply with the provisions:

No.	Title	Chapter	Effective by
1B1	Haz. Substances restrictions	2.4.5.1.4	*2025*
1B2	ATF treatment (circularity)	2.4.5.1.5	*2025**
1B3	CoD (traceability)	2.4.5.1.6	*2025***

(*) based on the understanding that various MS have such requirements in place already.
(**) based on the understanding that the concept of CoDs exists for M1 and N1 vehicles.

[316] Depending on the future legislative setup, i.e., the decision of merging ELVD and 3R Directive or not, the scope of the 3R Directive would need to be amended too, as well as the type-approval Regulations for M, N, O (2018/858) and L (168/2013), making/introducing the link to the 3R legislative act.

It is suggested that all measures in policy option A are added to this option together with measures B1-B3, as they are serving various purposes that B1-B3 cannot or can only partially cover. To start with A1, this is related to B1, i.e., recyclers will need information specifically on the location of component with contents of hazardous substances. Also, measure A2 is connected to B3. In this policy option, a combination of these measures might be envisaged. Then, A3 is independent of the measures B1-B3, but is serving to provide enough information to be able to conclude on additional measures under policy option C.

In order for this measure to be effective and not contra-productive, the legal text must clearly differentiate between provisions applying to vehicles of type M1 & N1 (current scope) and new vehicles in scope. For example, this could be done similarly to Art. 3(5) of the current ELV legislation which is specifically referring to the articles which apply to three-wheel motor vehicles. Alternatively, if the Directive is turned into a Regulation, it could start with provisions that apply to all vehicles and then include separate chapters for each vehicle type.

C. Scope Extension under ELVD and 3R Directive with full application of requirements

This measure is similar to Option B in so far that it aims to realise the potentials for circularity related L, M, N and O category vehicles by including new types of vehicles in scope. It is however more ambitious as through the early application of all provisions. It aims to generate a positive environmental impact which was acknowledged to be the overarching aim by stakeholders in the OPC.

The Option C builds on option A+B[317] and adds the following measures:

No.	Title	Chapter	Effective by
1C1	Extension of scope of the 3R Directive and 3R Type Approval requirements to include conformity of production and market surveillance for all types of vehicles	2.4.5.1.7	*2030*
1C2	Design for Circularity	2.4.5.1.8	*2027*
1C3	Reuse & Recycling	2.4.5.1.9	*2030*
1C4	Advanced traceability	2.4.5.1.10	*2030*
1C5	Export restrictions	2.4.5.1.11	*2027*

The policy option 1C is supported by the following measure addressed in the context of Extended Producer Responsibility (EPR) too.

No.	Title	Chapter	Effective by
1C6	EPR for all vehicles	2.4.5.1.12	*2030*

As can be seen from the list, measures in this option target all of the above-mentioned problems:

- As a whole, this intervention harmonizes the EoL rules for vehicles not in scope of ELVD. Once in place, additional vehicles placed on the market, i.e., the growing trend in the number of vehicles in stock, does not pose a problem as such anymore.

[317] Though, A3 is only reasonable if C1 and C3 are implemented with an offset in time, and for B3, overlaps of C4 and C5 might be checked

- Measures A1, B1+B2, and C2+C3+C6 represent the bundle of measures addressing circularity and EPR as being the supporting mechanism for circularity.
- Measures A2, B3, and C4+5 addressing the aspects of missing traceability and high exports.
- Measures C1 addresses the aspect of the current inconsistency between 3R Directive and ELVD and provides a legal incentive for Design-related measures.

In detail, this measure aims at the inclusion of the vehicles of types Le1-Le7 (motorcycles), M2 and M3 (buses), N2 and N3 (lorries) and O1-O4 (trailer and semi-trailer) with obligations which are as ambitious as those of light duty vehicles (passenger cars).

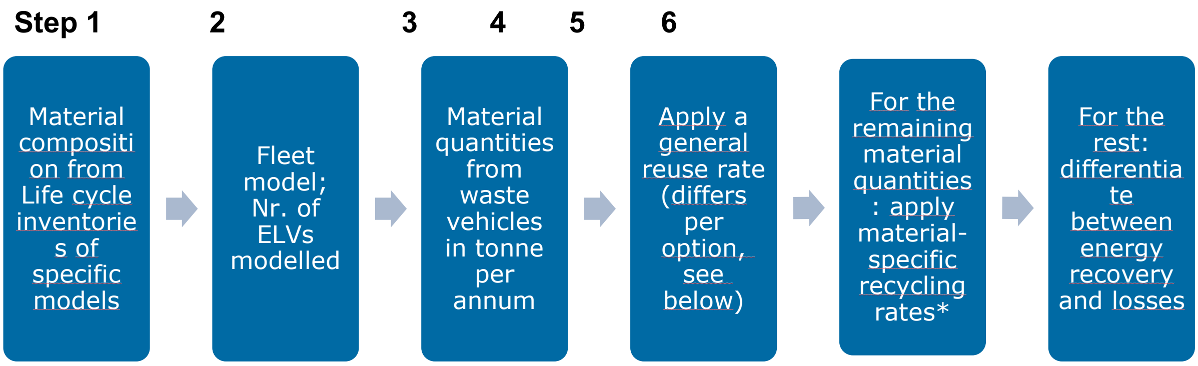
It is suggested that A1 (Information to recyclers) and A2 (MS reporting (via Eurostat) on ELVs newly added to the scope by number) as well as B1 (Hazardous substances), B2 (ATF requirement) and B3 (introduction of CoD) are added to this option as they are serving various purposes that C1-C6 cannot or can only partially cover. The reasoning is that A1 and B1 which are related to each other and B2 are not addressed in C1-C6. Measure A2 is connected to B3 and together they might have overlaps with C4 and/or C5. For measure A3 (OEM and ATF to EC: One-time reporting oblig. on EoL), addition to this option only has an added value if the provision not coming into force at the same time – but earlier – than C1 and C3.

3.4.3 Methodology & overview of assumptions

Methodological approach for quantification of material streams

In addition to the general model description in chapter 6.9, the following figure provides a visualisation of calculation steps.

Figure 3-44 Methodological approach for quantification of material streams



(*) recycling rates assumed relate to 'recycling after shredding'.

The main raw data can be found in the Annex I to this report (step 1: see tables in 6.1.3; step 2: see 'description of the model' see section 6.9 and assessment of robustness and completeness of fleet data see section 6.1.1; step 3: Table 3-83). Steps 4 to 6 can be summarised as follows: Assumed reuse, recycling and loss rates per Option are displayed in Table 3-84. The only reference to reuse rates (explicit numbers), is the survey of Finish Motorcycle Association (SMOTO 2021) among Finish motorcycle stakeholders: Between 60 and 70% at Finish operators specialized in the handling of PTW, 95% for 'hobbyists' and 10% at operators specialized in car handling. Though, car recyclers play a minor role in PTW dismantling and recycling according to ACEM (2021), the reported reuse rates differ greatly from each other. It is unclear to which extent the data is representative for reuse rates for PTW in the European Union as a whole. As mentioned earlier in this report, no figures are available as to the reuse rates for lorries, buses and trailers. Reuse rates were assumed to be 30% (Baseline, Option A & B) and two variants were considered in Option C: 40% and

70%. These reuse rates were put up for discussion at the ELV stakeholder workshop in March 2022, however, stakeholders neither supported nor rejected the assumed reuse rates referring to the fact that 'such data is not available' (preferred answer to respective Slido question in the ELV stakeholder workshop).

Table 3-83 Option-related assumptions for the modelling

		Baseline	Option A	Option B	Option C
Reference year		2022	2030	2030	2030
Reuse rate[318]		30%	30%	30%	40%/70%
Recycling rates*	Steel	99%	99%	99%	99%
	Aluminium	85%	85%	85%	90%
	Iron	99%	99%	99%	99%
	Copper	85%	85%	85%	90%
	Glass	0%	0%	0%	45%
	Plastic	30%	30%	30%	35%
	Misc.	0%	0%	0%	0%
	rubber	0%	0%	0%	0%
Recovery rates*		13-21%	13-21%	15-21%	15-19 %
Loss rates		2-5%	2-5%	2-5%	0,5-2%

(*) depend on the material, assumptions are the same as for circularity measures (see description of the model, Annex I chapter 6.9)

Assessing the impacts of mandatory provisions for different types of vehicles, even if qualitatively, will have high uncertainties in cases where the details of the provisions for M1 and N1 vehicles have not been decided. As a consequence and seeing as the end-of-life treatment of new vehicles in scope is not as well understood as for passenger cars, it is suggested to grant a transition period of three to five years from entry into force onwards so that the market can transition smoothly towards the fulfilment of all provisions.

Quantification of impacts (if not indicated in the respective section)

- Benefits from increase of circularity: see 'description of the model' in section 6.10.
- Administrative cost model according to European Commission (2015)

It is important to be aware that the assumptions were made for the purpose of estimating magnitudes and are far from being accurate "model" forecasts. The shifts considered for calculating the impacts of the policy options are more of an expert estimate than a correct calculation.

3.4.4 Analysis

Here, the question shall be answered, what are the likely impacts of each of the short-listed options. Sub-chapter 3.4.4.1 shows selected impact categories.

[318] It is uncertain which components are being reused. We apply a general reuse rate that is identical for all materials in the vehicle. In practice, it is possible that components of one material are more often reused than components of another material resulting in different reuse rates per material. This cannot be displayed due to lack of data of the components (and their material composition) that are being reused.

3.4.4.1 Selection of potential impacts and list of affected stakeholders

According BRG Tool #18 the impact assessment potential impacts "should be screened objectively in order to identify all potentially important impacts – considering both positive/negative, direct/indirect, intended/unintended as well as short/long-term effects". Some of the categories are cross-cutting and can be analysed from different angles (for example employment, income distribution, impacts on consumers or environmental impacts). A (well-justified) choice should then be made on the most significant impacts to be retained for a more thorough analysis.

The full list of key impacts to screen is displayed in section 6.6.2.5 in Annex I. The total list of selected impacts for this sub-part of the impact assessment can be found in 6.2.1 in Annex I, however, find an attribution of impacts to measures and affected stakeholders in the following table.

Expected affected stakeholder groups are:

- Vehicle owners
- Producers/manufactures (and in some cases their supply) incl. SMEs
- EoL stakeholders[319] (garages, ATFs/non-authorised dismantlers, shredders, used car dealers, industries involved in processing/recycling of waste arising from ELVs treated in the EU), incl. SMEs
- For individual measures (mainly under policy option C): Customs Services, National vehicle registers, insurances
- Public authorities on various levels (MS & EU)

ACEM (2021) report a high rate of SMEs among the PTW manufacturers: '9 small enterprises cover 20% of the market, medium (=4) cover 30% of the market, three big producers cover the other half.' among the EoL stakeholders a high SME rate is expected generally.

Table 3-84 Measures, their relevant impact categories, vehicles specifics in the measures and affected stakeholder

<table>
<tr><th>Measure</th><th>Name</th><th>Relevant impact category</th><th>Vehicle specifics</th><th>Affected stakeholder</th></tr>
<tr><td>A1</td><td>Info to recycler</td><td rowspan="3">• Administrative burden
• Costs for OEM and ATFs for Reporting and providing information
• Benefits through reporting</td><td>Independent</td><td>Manufacturers</td></tr>
<tr><td>A2</td><td>MS reporting on ELV</td><td>MS specific, highest effort expected for PTW</td><td>MS authority
ATFs/dismantlers</td></tr>
<tr><td>A3</td><td>One-off reporting on EoL</td><td>MS specific, highest effort expected for PTW</td><td>MS
Manufacturers
EoL stakeholder</td></tr>
<tr><td>B1</td><td>Haz subst</td><td>• Administrative burden for authorities</td><td>Independent, but individual for PTW</td><td>Manufacturers and their suppliers</td></tr>
</table>

[319] Some of the measures can affect the total EoL management chain, some measures might only affect one of the groups within the EoL stakeholders, if so, this shall be indicated explicit.

Measure	Name	Relevant impact category	Vehicle specifics	Affected stakeholder
		• Administrative burden for business operators: supply chain management • Env benefits from heavy metal restrictions • Revenues for dismantlers and recyclers from recycling • Health effects (?) • Costs for OEMs for change of design	compared to other vehicles	EoL stakeholders
B2	ATF	• Environmental benefits from formalised treatment • Burden for ATF through authorization • Administrative burden • Distribution effect (economic): externalized costs will be internalized • Distribution effect: informal jobs to be formalized	MS specific, highest effort expected for PTW	Vehicle owners ATFs/dismantlers
B3	CoD	• Administrative burden • Additional burden for consumers in managing an ELV	MS specific, highest effort expected for PTW	Vehicle owners ATFs/dismantlers
C1	3R TA	• Administrative burden for authorities • Administrative burden for business operators • Costs for OEMs for change of design • Competition effects	Independent	Authorities Manufacturers
C2	D4CE	• Costs for OEMs for change of design • Competition effects • Developments in the internal market, incl. innovation	Independent	Authorities Manufacturers and their suppliers
C3	3R targets	• Administrative burden • Environmental benefits from increase of reuse and recycling • Revenues for dismantlers from spare parts • Revenues for dismantlers and recyclers from recycling • Costs for OEMs for change of design	Independent but individual per vehicle category	Authorities Manufacturers EoL Stakeholder
C4	Traceability	• Administrative burden • Distribution effect: informal jobs to be formalized	Independent	Authorities Vehicle owners EoL stakeholders Illegal operators

Measure	Name	Relevant impact category	Vehicle specifics	Affected stakeholder
		• Additional burden for consumers in managing an ELV		
C5	Export	• Administrative burden • Revenues from exported used lorries <-> lost revenues from missing vehicles and exported used lorries • Distribution effect: informal jobs to be formalized • Developments in the internal market, incl. innovation	Independent, however, unknown for PTW	Authorities EoL stakeholders Illegal operators
C6	EPR	• Costs for OEMs for change of design • Administrative burden for business operators to set up system • Distribution effect (economic): EPR	Independent	Authorities Manufactures EoL stakeholders

In the next section selected impacts are assessed. The structure the assessment was prepared according to the impact categories: From Table 3-84 one can read under which impact categories the respective measures are treated; if possible, a differentiation between different vehicle categories is made in the description or calculation of the impacts.

According to Better Regulation Guidelines, in an impact assessment, all relevant impacts should be assessed qualitatively and quantitatively whenever possible. In this case, as for the other chapters, the quantification of impacts was initially not possible for a number of impact categories, especially where costs are concerned. Efforts were made in the study to obtain quantitative data however quantifiable data was not always available on time. A further analysis of the economic impacts of the scope extension is however provided in Annex I, chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** to provide further clarity. From the expected impacts, there are those that can be quantified and others where quantification is not possible, they will be qualitatively described and assessed within the next chapters. The quantitative analysis focusses on the types and dimensions of the materials retrieved from ELVs other than M1 and N1. Based on this, it is possible to quantify environmental impacts in the baseline (the year 2022) and for future reuse-recycling-recovery scenarios (2030[320]).

Equally, the types and dimensions of materials retrieved allow quantifying the economic benefit that recyclers can generate from the sale of the secondary raw materials. For various other impact indicators, a quantification is not possible; where applicable, this is explained in relation to the impact indicator below.

[320] The year was chosen because it is expected that after the legislative process and possible transition periods, the measures could apply to new vehicles from 2030 onwards.

3.4.4.2 Environmental impacts

Currently, negative impacts on the environment are associated with some of the identified problems: Because the potential to contribute to the CE of a large share of vehicles is not exploited yet, because there is no incentive to design for circularity, and because of the expected increase of the total amount of vehicles, vehicles designed and treated at EoL currently may cause environmental harm. This is waste that is not treated in line with higher levels of the waste hierarchy. I.e., more resources are needed than necessary, e.g., if a spare part is a new one instead of a refurbished one. Also, it is about the amount of hazardous waste from end-of-life vehicles as well as emissions of exhaust gases or leaking liquids in treatment facilities that do not meet certain environmental standards – in the EU and outside if used vehicles are exported. The different possibility of the policy options to prevent this harm shall be evaluated in the following.

From measures, B1 (heavy metal restrictions), B2 (ATF), C3 (3R targets), C4 (traceability), C5 (export restrictions) and partly A1 (information for waste management operators), environmental benefits are expected to be levered directly. For some measures, A2, A3, B3, C1, C2, and C6 explicitly, no direct environmental benefits are expected but these measures represent a means for that the measures with direct environmental benefits may work more effectively: The information requirement on EoL (A3) and 3R type-approval, Design for circularity and EPR (measures C1, C2 and C6) support the benefits from increase of circularity. Reporting of ELVs (A2), certificates of destruction (B3) as well as an EPR (C6) contribute to lesser environmental burden from missing vehicles and export, i.e., to environmental benefits from formalised treatment (see below).

3.4.4.2.1 Material quantities from ELVs for options A, B and C

In a first place, the measures proposed to achieve the objective in relation to circularity impact the amount of materials to be retrieved from end-of-life vehicles by formalized waste management under EU-wide rules. Already today, materials are retrieved from ELV that are not in scope of ELVD, but the dimensions are unclear. Materials expected from waste PTW, lorries and buses in 2020 are displayed above (baseline description). In 2030, material quantities from waste lorries, busses and PTW are expected to add to 984,12 - 4673,70 Million tons of material (calculation based on expected ELVs and material compositions per vehicles). These are split between the different materials as indicated in the table below.

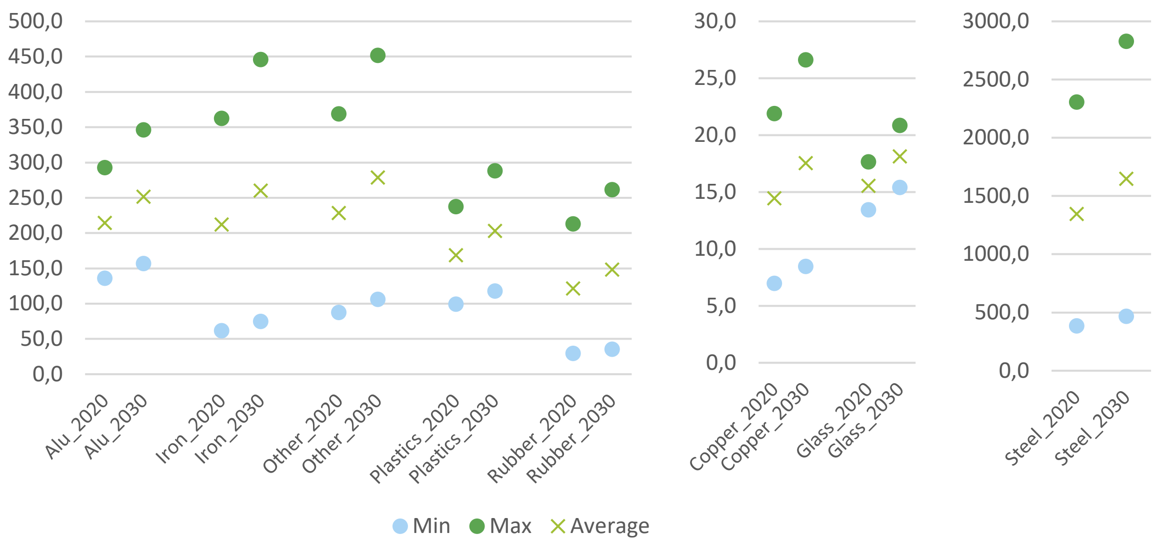
Table 3-85 Material quantities from waste lorries, buses and PTW in 2030 in mio tons

	Range_min [mio tons]	Range_max [mio tons]	%_lorry	%_bus	%_PTW	Plus compared to 2020 absolute (relative)
Alu_2030	157,2	346,4	34%	34%	31%	37,1 (117%)
Copper_2030	8,5	26,6	70%	5%	25%	3,1 (121%)
Glass_2030	15,4	20,9	41%	58%	1%	2,6 (117%)
Iron_2030	75,1	446,0	90%	10%	0%	48,2 (123%)
Other_2030	106,1	452,2	85%	13%	3%	50,7 (122%)
Plastics_2030	118,3	288,6	69%	18%	13%	34,8 (121%)
Rubber_2030	35,5	261,6	81%	6%	13%	27,0 (122%)
Steel_2030	468,0	2831,4	84%	8%	8%	301,7 (122%)

Source: calculation based on expected ELVs in 2030 and material compositions per vehicles for which data can be found in the Annex I.

Percentages per vehicle are the same than in the baseline with few individual variances, details in Annex I, Table 6-13. The data is shown in Figure 3-45 and the Annex, Table 6-12.

Figure 3-45 Expected material quantities from PTW, buses and lorries arriving at EoL in 2019 and 2030 in million tons



Source: Data in Table 6-12.

The expected amounts of materials are the same in **all options**. However, the question is how these material streams are being influenced in relation to their direction (e.g., export) or at what level of the waste hierarchy they are treated (e.g., reused or recycled versus recovered). A measurable impact on these indicators is only expected to be observed in relation to **Option C** (see more explanations in the course of the analysis) The measures C2 (design for circularity) and C3 (3R targets) bundle measures to be taken in relation to circularity and offer many different possibilities for regulation, ranging from circularity measures chosen by industry (pledges, strategies), to (further) information requirements e.g., on material composition or on novel materials for which there are currently no recycling facilities, and to clear targets for recycled content of certain materials, or 3R targets. In general, from well-tailored, ambitious but achievable targets in relation to circularity, it is expected that more waste is prevented, e.g., the longevity of vehicles increases, and that an increase in the use of spare parts in repairs and new vehicles, an increase of the general turn-over for used and new spare parts, and increased amounts and higher quality of recycled material can be observed. As a result, recovered materials and losses would decrease. Because the underlying conditions, i.e., the number of ELVs, in some cases the material composition of vehicles, the current recycled material quantities, and the current reuse rate are unknown, it is not possible to decide what exactly "well-tailored, ambitious but achievable targets" are, and to assess the concrete benefits and costs of changes in the above-mentioned indicators. Also, effects of the circularity measures on M1 and N1 vehicles have not been observed, but only calculated and described (see above).

3.4.4.2.2 Benefits from increase of circularity (reuse and recycling)

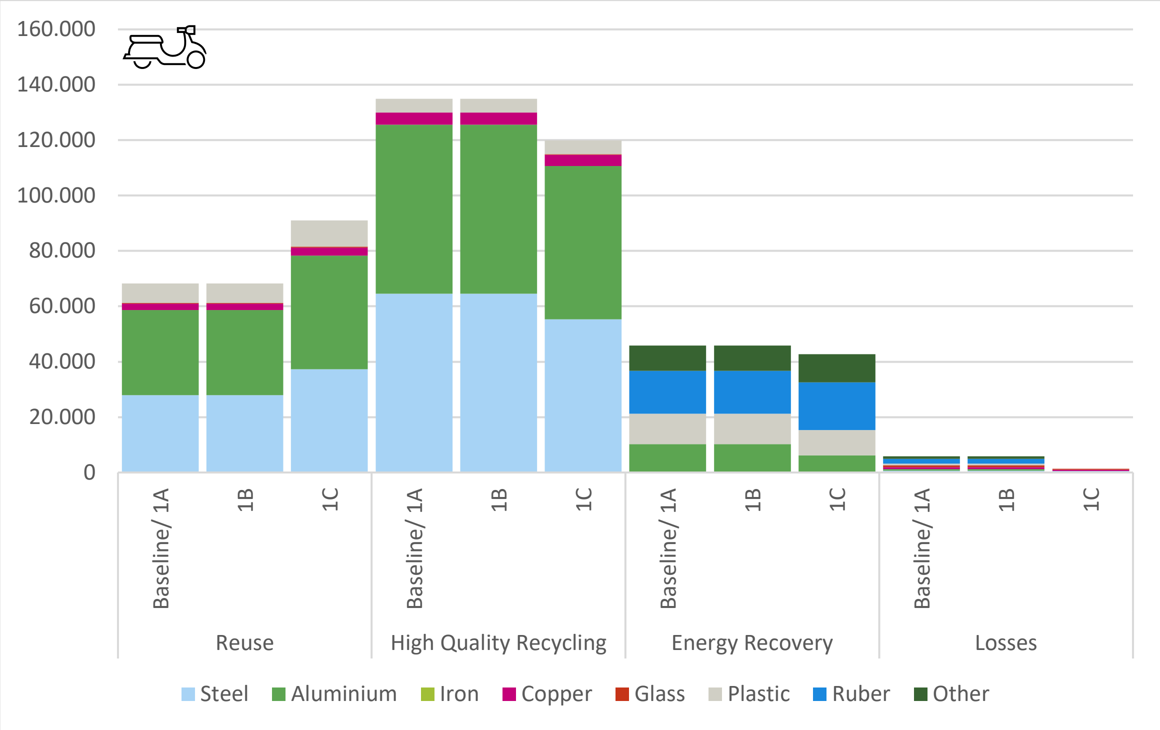
The impact category of environmental benefits resulting from an increase of reuse and recycling are expected to unfold their potential only in Option C (in relation to measures C2-3). Measures in Options A and B (A1 and B1-2 specifically) only indirectly result in potentially higher reuse quota or increases in the amounts or quality of recycling which might not be monitorable, e.g., for the scope extension with information requirements (A1-3), a slight increase of reuse and recycling might be the result due to the awareness of stakeholders for ELVs other than M1 and N1. In that sense, assumptions have been made as to reuse, recycling and recovery quotas in the different policy options.

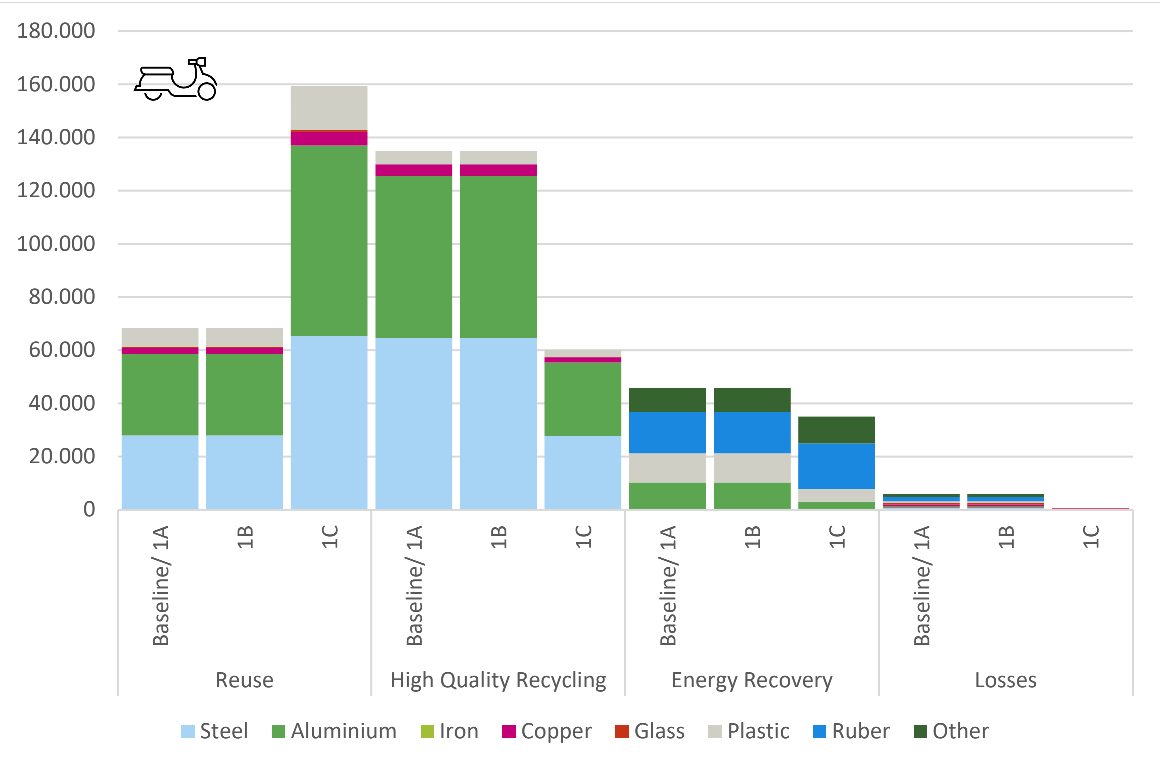
As described in the current situation and problem description above, stakeholders mentioned a higher reuse quota for lorries and PTW specifically, the amount of reuse of parts was not mentioned by stakeholders. For PTW, data on reuse exists from the survey provided by SMOTO (2021). It was shown that dismantling for reuse can be between 10% (if dismantled at car dismantling facilities) and 90% (for privates/semi-professionals). Without information about the reuse rate, it is not possible to conclude on recycled quantities neither, because material in component parts that have been dismantled are no longer available for recycling. This means, at least an estimate for the reuse rate allows the quantification which show then an estimate of the benefits of circularity. For the baseline, the reuse quota for PTW, lorries, buses and trailers is estimated at 30% on average (in the EU and across different dismantlers)[321]. In order to make such a rough estimate, in Option C, two average reuse rates were selected, and two variants calculated in the following. Neither of these represent reality, but it is expected that the average situation is in the corridor between these two variants. Based on the detailed assumptions in Table 3-83 (Annex I), material quantities associated with reuse, recycling, recovery and losses are calculated for a PTW (type Le3A2), a lorry (12 GVW) and a bus (12 GVW) with two variants for a reuse quota of 40% and one of 70%. In case of the 40%-variant, it is assumed that on average, the reuse rate in the baseline (30% on average) is high compared to the possibilities with the current market conditions. Thus, measures would entail a slight but not substantial increase. In the 70%-variant, it is assumed that the baseline is the lower limit of what is possible (on average) with the current market conditions. In this case, measures of Option C could entail a significant increase of reuse. Recycling rates were defined and continuously used for the purpose of this IA, see chapter 3.4.3 (Annex I).

For each policy option, see the material quantities arriving at different EoL steps for PTW, buses and lorries in the figures below. Please note that due to the missing material composition of trailers, no assessment of benefits from increase of circularity for trailers could be calculated.

[321] For cars and vans a reuse quota of 5% is assumed in the model calculating the impacts of measures under main objective "circularity".

Figure 3-46 Material quantities for a powered two-wheeler (type Le3 A2) with with 40% reuse in 2030 (top) and 70% in 2030 (down)

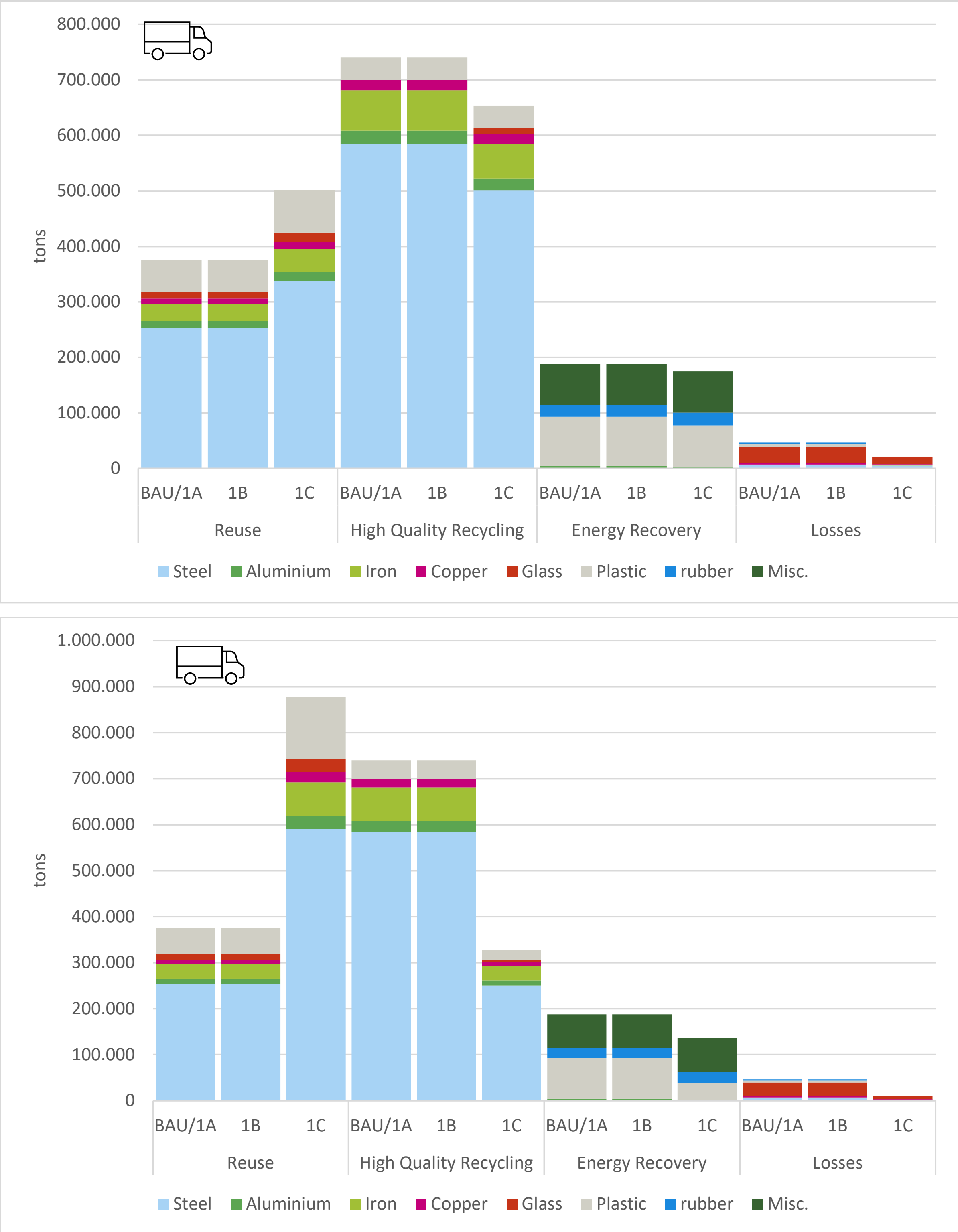




Source: calculated at Oeko-Institut (2022), description chapter 6.9, and recycling rates in chapter 3.4.3 (Annex), data for variant with 40% reuse in Annex,

Table 6-14. Recycling rates in 3.4.3

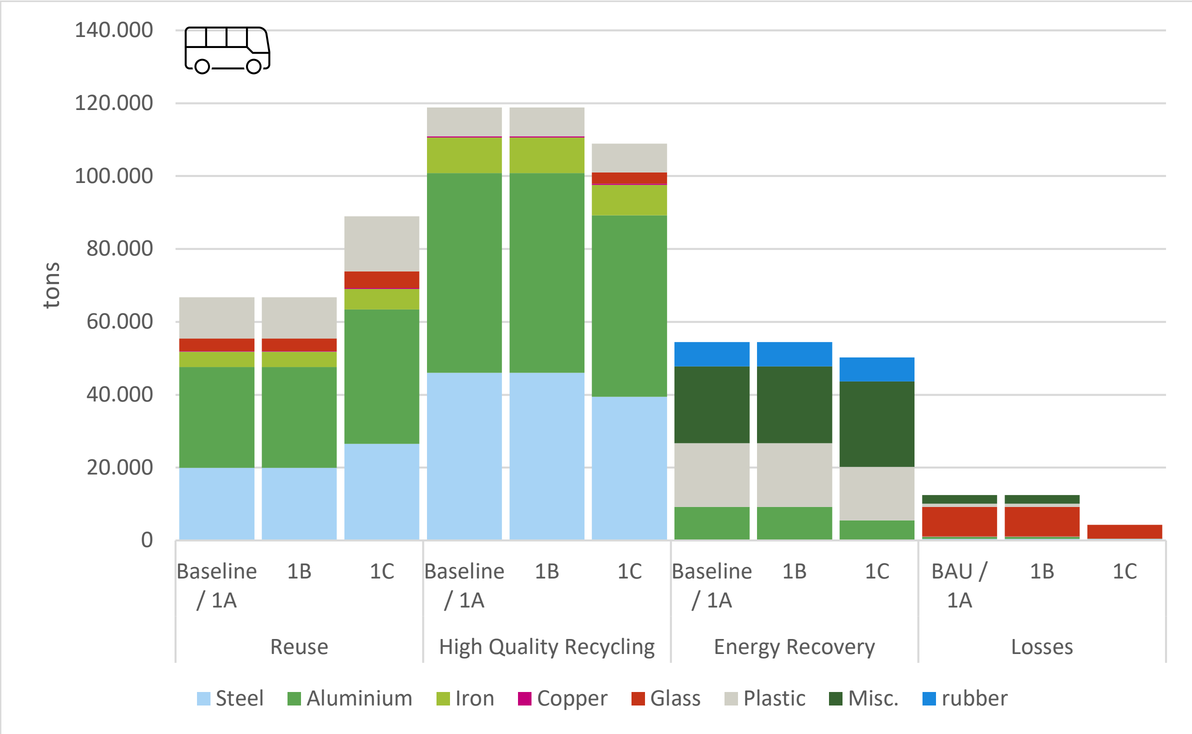
Figure 3-47 Material quantities for 12 t GVW lorry with 40% reuse in 2030 (top) and 70% in 2030 (down)

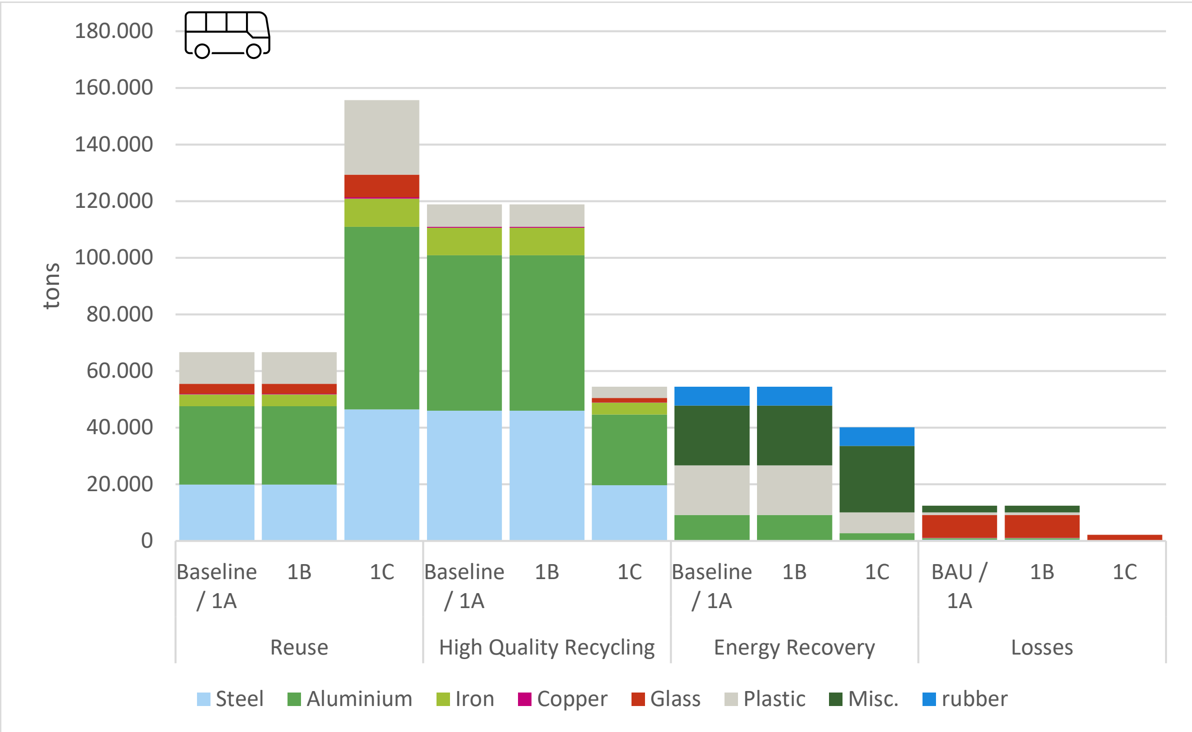


BAU = business-as-usual = baseline; used as its shorter. Source: calculated at Oeko-Institut (2022), description chapter 6.9, and recycling rates in chapter 3.4.3 (Annex), data for variant with 40% reuse in Annex,

Table 6-14. Recycling rates in 3.4.3

Figure 3-48 Material quantities for buses (12 GVW) with 40% reuse in 2030 (top) and 70% in 2030 (down)



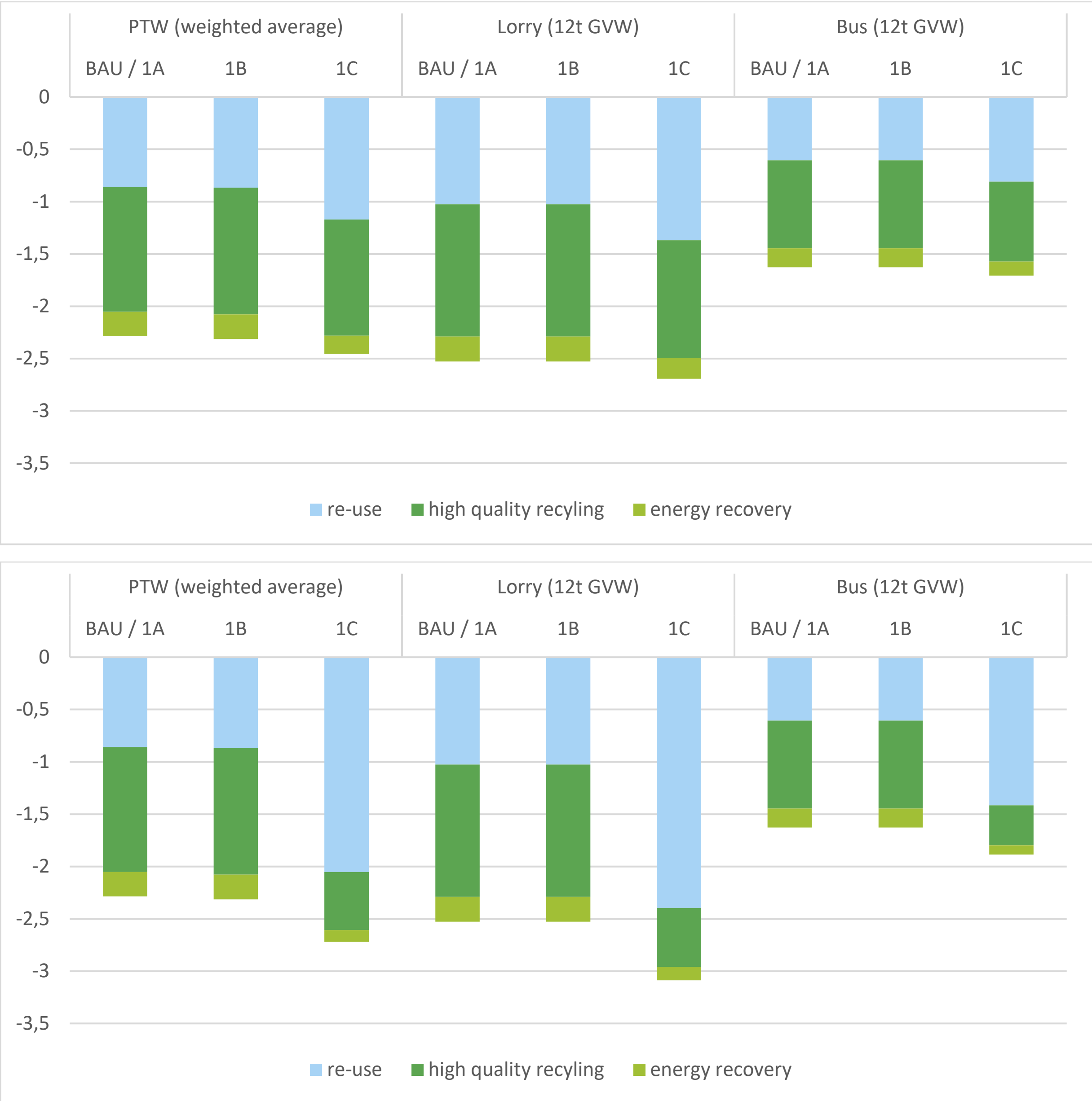


BAU = business-as-usual = baseline; used as its shorter. Source: calculated at Oeko-Institut (2022), description chapter 6.9, and recycling rates in chapter 3.4.3 (Annex), data for variant with 40% reuse in Annex,

Table 6-14. Recycling rates in 3.4.3

There are green-house gas emission savings associated with the material quantities that are reused, recycled or recovered. These are shown in Figure 3-49. The CO_2 benefits for reuse, recycling and energy recovery were calculated as described in the Annex I (section 6.9).

Figure 3-49 Savings of greenhouse gas emissions through EoL treatment for expected number of ELVs in the EU per year (Global Warming Potential) in million tons of CO_2-eq. with 40% reuse in 2030 (top) and 70% in 2030 (down)



Assumption: PTW = weighted average over different L-types, lorries = exemplary model with 12 GVW, buses = 12t GVW
BAU = business-as-usual = baseline; used as its shorter.
Source: calculated by Oeko-Institut. Data in Annex I, Table 6-15.

As initially mentioned, for **Option A & B**, no direct benefits in terms of material quantities and green-house gas emission savings can be identified compared to the baseline.

For Option C, in the variant with a 70% reuse rate in 2030, the following total greenhouse gas emission savings (total) are expected:

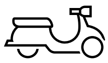
- 2,72 million tons of CO_2eq for PTW,
- 3,09 million tons of CO_2eq for lorries, and
- 1,88 million tons of CO_2eq for buses.

Compared to the greenhouse gas emission savings in the baseline, in 2030, this results in savings (difference between baseline and Option C with 70% reuse) of

- 433 000 tons of CO_2eq for all PTW, or 0,278 tons per end-of-life PTW.
- 562 000 tons of CO_2eq for all lorries, or 2,134 tons of CO_2eq per end-of-life lorry, and
- 257 000 tons of CO_2eq for all buses, or 8,186 tons of CO_2eq per end-of-life bus.

Based on the figures above, benefits from increase of circularity can be expected from **Option C** (C3 Reuse & Recycling and C2 Design for circularity). For Option C, in contrast to B, the provisions on reuse and recycling (currently Art. 7) shall apply to all vehicles by definition of this measure. However, SMOTO (2021) brings forward the concern that the common reuse practices could be undermined by the perceived focus of the current ELVD on recycling rather than reuse. Stakeholders contributing through the OPC questionnaire stated that immediate application of the following measures was not feasible: Material-specific recycling targets (22% of stakeholders for motorcycle and 18% for trucks), a reuse target (23% of stakeholders for motorcycle and trucks each) as well as recycled content target (18% of stakeholders for motorcycle and 23% for trucks).

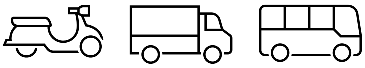
Indirect (long-term) benefits can be expected from information requirements (**Option A)** and C1 Type approval based on the assumption that measures to increase circularity follow after the information has been gathered.



For motorcycles, type approval requirements are supported by stakeholders: A recyclability target is preferred whereas recycled content targets and reuse targets are explicitly not recommended for motorbikes (EUROFER 2021b). To substantiate the 3R type approval requirement, an anonymous stakeholder (motorbike manufacturer, OPC contribution) proposed a list of non-reusable parts for motorcycles in addition to those listed in Art. 8 of the 3R Type approval Directive for M1 and N1: Wheel suspension (front/rear) incl. triple clamp, swing arm and all damping parts, handlebar, all kind/material of rims, sub-frame, and all kind/ material of fuel tank.

3.4.4.2.3 Environmental benefits from formalised treatment

Direct impacts expected relate to environmental benefits from an increase of the environmental performance during treatment of ELVs in authorized treatment facilities, e.g., exhaust gas emissions or leakage of hazardous liquids when preventive measures are not sufficient.



In the **baseline,** 822 - 3825 mio tons of waste from ELVs occur from PTW, lorries and buses. Some MS require that vehicles other than M1 and N1 are treated in ATFs, e.g., lorries in Spain, motorcycles in Italy[322]. 'Given the short time that has elapsed since the regulation entered into force, there is no evaluation of the changes that have occurred in the material flows of these vehicles (trucks and motorcycles), nor are there any impact evaluations', says a representative of Ministerio para la Transición Ecológica y el Reto Demográfico, Italy (2022). However, in some MS PTW, lorries, trailers and buses are not in the scope of general waste regulation nor any specific EoL regulation. Further, it is unclear to which extent treatment facilities for vehicles other than cars and vans, though they might follow general requirements for waste treatment, have the same standards than ATFs according to the criteria set out for ATFs in the ELVD. From this vague information, the share of the waste volume that is currently managed in according with sufficiently high standards compared to the waste volume that is not handled properly cannot be derived. In the baseline it is clear that used vehicles are exported to non-EU countries. From the list of importing countries of lorries and considering countries with comparable waste management standards for other vehicles, it is assumed, that waste management standards in importing countries are not equal to those in the EU in countries where regulation exists.

As a result, in some MS and countries importing used vehicles, it is not ensured that liquids of ELVs, exhaust gas emissions from treatment or hazardous waste are managed in an environmentally sound manner.

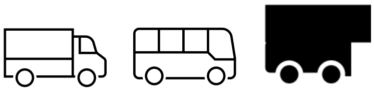
In **Option A,** very little additional environmental benefits are expected from formalized EoL management. A small improvement may result from recyclers and dismantlers being more aware of pollutant concentrations in certain components if manufacturers were required to report on them under the A1 requirements (information for waste management operators). The reporting obligation for recyclers could be However, information requirements for MS on the numbers of ELVs as well as the one-time reporting obligation on EoL contribute to making the problem tangible and quantifiable. Also, the problem of non-harmonization of rules in the different MS will be visible. It is not expected that there are differences for different vehicle categories.

The ATF requirement in **Option B** will improve the environmental conditions of treatment in those MS that currently have no regulation for ELVs other than cars and vans, or in those MS that only have waste management rules for one of the vehicle categories, e.g., only for motorbikes. Option B would extend this to all L-Type approved vehicles. For those vehicles, that arrive at dismantlers, requirements on depollution are being followed resulting in lower risk for leakage of hazardous liquids or hazardous substances in general to the environment, and higher efficiencies in exhaust gas control processes, i.e., less emissions to the environment, can be expected. Due to the differences in MS, no EU-wide picture can be drawn as to the extent of the improvement. Also, the requirement to treat ELVs in an ATF does not necessarily increase the number of vehicles arriving at dismantlers.

Also in Option B, the combination of A1 (Information for waste management operators) and B1 (restriction of the four heavy metals) would ensure that recyclers know which parts contain which pollutants, and certain hazardous substances, actually the four heavy metals, would no longer be contained in the vehicles or only in cases specified by exemptions listed in Annex II, so that it can be assumed that the amount of hazardous waste decreases or can be better

[322] The legislative decree D.Lgs 152/06, Article 231 'End-of-life vehicles not covered by D.Lgs 209/03', details how motorcycles must be managed, e.g., the technical requirements of the ATF motorcycles and for the dismantling phases (depollution and demolition) are the same.

separated due to the information about the concentrations of hazardous substances in specific components. Differences for the different vehicles are expected in the sense that amount and type of prevented hazardous waste will differ per vehicle category based on different material composition due to vehicle category specific requirements for the materials used, e.g., for PTW, materials are exposed to weathering directly, longer lifecycles[323], different operating conditions (e. g. temperatures, vibrations, wetness, dirt etc.), higher technical characteristics (e. g. revolution speed of engine).



It should be noted that Option B has not any influence on the amounts of vehicles exported which is currently ~35% of the expected waste lorries, 20% of waste buses and an absolute number of ~75,000 used (semi-)trailers per year. Thus, it is expected that neither the amount of (hazardous) waste nor the environmental conditions of recycling in receiving countries of export does change compared to the baseline. For PTW the number of exported vehicles is unclear.

Measures C4 and C5 have an impact on the benefits from formalised treatment in **Option C**. From measure on advanced traceability, it is expected that this results in an increase of the number of vehicles treated in ATFs, thus, less environmental problems (explained above) associated with vehicles of unknown whereabout within the EU. From measure on export restrictions, it is expected that this results in an increase of vehicles arriving at European dismantlers, thus, leading to less environmental problems associated with exported vehicles in importing countries.

3.4.4.3 Economic impacts

Some of the problems can be explained with market failures, e.g., it might be economically viable to export used cars than to repair, refurbish or recycle them in Europe, however, external costs associated with the export are not included in this calculation and there are small signs that the export of used vehicles might decrease in the future. Arguments were presented above.

As a consequence, measures proposed to target the problems have economic implications. Then, a number of regulatory failures was identified, e.g., the missing incentive to design for circularity, insufficient harmonized across the EU, and inconsistency between scopes of ELVD and 3R Directive. In these three cases, the highest burden is on the environment. It is inherent in some of the measures proposed to address these problems, that they are associated with administrative burden for manufacturers, EoL stakeholders as well as authorities on different levels.

In the field of economic impacts, various burden, e.g., costs, and developments in the markets can be considered for OEMs, ATFs, particularly for SMEs, and costs for public authorities are expected at this stage. To compare the efficiency of the measures, particular attention will be given to differences in costs for OEMs and in costs for MS authorities: As many OEMs are expected to be SME (distributors of Cat. N and O vehicles, body builders for trailers and semi-trailers, small motorcycle manufacturers or repair shops, etc.), attention shall be given to differences also to OEMs in this respect.

[323] ACEM (2021): "15 years; cars' lifetime is 11.5 years, thus, at least 4 years difference which means that Motorcycle ELVs are elder than car ELVs and will therefore longer contain SVHC materials which are not yet banned for motorcycles. As consequence residual amounts of SVHC due to recycling have to be tolerated (e.g., lead in aluminium alloys) for the use of quality-assured secondary materials"

3.4.4.3.1 Economic impacts for manufacturers

This section covers six impact categories:

1) Costs for manufactures for the change of the design of vehicles, e.g., different material choices,
2) Administrative costs for manufactures,
3) Competition effects,
4) Developments in the internal market, incl. innovation,
5) Effects on SMEs, and
6) Costs of an EPR.

For this section, it should be noted that no information is available on the magnitude of economic effects or on differences between vehicles. In the interviews, stakeholders only emphasised that the introduction of regulations for new vehicles would have costs but did not detail the dimension. The following table (Table 3-86) is included to provide at least an indication based on the consultant's overview. With regard to the differences between the options, the table summarises the explanatory text following the table. The differentiation between the vehicle categories can only be assumed. Where one vehicle category is assumed to be different than the other categories, the boxes are marked in green and explained below the table.

Table 3-86 Comparison of economic impacts for manufacturers of different vehicle categories compared to the baseline (0 = no/little impact, +/++/+++ = low, medium, high costs/impact)

Type of costs/effect*	PTW manufac.			Lorry manufac.			Bus Manufac.			Trailer manufac.			Manufac. of currently exempt vehicles**		
Option	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Design	0	+	++	0	+	++	0	+	++	0	+	++	0	+	+++[a]
Administr.	+++[b]	++	+++	++	++	+++	++	++	+++	++	++	+++	++	++	+++[c]
Competitiv.	0	0	++	0	0	++	0	0	++	0	0	++	0	0	++
Innovation	0	+[d]	++[d]	0	0	+	0	0	+	0	0	+	0	+[e]	++[e]
SMEs	++[f]	++[f]	?	0	+	+	?	?	?	++[f]	++[f]	?	++[f]	++[f]	?
EPR + fees	./.	./.	+ to +++	./.	./.	+ to +++	./.	./.	+ to +++	./.	./.	+ to +++	./.	./.	+ to +++

a) While it is assumed that reasonable 3R targets, recycled content and other design requirements can be defined for PTW, lorries, buses and trailers, it is also assumed that 3R type approval puts higher costs for changes in the design on second-/third-stage manufacturers of multi-stage build vehicles.
b) Due to the B2C market of PTW, it is expected that reporting on EoL as well as monitoring and reporting the number of ELVs could be more effort compared to the other vehicle categories.
c) It is clear that administrative costs of 3R type approval are high for all vehicles, whether there are even more costs of second-/third-stage manufacturers of multi-stage build vehicles, however, is unclear.
d) PTW are a consumer good compared, they have various differences in the materials used and, in view of the consultant, the sector is least prepared for ELVD requirements compared to the other vehicle categories assessed. Thus, developments in the market including innovation are highly expected.
e) Based on the current exemption for multi-stage-built vehicles, so far, manufacturers did not have to consider ELVD/3R Directive requirements. Thus, developments in the market including innovation are highly expected.
f) High SME rate compared to lorries. For buses, the distribution of SMEs compared to bigger businesses is unclear.

(*) Types of economic effects relate to the impact categories mentioned in the text directly before this table.
(**) stakeholders in the field of vehicles that are currently exempted from ELVD or 3R Directive, mainly producers of bodywork or components built on base vehicles (second-/third-stage manufacturers).
Source: own assumptions.

Costs for manufacturers for change of design

Compared to the baseline, additional costs for manufacturers in relation to changes of the design of vehicles are not expected in Option A. However, such costs occur in Option B based on B1 (restriction of the four heavy metals) and in Option C based on measures C1 (3R type approval), C2 (Design for circularity), and C3 (3R targets.)

For **Option B**, it is expected that materials exist on the market that are free of the substances prohibited under the ELVD today due to car and van manufactures requesting such material since the introduction of the ELVD. From the comparison of the material composition (Figure 2-29), it is acknowledged that not all materials used in PTW, lorries, buses and trailers are identical or used in identical amounts compared to cars and vans, e.g., wood, textiles, certain plastic parts. However, on the market, it is expected that heavy metal-free material for the manufacturing of vehicles can be supplied, and there is the possibility to apply for exemptions (see administrative costs for manufacturers). What might cause an issue is the fact that the vehicles have in common

Costs for the change of the design are expected higher in **Option C** than in Option B as there are on the one hand the restriction of the four heavy metals but on the other hand additional design requirements such as possible recycled content targets and/or requirements from 3R targets that have an impact on the material composition of the vehicles. Currently, measures C1-C3 are defined too vague due to missing information for PTW, lorries, buses and trailers, and a decision on comparable measures for vans and cars has not been taken so far. Therefore, no more indication of costs that have to be borne by manufacturers for design changes can be provided at this point of time. If the design requirements set in the future ELV legislation and controlled through the 3R type approval (under measure C1) are not adapted to the vehicle specificities, measure C1 is expected to entail high cost for design changes; e.g., if possible 3R targets for a vehicle type do not correspond to what is achievable (although it is unclear what is achievable and demanding at the same time).

Available information does not allow drawing conclusions whether relative costs for changes in the design, e.g., in relation to the total manufacturing costs of the vehicles are comparable for different vehicle categories.

Administrative costs for manufacturers

This includes costs for reporting/providing information which is part of **all three options** (Option A, B and C). Providing information for waste management operators (A1) are regular administrative costs that come with every new model, information for the one-off reporting foreseen under measure A3 is a one-off cost. Impacts if implementation of a digital product passport as one form of providing information to recyclers are evaluated in Deloitte (2022)[324]. Costs for providing information are not connected with direct benefits (as no requirements on design or EoL are foreseen in Option A). Other administrative costs are coupled to every new vehicle developed.

[324] The total costs of a potential digital product passport have been modelled using different data transmission standards and it has been evaluated which stakeholders would be burdened with which costs.

Table 3-87 Admin. Costs (AC) for lorry and PTW manufacturers in Policy Option A

Activity	Type of obligation	Manufacturers	Total AC
Information to waste operators	Submission of (recurring) reports per type-approved vehicle*	Lorry manufacturers and their suppliers (~ 14**)	0***
Information to waste operators	Submission of (recurring) reports*	PTW manufacturers (~16**)	9.869
Maintenance online platform for information sharing	Submission of (recurring) reports	PTW manufacturers (~16**), not relevant for lorries as voluntarily implemented in the baseline	3.041****

Assumptions: (*) three type approvals per year; (**) assumptions displayed in the Table in the annex. (***) 100% of AC already covered by the baseline; (****) total annualised one-off administrative costs
Source:

Table 6-17 and Table 6-18 (Annex I).

Costs for the management of the supply chain occur with **Option B** for hazardous substances (restriction of the four heavy metals) and additional supply chain management costs occur with **Option C** for changes in the design, e.g., recycled content targets. Requirements in Option B and C could imply the one-time search for and contracting of new suppliers.

Table 3-88 Admin. Costs (AC) for all non-passenger car vehicle manufacturers (~30 companies) in Policy Option B[325]

Activity	Type of obligation	Days of work	Total AC
Contribution to the development of vehicle specific Annex II of ELVD (for lorries + trailers; busses; L-cat vehicles)	Application for general authorisation or exemption	3	6.168
Supply chain management	Notification of (specific) activities or events	1	6.516*

Assumptions: (*) total annualised one-off administrative costs
Source:

Table 6-17 and Table 6-18 (Annex I).

Relevant in **Option C only**, costs occur associated with changes in the type-approval processes. In 3R Directive-related interviews, stakeholders indicated that the manufacturers have departments working in the general type-approval, e.g., in relation to security-related aspects etc. For such departments, the 3R type-approval would be an additional task. This task consists of the preliminary assessment of the manufacturer (independent of the models and regularly every 2 to 3 years) and model-specific type-approval, thus, the recyclability calculation plus other 3R Directive, Annex I requirements. In both cases, the main task is to collect, store and prepare information in a certain way that technical services and Member State competent authorities can perform their checks. The questionnaire for the stakeholder interviews in relation to the 3R Directive were prepared in a way to retrieve quantitative data, e.g., when asking how much time is required for the preparation of documents for a 3R type

325 For a full calculation and further assumptions, see

Table 6-17 and Table 6-18 (Annex I).

approval, or in relation to implementation costs.[326] As no information was obtained through the stakeholder consultation, and as type-approval documents are non-disclosed generally, no quantification of the administrative costs for manufacturers could be presented initially. However, a more detailed calculation is presented in Annex I.

Examples for administrative costs listed by the motorcycle manufacturers' association (ACEM 2021) are 'operational fees for database to document recycling relevant information of all models (per OEM per year), effort for vehicle documentation in database, efforts on analysis of material compliance, efforts on application for exemptions, costs for set up and operation of return systems and effort for type approval based on additional documentation obligations'. ACEM (2021) also explains that 'the costs cannot yet be quantified in detail (but can be compared to the efforts that car manufacturers have had in the past).' Though this information is from the motorbike manufacturers association (ACEM), it is expected that manufacturers of other vehicle categories have the same costs.

Competitiveness

It is assumed that reporting requirements (Option A) and the requirements in Option B (restriction of the four heavy metals, ATF and CoD) does not have any implications on the competitiveness of the manufacturers of vehicles. Thus, this impact category plays a role only for Option C. Changes to design may affect the competitiveness of vehicles, though this is assumed to affect manufacturers similarly. This is not to say that the competitiveness of some will not be affected, but that the same requirements apply to all and in this sense that the provision shall not create unfair competition. Until the measures are decided and come into force, it is possible that certain manufacturers will voluntarily start implementing certain strategies. It became clear that the industry is already dealing with some requirements in detail, e.g., heavy metal restrictions and related Annex II exemptions (BMW Group 2022; SCANIA 2022). Other than voluntary preparatory action for a potential regulation might be green public procurement. The public procurement authorities might include certain requirement in tenders for vehicles, e.g., buses for public transport or PTW for police, lorries for logistic services. It cannot be ruled out that the voluntary preparatory work of some companies will have an impact on competition until it comes into force.

Thus, the question is how the introduction of new design requirements (measures C2 and C3) will affect the competitive position of EU manufacturers against manufacturers from other key markets. At this point of time, the measures C2 and C3 are not yet fixed in the sense that no target values for any 3R targets nor recycled content targets, and no decision on due diligence requirements or requirements on non-recyclable materials etc. exist in general, especially not for vehicles that could possibly enter the scope of the legislation. Of cause, more and ambitious requirements might weaken the position of manufacturers of the EU compared to non-EU business operators, however, being able to communicate repairability rates, reuse quota, or number of spare parts based on circularity requirements imposed might even strengthen the businesses' position in the market based on the assumption of consumers being highly interested in sustainable practices.

[326] We provided optional answers, e.g., <0.5 years full time equivalents (FTE), 0.5 – 2 FTE or >2 FTE per each 3R TA, facilitating manufacturers can provide data on a non-confidential basis. However, requested information and data was not provided and/or declared non-disclosed. The stakeholder involvement and their contribution are described in Annex II and Annex III.

Developments in the internal market, incl. innovation

When regulations are introduced, a market inevitably changes because different companies are differently prepared for the changes. Nevertheless, all rules in the European market apply to all business operators. It is expected that the measures from options A and B will have little impact on the vehicle manufacturers' market. Assuming that the specific targets for the measures in Option C are based on the feasibility of the sector, which claims to already have high reuse rates and uses similar mostly recyclable materials as used in cars and vans, it can also be assumed that Option C will have little economic impact on the internal market. In any case, with the introduction of circularity measures from Option C, there is an opportunity for innovation, but, as the market already sees itself in line with the CE objectives, these measures are not considered to be an extraordinary innovation driver for manufacturers of vehicles with the exception of PTW manufacturers. PTW are a consumer good; they have various differences in the materials used. In view of the consultant, the sector is least prepared for ELVD requirements compared to the other vehicle categories assessed. Thus, developments in the market including innovation are expected.

Effects on SMEs

Small and medium-sized enterprises (SMEs) are mainly engaged in the production and supply of components for the production of PTW and trailers. Many SMEs are also involved in body work for base vehicles (in relation to multi-stage-built vehicles). The structure of the business sector for buses is unclear.

The main administrative costs, e.g., the cost of reporting (Option A), are similar regardless of the size of the company, these costs therefore burden SMEs proportionally more than large companies. In result, Option A is a high burden for SMEs. Option B also involves administrative costs related to the supply chain management of hazardous substances (the restriction of the four heavy metals), but it is expected that the market for hazardous substance-free components exists, and it is a one-off cost. Option B therefore does not imply much more additional effort for SMEs than option A. The impacts of Option C on upstream supply chains and small businesses are unclear until more precise targets for the measures are agreed. Because the PTW, lorries, buses and trailers sectors claim themselves already circular in relation to reusability for example, it is possible that SMEs' businesses may not need to change incredibly. But that is speculation at this point.

Costs of an EPR

There are two types of costs here: those incurred for the establishment and structure of the EPR, e.g., the formation of a producer responsibility organisation (PRO); the other costs are the fees that the producers would have to pay. The vehicle manufacturers in Europe are already networked, PROs already exist in some MS and expertise on EPR is presumably available; it will also be possible to join forces with the EPR/PRO for M1 and N1, if there is to be one. It is likely that for the first type of costs (set-up and structure) there will not be significantly more costs than in the baseline. The fees cannot be named at this stage, nor can they be given an order of magnitude. they depend on what obligations there will be for the ATFs/waste operators and whether these will be economically viable for the ATFs or not. It is clear that the fee for different vehicles will be different because it depends, for example, on the amount of material or the complexity of how easily something can be dismantled. There is the principle of modulation of fees, so that there could be a wide range of fees.

As presented above, two Member States included PTW in their EPR or set up a voluntary EPR, whereas in France the corresponding law only applies from 01.01.2022. An evaluation of costs and benefits is not yet available due to the short time. The Dutch voluntary EPR for scooters for mopeds and mopeds up to 50 cubic centimetres, the Scooter Recycling Nederland (SRN), was founded in 2011 (Auto Recycling World 2021). 'The network exists of 180 delivery points and 65 scooter dismantlers (mostly cars dismantlers that do scooters as a side job). Aim is collection without costs for the last owner and sustainable recycling.' (EGARA 2022b) The system is voluntary at present. According to the SRN webpage (BOVAG; RAI 2022), 25 000 scooters were scrapped at drop-off points of 1.2 million scooters in the Netherlands. No costs for construction and/or maintenance could be obtained from the interview with ARN as SRN's "big sister".

3.4.4.3.2 Economic impacts for EoL stakeholders

This section covers six impact categories:

1) Revenues for dismantlers from spare parts and for dismantlers and recyclers from recycling;
2) Revenues & lost revenues from missing vehicles and exported used vehicles;
3) Administrative burdens on businesses,
4) Competition effects,
5) Developments in the internal market, incl. (investments in) capacities, and
6) Effects on SMEs.

The following table is included to summarise the explanatory text following the table. In some cases, the differentiation between the vehicle categories can only be assumed. Where one vehicle category is assumed to be different than the other categories, the boxes are marked in green and explained below the table.

Table 3-89 Comparison of economic impacts for EoL stakeholders compared to the baseline (0 = no/little impact, +/++/+++ indicates the expected level of effects, but not whether positive or negative)

Type of effect*	PTW dismantler**			Bus, trailer, lorry dismantler***			Recycler			Shredder		
Option	A	B	C	A	B	C	A	B	C	A	B	C
Admin. costs[a]	++	+++	+++	++	+++	+++	0	0	+	0	0	+
Spare parts and recycling[b]	./.	./.	++	./.	./.	++	./.	./.	+	./.	./.	+
Missing v. and export[c]	./.	./.	?	./.	./.	+++	./.	./.	+++	./.	./.	+++
Competitiveness[d]	+	+ to +++	+++	+	+ to +++	+++	+	+	++	0	0	++
Internal market[e]	0	+++	+++	0	+++	+++	0	+	++	0	+	++
SMEs[f]	++	++	?	+	+	?	./.	./.	?	./.	./.	?

a) ./.
b) the sector claims a high reusability; thus, dismantlers will profit more from measures introducing measures for increased circularity. Still, based on the claim, this is not a triple *plus* because if it is right, that reusability is already high, then, compared to the baseline there will be medium changes.
c) only relevant in Option C and lack of data for PTW; in general perceived highly relevant
d) in Option A, an increase in the competitiveness is expected based on additional information (A1), however, this affects mainly dismantlers and recyclers. Option B (measure B2) introduces a difference between informal and formal dismantlers for dismantlers, this will have an influence, which is however unknown
e) Together with the competitiveness changes in the internal market are expected, however, with differentiation between dismantlers on the one side and recyclers and shredders on the other side, still they would receive a lot more material from ELVs, e.g., if export was restricted (measure C5).
f) Share of SMEs in the sectors highly unsure, however, expected higher for PTW than for buses, lorries and (semi-) trailers, and higher for dismantlers than for recyclers and shredders.

(*) Types of economic effects relate to the impact categories mentioned in the text directly before this table; (**) Business operators; (***) all three vehicle categories require from an ATF to have enough space and respective tools, thus, it is assumed that this is one category of dismantlers. It might be possible that some are specialized in only some of the vehicle categories.
Source: own assumptions.

Administrative costs for EoL stakeholder

In **Option A**, specifically burdens dismantlers in relation to reporting and providing information. The reporting to Eurostat is done a little bit differently by all MS, respectively they collect the data differently, which have to be entered into the tables for the reporting. However, they often base their data on the CoDs issued by the ATFs. In A2, MS are supposed to report on the waste PTW, lorries, buses and trailers arriving at dismantlers. Here, MS may need to deviate from their typical data collection process and ask dismantlers directly, who in turn must report. However, some MS may even already collect this data, e.g., in Italy and France, where PTW are included in the scope of the respective ELV legislation. It will be slightly different in each member state how much additional burden is placed on dismantlers. See the quantification in the table below.

Measures of **Option B** might entail additional administrative burden for ATFs for the authorization process as well as efforts associated with the issuing of CoDs/management of (de-) registration. FORS (a Polish Recycling Association) speaks for the practice of certificates of destruction for end-of-life motorcycles (FORS 2021). As reported elsewhere, today in some MS dismantlers are already committed to the general requirements of the Waste Framework Directive (WFD). If this is the case, a formalization process to become an ATF according to the (current) rules of the ELVD is probably not a significantly expensive process: Still, a third-party expert must be hired once, and all documents must be compiled. The situation is different if dismantlers do not yet work according to the standards of the WFD. It can be assumed that the situation of such informal operators is very different, i.e., the costs for a conversion to an authorized operation will be very different. Current costs for ATFs for the formalization process under ELVD are not known, as the requirement for car ATF has been in place since the coming into force of ELVD. See the quantification in the table below.

Table 3-90 Yearly Admin. Costs (AC) for the EU dismantling sector (~4 500 ATFs[327])

	Activity	Type of obligation	Days of work	Total AC
A2	Reporting on treated ELVs to MS authority	Submission of (recurring) reports	1	925.200
B2	Authorisation process	Certification of products or processes	5 min per ELV*	3.700.800
B3	Notify vehicle registers	Notification of (specific) activities or events	10 min per ELV**	5.809.237

Assumption: (*) 3 250 000 ELVs (=sum of waste lorries, buses, trailers and L-cat vehicles). (**) assuming that in 1/3 of the EU MS CoD requirements exist in the national legislation. Further assumptions in Annex. Source:

Table 6-17 (Annex I).

With possible changes in the numbers of ELVs and changes in the material volumes arriving at recyclers a certain level of management can be expected in **Option C**. Compared to option B, this is not specifically a higher burden.

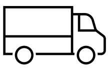
Used spare parts and material for recycling and related revenues for EoL stakeholders

The impact category of revenues for dismantlers and recyclers from spare parts and recycling is only relevant in relation to the bundle of measures of Option C. In **Option A** and **Option B**, minimal changes in the baseline are expected as to additional amounts of spare parts for sale or increased amounts of material for recycling. This is due to measures A1 (information to recyclers) and B1 (restriction of the four heavy metals), because if the dismantlers receive

[327] Taking into account that 15% (per unit) of vehicles are not in scope today and assuming the identical additional share for ATFs might be required for the dismantling of PTW, lorries, buses and (semi-)trailers, this results in a number 4.500 ATFs being required for vehicles other than M1 and N1 (assumed authorised facilities for M1 and N1 vehicle treatment: ~ 30 000).

more (and targeted) information on these hazardous substances and on the material compositions of components, and if they can be sure that the vehicles do not contain the heavy metals restricted through ELVD, they probably take more targeted decisions regarding the removal of certain components. At the same time, this must always be weighed against the effort resulting from removing additional parts from the end-of-life vehicles. It is therefore assumed that the changes in the material flows are minimal for measures A1 and B1 each, but even in combination. Probably, additional revenues for EoL stakeholders will be marginal too. Other measures from **Option A**, the information requirements on ELVs (A2) and the one-off reporting describing the status-quo in the EoL markets and material streams therein (A3) will also have little to no impact on recycled volumes or additional profit opportunities for EoL stakeholders. The impacts of the introduction of the ATF requirement (B2) in **Option B** in relation to material to be recycled or amounts of used spare parts in the market are also assessed marginal, as outlined before, this requirement is more about formalization of the EoL and prevention of pollution of informal dismantling. However, generally, it can be expected that the extension of scope as such (which is foreseen in all Options) rises the attention and awareness of the sector. Voluntarily future-proof decisions could be taken by industry stakeholders resulting in (unforeseeable) benefits for circularity.

Option C is the policy option that has influences on the number of available (used) spare parts, increase in the quality of recycled material and amount of recycled material (mainly measure C2 and C3). Changes in these indicators, influence the economic impacts for EoL stakeholders. At this stage, data is lacking as to define the exact measures (neither the measures themselves nor the ambition level of the targets).



To provide at least one example in relation to spare parts in lorries, the baseline described by Saidini et al. (2018) is used to calculate revenues generated through the second-hand sale of dismantled components today. Saidini et al. (2018) conclude that ‘redistribution of second-hand components is a profitable business, e.g., when a Volvo FH Globetrotter is dismantled properly (95% of its weight, i.e., 7,000 kg), the overall resale of spare parts can reach 40,000 euros.’ Based on these numbers using the expected waste lorries in 2020, revenues from the sale of spare parts from lorries in the EU are calculated to 5.3 billion Euro, an additional amount of 3.0 billion Euro is lost revenue for the European EoL stakeholders due to missing vehicles (Table 3-91).

Table 3-91 Calculation of revenue from resale of spare parts

Expected waste lorries > 3,5t in 2020 (Oeko model based on PRIMES)	207130	#
Missing vehicles (see Figure 2-25)	36%	%
Lorries dismantled in EU (64% of the expected waste lorries)	132563	#
Resale of spare parts per vehicle (Saidini et al. 2018)	40000	Euro
Revenue from resale of spare parts in the EU	**5.302.539.862**	**Euro**
Lost revenue from resale of spare parts through missing vehicles	**2.982.678.672**	**Euro**

Source: indicated in the lines of the tables.

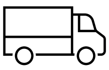
The study does not provide an additional information as to the amount of material or revenue that can be generated from the “rest” of the lorry after having dismantled components for second-hand sale. Also, from this information it is difficult to conclude on expected impacts of measures from Option C in relation to the numbers. If reuse was supported through the introduction of measures, it is expected that the revenue increases, however, there is the risk that measures, such as a separate recycling target, could jeopardize current repair and reuse practices as ATFs could compete with such operators to ensure fulfilment of the recycling target. In such a case, revenues from spare parts decrease.

In relation to recycling, hypothetically, based on the expected numbers of ELVs in 2020 (baseline) and 2030 (Option C) using the material composition and current prices for secondary raw material, the revenues generated from the materials from ELVs if they were recycled (assuming 100% recycling) can be calculated. However, this calculation is misleading in various ways: First, it does not take into account reuse rates, which however are unknown at this point of time. Then, prices for secondary raw material are volatile, and especially are expected to change over the course of the next years, thus, calculating revenues is not providing a profound statement of the impacts.

Thus, as it is not possible to calculate impacts on the material and component parts indicators, and to derive changes in the costs and revenues for EoL stakeholders. In Option C, another measures in relation to circularity is C1, i.e., the introduction of the 3R Type-approval for new vehicle categories. It is clear that the introduction of 3R type approval does not impact the amounts of spare parts, material recycled or their quality directly. Rather it is a tool to ensure that other measures in relation to design for circularity are being checked when new types enter the market.

Missing and exported used vehicles

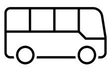
Currently, used vehicle dealers and ATFs are selling used vehicles for export. The **baseline** in terms of numbers and importing countries is described in the problem description (chapter 2.4.3.1). On average these were 156 959 lorries (incl. road tractors)[328], 9 326 buses and 75 074 trailers per year. For PTW, there is not dada. With these exports, these operators generate revenue.



Different priced for exported lorries per kg are provided by the Dutch Ministry of Infrastructure and Waste management and provided in the Annex I, Table 6-19. In Western Africa, the price is 0.99 €/kg (lowest in comparison of the regions), the expected price for exports to Western Europe is 9.79 €/kg (highest in comparison), the average of the median prices of all regions is 3.11 €/kg. For lorries, the provided prices can be used to calculate the revenue from used vehicles per year (for 157 000 exported lorries using an average weight of 8500 kg per lorry): 1.3 billion € to 13.1 billion € with an average of 4.1 billion € per year. At the same time, business operators in Europe loose revenues from materials in missing vehicles or that are exported as “used vehicles”. In the baseline, for lorries, it is expected that 502 425 tons of material are lost due to missing traceability (assuming 34% of unknown whereabouts according to Mehlhart et al. 2017) and 1.1 million tons due to Extra EU export (based on export data). With the current prices for recycled materials (and assuming 100% recycling), this adds to 99 million Euro for the lost material due to missing traceability and another 218 million Euro for the lost material of exported lorries (Table 6-15 and

[328] 80120 road tractors, 76839 lorries

Table 6-16, Annex I[329]). This comparison is insofar misleading that other stakeholders, namely used vehicle dealers and ATFs generate revenue from sales of exported material than from sales of recycled material in the EU. Nevertheless, the difference in revenues indicates the reason for the high export figures: In terms of the overall economy, at current prices, recycled material can only generate about 10% of the revenues per year made with exports. In addition, In the workshop, it was mentioned 'that the export of old trucks in Africa or other countries will be more and more difficult because of more complex exhaust emission control system in trucks, more hybridization of engines and other technical reasons. The second use of trucks will be more difficult even if the road infrastructure is more and more developed in these countries. Renault Trucks want to develop a network of specialized companies of treatment of trucks.' (Eric Lecointre, Workshop 2022).



Except for the numbers from trade statistics on the export of used buses, such detailed numbers as for lorries are not available, e.g., the prices for exported used vehicles. In the baseline, for lorries, it is expected that 101.000 tons of material are lost due to missing traceability and 100 000 tons due to Extra EU export. With the current prices for recycled materials (and assuming 100% recycling), this adds to 35,5 million Euro for the lost material due to missing traceability and another 35,0 million Euro for the lost material of exported lorries (Table 6-15 and

Table 6-16, Annex I).

The average number of exported trailers is known (see above), assuming a typical vehicle weight of 5820 kg (Annex I, Table 6-8), the weight of the exported trailers can be calculated to 440 000 tons per year. This is slightly less than half of the weight of exported lorries. Whether prices for exported trailers are comparable to prices for lorries is not known, so we cannot conclude that half of the weight is half of the revenue. Also, the distribution of different types of trailers and their material composition is not known, there is also a lack of knowledge in relation to trailers of unknown whereabout in the EU, and it is assumed that extrapolating the number of missing vehicles from passenger cars to trailers does not give the right picture.

No data is available as to assess this situation for PTW.

In **Option A** and **Option B**, no change in the baseline is expected. The introduction of a CoD (B3) will probably help to build the base for additional measures (C4 and C5) providing a monitoring indicator, but introduction of B3 is expected to not change the situation as such.

Option C is the policy option that has influences on the above-mentioned markets. Especially, measures C4 and C5 will support in reducing the tons of material from missing vehicles and increase the amount of material from ELVs treated in the EU. However, it is unlikely that measures under option C influence the revenues in such a way that the money currently earned from the export of used vehicles (calculated in the baseline, i.e., 4.1 billion Euro per year for used lorries) leads to a higher profit for the EoL stakeholders to the same extent. At the same time, it is unlikely that the potential profits calculated above in the scenario that the exported and missing vehicles were recycled in Europe today (for lorries, in the baseline calculated to ~10% of the revenue from export of used vehicles), would reflect the actual

[329] No priced for recycled iron, rubber and other waste included.

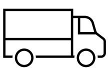
profits at the time of the introduction of Option C. There are many reasons for this: For example, the prices of secondary raw materials are expected to change over time, and the prices that can be obtained when exporting vehicles are expected to change as well. First signs of a change in the export market are visible, e.g., slightly decreasing export volumes, more restrictive import laws in African countries, statements like the one from Renault quoted above, or changes in the social perceptions in relation to material consumption overall. It is also unclear how the total vehicle fleets would behave if, for example, whether an export restriction would lead to (even) more repairs. Overall, impacts of measures of Option C are highly uncertain.

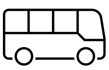
Competitiveness & development of the internal market incl. treatment capacities

It is assumed that reporting requirements (**Option A**) result in an increase in the competitiveness based on additional information (A1), however, this affects mainly dismantlers and recyclers, to a certain extent, but not shredders. Measures in Option A will probably do not have an effect on the existing capacities of dismantlers, recyclers or shredders, or create changes in the market.

Option B (measure B2 ATF) introduces the legal difference between informal and formal dismantlers, this will have an influence, the level of the effect is however unknown. As the same requirements apply to all parties, the provision shall not create unfair competition, but ATFs will have to compete against the businesses of informal dismantlers with less administrative burden and less requirements to the dismantling. Also, in Option B, the requirement to be dismantled in ATFs requires providing the capacities for the treatment in authorized facilities. In total, this option is expected to have high influences on the market situation as a total, especially for PTW, where it is expected that no ATFs exist compared to lorries (at least in some MS).

For the treatment capacities for PTW, due to the unclear general situation of EoL treatment, it is unclear whether investments in “new” PTW-specific ATFs are required or whether current capacities for cars and vans can cover the dismantling of PTW given that only few are expected to be dismantled but repaired or used as ‘spare parts depot’. A participant of the workshop warned that distances between ATFs might pose a problem in terms of availability and accessibility for the general public: ‘We would need to consider the geographical distribution of ATFs. It would not be economically viable to place ATFs in many places and this would affect consumers who need to dispose of an ELV’, FIM - Chris Hodder (Workshop 2022). A statement of ACEM (2021) speaks against the existence of such a problem explaining that ‘in the pre-treatment, thus depollution (battery and hydraulic oil, cooling fluid,…), there is no difference to cars. The same processes are used except for what does not exist in motorcycles (climate fluid, washing, …). In a recycling and dismantling centre in Munich, cars and motorcycles are dismantled with the same processes.’ The consultant assesses the investment needs in PTW-specific ATFs rather low, but the additional material volumes to be expected at general (car & van) ATFs cannot be assessed.





If trucks were included, the Czech Ministry of Environment (2021) sees “problems in their size and different composition of materials”. On the other hand, from the interview with ANERVI/AETRAC, it has become clear that in Spain there are lorry-specific ATFs that are authorized and can also treat trailers. Depending on whether this is the same throughout the EU, an ATF requirement with the issuing of CoDs (measures B2 & B3) will not have a significant impact on the market or its competitiveness. The situation for buses is unclear.

In **Option B**, for recyclers and shredders, the market could slightly change, however, as ELVs are only one input stream for recyclers and shredders, expected effects are only marginal.

High effects are expected in **Option C**. Changes to design may affect recyclability. In comparison with competitors from extra EU markets, a positive effect is expected for European dismantlers and recyclers. At this point of time, the measures C2 and C3 are not yet fixed in the sense that no target values for any 3R targets nor recycled content targets, and no decision on requirements on non-recyclable materials etc. exist in general, especially not for vehicles that could possibly enter the scope of the legislation, so the extent of such a positive effect cannot be assessed.

It is also not clear how exactly measures C4 and C5 will be designed, however, what is clear is that both measures would have a high impact on the number of ELVs to be treated in Europe. In the extreme case of an export ban, this number increases to 35% more lorries, 20% more buses and about 75,000 trailers per year. A more detailed analysis can be found in Annex I, section 6.10.2. In addition, there would be more vehicles whose whereabouts would be clarified, and which would be submitted to a formalized EoL treatment. This increases the input, may require additional capacity and possibly strengthens the business of dismantlers, recyclers and shredders. Whether the additional revenue from such business operations can cover the additional investment costs cannot be said because the number of volumes treated in the EU is unclear. Then, dependent on the details of the arrangement, an EPR (measure C6) could lead to a complete change of the business whereas the aim of an EPR is of course not to generate more profit for the waste operators per se but to off-set their costs when they exceed a certain limit. It can be assumed that the waste operators could be given more to do, for which they would also be paid accordingly. This means they would have to remove and/or recycle components that they have not removed so far because it was not economically viable for them to do so. However, the new legislation could require such work potentially financed by EPR fees that manufacturers pay.

Effects on SMEs

Small and medium-sized enterprises (SMEs) are expected to be mainly engaged in the dismantling; however, the exact structure of the business sector is unclear for all vehicle categories. As pointed out in relation to SMEs that are working in the manufacturing of vehicles, the main administrative costs burden SMEs proportionally more than large companies. In result, **Option A** is a high burden for SMEs. **Option B** also involves administrative costs related to the knowledge management of the restricted heavy metals, however, dismantlers engaged in car, e.g., relevant for the dismantling of PTW, know the procedures and “their” materials that are to be dismantled mandatorily. For lorries and trailers, ATFs already exist today. Option B therefore does not imply much more additional effort for SMEs than option A. As well addressed in the section on SMEs working in manufacturing of vehicles, the impacts of **Option C** are unclear. Because the PTW, lorries, buses and trailers sectors claim themselves already circular in relation to reusability for example, it is possible that SMEs' businesses may not need to change incredibly. But that is speculation at this point.

3.4.4.3.3 Administrative burden for public authorities

It is noted that all options inhibit administrative burden for public authorities. It is the nature of the extension of the scope which is part of all proposed policy options.

The following is assumed for national public authorities: In **Option A**, measures A2 (reporting on ELV) and A3 (one-off reporting) would result in burden for Member State authorities: Actions related to measure A2 need to be reconciled with the current reporting process for

ELVs[330] and potential decisions for cars and vans (Measure "Improve reporting obligations on the current vehicle market and the ELVs on their territory", chapter 2.2.5.1.9). Some MS have started statistical data collection, for example, Spain included differentiated waste codes for different vehicle types in October 2021.[331]

Yearly costs are estimated to 2.779 Euro[332]. The reporting obligations for end-of-life treatment of possibly additional vehicles in scope (A3) will require a one-off investment from MS for conducting the reporting, as gathering information via the 3R type-approval legislation, e.g., on the intended recyclability rate of a new vehicle type, is not possible. These are calculated to add up to 38.910 Euro in total[333]. For a quantification, see Nr. 4 & 5 of

Table 6-17 (Annex I).

In **Option B**, for collection-related requirements, e.g., ATF treatment and CoD, administrative burden dan be expected for national public authorities, i.e., more inspection/enforcement campaigns. Costs for such additional work in relation to cars and vans are expected to be 20 cents but not more than 1 Euro per new M1 or N1 vehicle registered[334] (see the calculation in chapter 3.2.5.9). Taking into account that 15% (per unit) of vehicles are not in scope today and assuming the identical additional share for ATFs might be required for the dismantling of PTW, lorries, buses and (semi-)trailers, this results in a number 4.500 ATFs being required for vehicles other than M1 and N1[335]. Applying the same efforts (3 working days with 27 € labour costs), checking 10% of the (additional) ATFs would account for ~ 300 000 € for the entire EU + plus reporting to the EU (measure A2). Registration data for lorries and trailers is only available for 2012 which is considered not recent enough to conclude on the costs per vehicle. For the overview of administrative costs,

Table 6-17 (Annex I).

In **Option C**, more administrative efforts associated with 3R type approvals (measure C1), including enforcement and compliance checks with 3R targets (measure C3), design requirements (measure C2) etc. information on costs for such type-approvals for national authorities from 3R type-approval Evaluation is non-disclosed. In addition, measures C4 and C5 inhibit costs for advanced traceability and for custom services of MS to control EU exports.

[330] The current Commission Decision (2005/293/EC 2005) requires the Member States to complete the tables 1-4 and to report in addition on "the current national vehicle market and the end-of-life vehicles on their territory". This last aspect is detailed in a Eurostat guideline which is not legally binding.

[331] While 160104* is the EU waste code for ELVs331, in Spain, there are 160104*-10 (cars, vans) and 160104*-20 (other vehicles) Real Decreto 265/2021, Anexo VIII Codification Ler-Veh331

[332] Two days work assumed. MS already report on M1 and N1 ELVs, the format can be the same for other vehicles, thus, 75% of the costs occur in the baseline. For a quantification, see Nr. 4 & 5 of

Table 6-17 (Annex I).

[333] Assuming seven days of work in 27 MS for four different vehicle categories. For a quantification, see Nr. 4 & 5 of

Table 6-17 (Annex I).

[334] Based on the assumption of 10% of the ATFs being checked per year, assuming ~30.000 ATFs in EU, 3 full day effort for an inspection and average EU labour costs of 27€, and then the costs were allocated to almost 11 million newly registered cars (2019-2021).

[335] Assumed elsewhere for M1 and N1: 11 000 ATFs and 2 times more other facilities relevant for inspection

Administrative burden for the European Commission results from all options as well. In **Option A**, the EC has to provide its services from Eurostat for the reporting on the fleet, but if the format is not different from the cars and vans, the additional costs are estimated to be rather low. In Option A, a reporting format for MS has to be developed and the reports of MS on the EoL of the vehicles have to be received in order to decide next steps for further regulation (or not) based on this. The benefit of such reporting is that information is provided by those stakeholders that have the best overview, though, it requires the responsibility of a central body with cross-sectoral expertise in circular economy that can create linkages or use examples from other sectors, to come to a better-informed choice. There is the risk for public authorities that OEMs & ATFs cannot provide proprietary information, or the information provided may not cover relevant questions identified. In **Option B**, the EC incurs costs due to possible exemption requests for the hazardous substance (heavy metals) restrictions. Since it is expected that the process will be the same for all vehicle categories, there is no need to devise the format of exemption requests specifically for other vehicle categories.

In **Option C**, the impact of the measures on the EC cannot be estimated, however, it can be pointed out here that if general measures for cars and vans coincide with those for PTW, lorries, buses and trailers (though different target values might be agreed), costs will not be significantly greater than for a revision of the measures for cars and vans (circularity, 3R type-approval, traceability, export, EPR; see the impacts for "circularity" and "missing vehicles" in the chapters before). The **baseline** with no extension of scope has the risk of additional costs in postponing the decision, e.g., resulting from additional personnel costs for organisation of stakeholder dialogue, and one regulation revision process is considered more time-effective than bringing up the ELV legislation again in the (near) future.

3.4.4.3.4 Distributional effects (economic)

One economic distribution effect comes into play in **Option B** (B1 Heavy metal restriction., B2 ATF & B3 CoD) and **Option C** (C4 advanced traceability & C5 export restrictions) which is the internalization of external costs. Internalizing environmental, e.g., resulting from unformalized treatment (see above), and health costs, e.g., resulting from hazardous substances (see below) means charging them to the polluters ("polluter pays principle"). Currently, there are no sufficient economic incentives to reduce environmental pollution. This is a market failure ("misallocation") and an "externalization of these costs". Looking at **Option A**, not such a distribution effect will occur, as internalization of costs means actually paying the costs. Information and reporting instruments alone do not lead to internalization. In relation to Option B

The strongest distribution effect is expected to result from a potential measure C6 in **Option C**: The EPR will shift costs that carry recyclers today to manufacturers, in relation to EPR for PTW, lorries, buses and (semi-)trailers, the costs are discussed in section 3.4.4.3.1 in relation to manufacturers and in section 0 in relation to benefits for recyclers.

3.4.4.4 Impacts on stakeholders in the field of vehicles that are currently exempted from ELVD or 3R Directive and impacts resulting from discrepancies between the scope of 3R Directive and ELVD

This chapter deals mainly with multi-stage-built vehicles, small series, special-purpose vehicles and new and reused components for vehicles, which are either explicitly in the scope of the 3R Directive or explicitly excluded. As explained in the evaluation of the 3R Directive in Annex II, scopes of 3R Directive and ELVD are not similar. Currently, multi-stage-built vehicles, small series, special-purpose vehicles[336] are excluded from the 3R Directive while new and reused components of M1 and N1 vehicles are part of the scope of the 3R Directive.

At this point it must be explicitly mentioned that all policy options intend to extend the scope of the ELV legislation and 3R Directive: The definition of the policy options envisages the inclusion for all L-, M-, N- and O-type-approved vehicles. First of all, this means that the policy options foresee the inclusion of multi-stage-built vehicles, small series and special-purpose vehicles in the scope of the new ELV legislation. This is different for the new and reused components that are not covered by the policy options, though they are in scope of the 3R Directive.

The Table 3-84 names the various impact indicators for which the assessment was needed, if a proper evaluation of what the measures in the policy options have as an impact on stakeholders in the field of vehicles that are currently exempted from ELVD or 3R Directive: Administrative burden for authorities, mainly type approval authorities and technical services (can be authorities or non-authorities), administrative burden for business operators, manufacturers specifically, costs for OEMs for change of design, and competition effects.

It is anticipated that the impacts of **Option A**, at least measures A1 and A3 would be acceptable for the multi-stage-built vehicles and the special-purpose vehicles. It may not be proportionate for the small series. **Option B** could cause problems with regard to the heavy metal restrictions, e.g. for some special-purpose vehicles, but in ELVD, there is the mechanism of exemptions, so that they could be exempted from the necessary restrictions after evaluation of an exemption request. For the evaluation of the impact of the reporting on ELVs (A2) and the measures B2 (ATF) and B3 (CoD), too little is known about their current EoL treatment to be able to assess the advantages or disadvantages of such measures.

Some comments at the stakeholder workshop dealt with the multi-stage built and special vehicles, especially with regard to the definition of possible 3R targets, i.e., **Option C**: E.g., ‘please consider the special purpose and multi-stage vehicle, such as motorcaravans, when expanding the scope. The base vehicles are already subject to the requirements of ELV and 3R and fulfil the requirements. Including special purpose vehicles would not bring any improvement with regard to the aims of ELV or 3R. The bodywork of the habitation area is dismantled separately and sent to waste management. The exemptions [from scope] are still urgently needed’ (Caravaning Industrie). One participant spoke about the challenges of 3R targets for wheelchair-accessible vehicles (OECVA) and ACEA added that they had provided info regarding the complexity of multi-stage type approval for HDV earlier. As described by stakeholders and earlier in relation to the various impacts discussed above, **Option C** appears to be associated with high uncertainties in the impacts for manufacturers of multi-stage-built vehicles, small series, and special-purpose vehicles.

Motorcycle manufacturers point out spare parts that are in the scope of the 3R Directive. ACEM (2021) says that “based on a requirement that spare parts need to be provided up to 15 years after production, motorcycles will need exemptions for spare parts for type approved vehicles already produced. The design for new parts is expensive especially for low volumes. This leads to the risk that material changes for spare parts would not be realised.”

[336] Special purpose vehicles are generally exempt from the 3R Directive too, however, they are as per EC guidance document in scope of ELVD, but exempt from Art. 7 provisions of ELVD.

Other than that, six written contributions to the OPC focus on historic cars: Current practice of exempting historic cars (due to small series) should be pursued.

3.4.4.5 Social impacts

Most of the measures in the policy options are not intended/invented to have a direct impact on aspects of the society, except for health benefits associated with formalized treatment and heavy metal restrictions. Rather, the measures increase the administrative efforts or change the market situation in a way that jobs and the general public, here, vehicle owners, are effected, meaning that they are side effects.

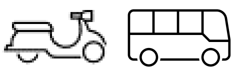
3.4.4.5.1 Jobs

As for social impacts, mainly distributional effects are expected, this means that to some extend jobs will be transferred from informal to the formalised sector, however, in most of the EU countries ELV other than M1 and N1 are treated under general conditions of the WFD.

As for social impacts, mainly distributional effects are expected, this means that to some extend jobs will be transferred from informal to the formalized sector, this is the case for measures B2 and C4 & 5. However, in many EU countries ELV other than M1 and N1 are treated under general conditions of the Waste Framework Directive. Thus, assuming that the jobs are in the formalized sector already, the number of jobs transferred to the formalized sector is marginal.

It is expected that new jobs are only created in case of Option C, when measures were introduced to ban the export and to stop the existence of unknown whereabout, and when as a consequence the numbers of ELVs to be treated in the EU increases drastically. On the other hand, it is expected that none of the measures reduces the numbers of jobs in the sector in a way that is different from development in numbers of jobs in the baseline, where, e.g., through automatization in vehicle production, a (continuation of the) reduction in jobs can be expected.

3.4.4.5.2 Health benefits from formalized treatment and heavy metal restrictions



Lead is the predominant heavy metal for which exemptions under ELVD are still allowed, see especially the exemption for lead as an alloying element. Hexavalent chromium might be used in corrosion preventive coatings in components presumably for trucks etc. It is assumed that Cd and Hg are rarely used. For this impact, examples for the damage costs from lead in waste buses and motor scooters are calculated showing the impacts for the **baseline**: Lead is mainly in the batteries of vehicles (lead-acid batteries) but also as an alloying element in steel, thus, it is expected that the higher the steel content in a vehicle, the higher the lead content (not taking into the battery). From Table 3-92 it is clear, that the lead indicated in the material composition data for this specific motor scooter can be allocated fully to the battery – or lead in steel (at least steel content in this model is ~50 kg) – was not specifically indicated. In the case of buses, the share of lead that can be allocated to the battery is just over one-third (Table 3-92). Another use of lead in larger vehicles, such as the buses, lorries and trailers are lead weights as balance correction weights. These used to be installed next to the tires, but it is expected that in such uses, lead has been replaced by other materials in recent years.

Without taking into account the lead incorporated in the batteries, the amount of lead in waste buses in 2025 in the EU is expected to be ~2600 tons (Table 3-92, 7th line). Assuming an efficiency of industrial emission control systems in shredders and recycling plants of 99,9%, the amount of lead that might be emitted from bus recycling in 2025 is 2,6 tons. Nedellec and Rabl (2016) calculated the costs for mortality and IQ losses per kilogram lead based on oral ingestion and inhalation of Pb compounds under typical conditions in Europe. The amount of damage costs for industrial emissions in the EU account for 29 343 € per kg Pb. **The damage costs for emissions from treatment of waste buses for the year 2025 could be 77,5 million €.**

Table 3-92 Lead in waste buses and motor scooters in 2025 and related damage costs

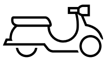
	Midibus (12t GVW)	Coach (19t GVW)	Motor scooter 50 cm3 engine
Total weight [kg]	8050	13400	93,62
Total lead content [kg]	90	156	0,82
Lead %	1,12%	1,16%	0,88%
Lead (in batteries) [kg]	34,5* (2 batteries assumed)		0,86
Lead in other materials	55,5	121,5	0
Expected no. of waste vehicles in 2025	28 061		0
Lead in ELVs (without battery) in 2025 [kg]**	828.662	1.814.003	0
Possible emissions from EoL treatment (99,9% efficiency of industrial emission control systems) [kg]	829	1.814	0
Damage costs in € in 2025	77.543.743		0

(*) For buses, one battery à 30 kg with a lead content of ~25% lead (Pb) and ~35% lead oxide (assumed PbO) contains 17,25 kg lead. For the scooter, battery weight is ~1,5 kg with the same lead content assumed, this results in 0,86 kg.
(**) assuming that the waste buses are equally divided between midibuses and coaches.
Source: Ricardo-AEA (2015) for buses, Ecoinvent for motorscooter, Nedellec and Rabl (2016) for damage costs.

This impact is not a pure environmental impact but rather relates to human health, and implementation is rather an economic question, as the calculated damage costs need to be compared to costs for implementing substance restrictions. From stakeholders, no information was obtained as to the costs for applying for exemptions or possible re-arrangements of supply chains in order to supply parts and components that do not contain the substances that are restricted. Stakeholders are of the opinion that current heavy metal restrictions cannot apply one-to-one to other vehicles but need their own evaluation (Karsten Kurz – Exide Technologies), more generally, stakeholders call 'to have category specific annexes II' (G. Gehlisch, Jörg Kleffner ACEM, Karin Alenius – ACEA). In addition to exemptions for full vehicles, one stakeholder suggested that 'exemption on the substance restrictions for spare parts' were needed 'in order to not endanger longevity of buses, HDV, motorcycles and all other vehicles.' (Dennis Eggeling, Vitesco)

Comparison of the options (relevant measures B1, B2, C4 & C5):

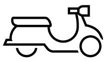
In option A, the heavy metals restrictions do not apply for vehicles that enter the scope, this means that damage costs remain the same as in the baseline. At the same time, manufacturers do not have additional costs for re-organizing suppliers, nor does the authority has costs in implementing the provision, e.g., commission consultancies in order to evaluate exemption requests. In Option B & C, the heavy metals restriction does apply, for society, this means that the expected damage costs can be saved, however, manufacturers will have costs for supplier management and costs for applying for exemption mechanisms, authorities will have costs for studies to evaluate exemption requests and market surveillance.



PTW have different requirements for materials used, e.g., as materials are exposed to weathering directly, longer lifecycles[337], different operating conditions (e.g. temperatures, vibrations, wetness, dirt etc.), higher technical characteristics (e.g. revolution speed of engine). ACEM (2021) says, ‘implementing new material restrictions is not easy and motorcycle- specific exemptions and transition times are needed. There are some synergies with cars in terms of the prohibited substances – some few suppliers are the same but most of the suppliers are different and often very small. Changes made for cars have not always been introduced for motorcycles’.

3.4.4.5.3 Impacts for vehicle owners

Option A doesn’t have any impact for vehicle owners in all vehicle categories.

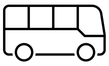


Private vehicle owners would mainly be affected from an inclusion of PTW into the ELVD. In the first place, in **Option B and C**, additional burden is associated with the management of (de-)registration and administrative efforts when the vehicle of a vehicle owner becomes an ELV. Then, the private should bring his ELV to an ATF and receive the CoD (Option B) or has additional efforts in relation to possible advanced traceability measures (Option C). Likely occurring in **Option C**, another aspect of additional burden for consumers might be potentially higher costs for new vehicles, e.g., ACEM (2021) says that ‘cost implications are foreseeable and might be a challenge for producers of motorcycles (especially those with small production volumes). It is not clear to this date whether these costs would affect the final price of the vehicle.’ Also, in relation to PTW, spare parts availability/accessibility or possibilities for informal repair, which some consumers might perceive as an easy, quick and ‘unbureaucratic’ option, might be affected from measures in **Option B** (mainly the ATF requirement) or **Option C**, mainly C4 (advanced traceability) but also C3 (3R targets) might have an effect. For impacts from restricted exports and managing the vehicles of former unknown whereabout, it is unclear whether this could make selling an ELV more difficult or easier.

In the sectors of lorries and trailers, businesses are expected to be the main costumers. Impacts from amendments of the (de-)registration procedure (**Option B**) are assessed to be less substantial than for privates and their PTW. Reasons are that lorries and trailers are already treated in ATFs in some MS, e.g., in Spain, so businesses are familiar with registration procedures and ATFs. Then, the probability is high that a business does not only own one vehicle but has a fleet for own transportation purposes or for providing lorries and/or trailers for leasing. In the latter case, the number of vehicles owned might even be higher. It is expected that the higher the number of vehicles owned, the less (administrative) effort is expected. In relation to measures under **Option C**, impacts on lorry and trailer owners might be the following: It is unclear how the acquisition costs for lorries could change if major changes have to be made in the material

[337] ACEM (2021): “15 years; cars’ lifetime is 11.5 years, thus, at least 4 years difference which means that Motorcycle ELVs are elder than car ELVs and will therefore longer contain SVHC materials which are not yet banned for motorcycles. As consequence residual amounts of SVHC due to recycling have to be tolerated (e. g. lead in aluminium alloys) for the use of quality-assured secondary materials”

selection to increase recyclability. As a consequence, depending on changes in material composition, this could result in higher fuel costs in the use phase. It is then expected that the business segment is profiting from formalized spare parts market and repair services. For impacts from restricted exports and managing the vehicles of former unknown whereabout, it is unclear whether this could make selling an ELV more difficult or easier.



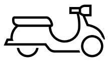
Compared to the companies that own lorries and trailers, businesses operating or providing buses for leasing are considered smaller. Here, even SMEs might be affected, e.g., bus service providers for group travelling might for example operate their business with five to a dozen of vehicles. For such entrepreneurs, the administrative effort associated with bringing ELVs to ATFs (**Option B**) might be higher than for lorry owners, however, longevity of buses result in one bus of the fleet of the bus service provider arriving at EoL, e.g., every 10 years, and probably, bus service providers are possibly organized in a business association that could provide guidance for managing ELVs. In **Option C**, probably, impacts for owners of buses are similar to lorries and trailers in relation to vehicle acquisition costs due to recyclability requirements (measures C1 & C2), for unclear impacts on fuel consumption in use, for probably more transparent and possibly more easily accessible availability of spare parts (C3), and for avoided exports (C5).

3.4.4.5.4 Comparison of the options

The five identified problems resulting in the analysis of an extension of scope of the ELVD are (1) that the potential to contribute to the CE of a large share of vehicles is not exploited yet, (2) as for cars and vans, traceability for vehicles not in scope of ELVD is not given/missing, export volumes of used vehicles are high. (3) For vehicles not in scope of ELVD, there is no legal incentive to design for circularity, (4) the current legal setup is insufficiently harmonized across the EU, and (5) discrepancies were identified in the scopes of ELVD and 3R Directive. And to add, (6) problems are expected to increase due to an expected increase of the total amount of vehicles.

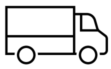
While of the above-mentioned problems, those numbered 3, 4 and 6 are equally relevant to all vehicle categories, in terms of problems numbered 1, 2 and 5 the most important aspects for different vehicle categories are:

PTW:



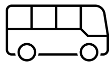
- The contribution to circular economy is expected high in terms of reuse, but uncertainties exist for other EoL routes and related stakeholders, incl. their market shares, applicability of environmental standards, illegal operations, etc.;
- the legislation is insufficiently harmonized;
- missing vehicles and export of used vehicles cannot be quantified.

Lorries:



- The lack of control on extra-EU export (~74% of expected ELVs) and transboundary shipment of ELVs within the EU, mainly because EVLs do not have to be reported by the MS;
- There is a lack of knowledge about EoL material flows;
- The use of lightweight, non-recyclable materials is probably relevant;
- The discrepancy between the scopes of ELVD and 3R Directive for lorries, being mainly multi-stage built vehicles, is relevant.

Buses:



- Lack of export control is probably a considerable problem, though in smaller range as for vehicles for transport.
- Probably weight reduction plays a role, but details are not known.
- It can be assumed that the circularity potential is not exploited.

(Semi-)Trailers:

- There is a large mass of materials from trailers for which there is currently no information available on their end-of-life (and for their design). It is therefore unclear whether the CE potential is exploited, where the levers for the CE lie, or whether there are problems with inadequate treatment.

Market and regulatory failures drive the problems. It is perceived an option to tackle the problems associated with vehicles in general in a (revised) ELV legislation. The related main objective is to *ensure a comprehensive coverage of the sustainable production and waste management at EoL (dismantling, sorting, reuse, recycling, recovery, disposal) of all relevant vehicles by the ELV Directive*. Thus, when ELVD is aiming at the promoting a circular approach in the production and end-of-life treatment of vehicles and that all vehicles are collected and recycled, the objective is to ensure the promotion of circularity and collection & recycling for vehicles currently outside of the scope of ELVD as well.

As the problems for PTW, lorries, buses and (semi-)trailers were found to be similar to those of cars and vans, the extension of scope to PTW, lorries, buses and (semi-)trailers has been considered and assessed together with different sets of requirements: A set of reporting obligations (Option A), reporting obligations and some requirements currently in place for M1 and N1 vehicles (Option B), and an application of the full set of requirements that are under consideration for M1 and N1 as part of the IA as well.

The comparison of the options is provided in a tabular format on the next page: Table 3-93.

3.4.4.6 Efficiency, effectiveness, and coherence

As all three options include that the scope of the legislation shall be expanded, however, under each option, a different set of requirements shall be set. Thus, the **effectiveness**, i.e., the extent to which the options may achieve the objective is coupled with the requirements which shall apply for the different vehicle categories. While Option A is supporting the objective through providing additional information to decide what may be “a comprehensive coverage”, Option B is already targeting specific production and EoL management steps, e.g., the heavy metal restrictions are a design requirement allowing better sorting of hazardous waste. Then, Option C, is expected to fully support the objective, provided that the ambition level and targets of the measures will be formulated and worked out in a way that isn’t contra productive, e.g., high recycling targets while reuse is highly relevant.

The **efficiency** describes the cost-benefit-ratio. For Option A, high costs are expected for OEMs, ATFs, incl. SMEs, and Member States which are not connected with direct benefits except for a potential small increase of benefits from circularity when dismantlers and recyclers know better the composition, location and hazardous substances contents. Thus, this option is considered highly inefficient. In Option B, compared to Option A, though additional costs occur for various stakeholders, costs are probably not so much higher, but benefits are expected from heavy metal restrictions and formalized treatment. Finally, in

Option C, it was identified, that measures cause high costs, which are not quantifiable, and unclear benefits (too many unknowns).

In terms of the **coherence** of the options with overarching objectives of EU policies, all of the three options contribute to the goals set out in the Circular Economy Action Plan (European Commission 2020a). The lack of knowledge is greatly affecting authorities in fact-based decision making in relation to measures to take in line with political priorities. In terms of individual legislative initiatives and existing regulation, relevant legislations to ensure coherence with are REACH, the general type approval and 3R Directive specifically. It was identified that in the case of a change in the scope of ELVD without parallel changes in the scope of the 3R Directive, 3R Directive cannot be used as a means to further implement additional requirements in relation to measures to support design for circularity. As a consequence, the regulator loses its mechanism to check compliance of design requirements supporting the ELV treatment. For chemical legislation, it should be avoided to have multiple, possibly contradicting requirements of different legislations for the same substances with the same scope (see this aspect covered under the aspect of hazardous substances specifically).

Table 3-93 Comparison of the options for main objective 1

Option →	A			B (+A)			C (+B +A)					
Impact indicators ↓	A1 Info for recyclers	A2 ELV reporting	A3 EoL report	B1 Haz. Subst.	B2 ATF	B3 CoD	C1 3R TA	C2 D4CE	C3 3R	C4 trace.	C5 export	C6 EPR
Materials available for reuse and recycling	0			0			0	+++		+++		0
Envi	n.a.			Benefits from heavy metal restrictions (+++)	Benefits from formalised treatment (++)	n.a.	Indirect (no data)	Benefits from increased circularity, e.g., less resources consumed associated with less CO_2 emissions		Benefits from vehicles formalized treatment, no leakage of hazardous fluids or less exhaust gas emissions from recycling		n.a.
Economic impacts for vehicle manufacturers	Costs for providing information to recyclers and for the one-off EoL report			Supply chain management; costs for changing the design, might apply for exemptions, if needed.	n.a.	n.a.	Costs in change of the design, administrative costs (- -)	Costs in change of the design, competition effects (0 to - -)		n.a.		(- to - - -)
Impacts for stakeholders affected from scope discrepancies between 3R and ELV Directive [1]							Costs in change of the design, administrative costs (- - -)	Costs in change of the design, competition effects (0 to - - -)				
Economic impacts for EoL stakeholders	Costs for providing information for ELV reporting and one-off EoL report			Minimal benefits for management of less hazardous waste	Authorization process (no data)	Administrative burden	n.a.	(- - - to +++)		(- - - to +++)		(+ to +++)
Economic impacts for SMEs	Higher costs compared to bigger companies			Higher costs compared to bigger companies			(no data)	(no data)		(no data)		(no data)

Option →	A			B (+A)			C (+B +A)				
Administrative (economic) burden for public authorities (MS + EC or MS/EC only)	EC for providing the concept (--)	MS for collection of data for Eurostat (- to - - -) [2]	MS for collection of data (- -) EC for study (- -)	EC for exemption evaluation and ensure compliance (if not through 3R Directive) (-)	MS for additional market surveillance (-)	MS for registration processes (-)	MS (- - -) EC for follow up with UNECE (-)	n.a.	MS and EC	MS and EC	MS or EC
Distributional economic effect	n.a.			Internalization of external costs, covered by EoL stakeholders, if not combined with EPR (C6)			n.a.	n.a.	Internalization of external costs		(No data)
Social	n.a.			Health benefits from heavy metal restrictions	Jobs transferred to the formal sector; additional burden for consumers in managing an ELV		n.a.	Increase of jobs due to an increase in the numbers of ELVs to be treated in the EU			n.a.
Effectiveness/Proportionality[338]	Low (0)			Medium (+)			Uncertain (- - - to +++)				
Efficiency (cost benefit ratio)	Highly inefficient (- -)			Low efficiency (+)			Uncertain: high costs but unclear benefits (- - - to +++)				
Coherence	Contribution to closing the lack of knowledge hindering authorities in fact-based decision making			Small contribution to CE			High contribution to CE probably not coherent with 3R Directive				

Abbreviation: n.a. = not applicable

Notes:
[1] includes multi-stage built, special purpose vehicles and small series
[2] dependent on the system setup of ELV reporting in the Member States
0: no impact; Costs or burdens: between 1 and 3 minus signs (-; --; or ---), indicating low (1 minus sign) and high (3 minus signs) costs or burdens; Benefits or savings: between 1 and 3 plus signs (+; ++; or +++), indicating low to high savings

338 BRG Tool #5, Section 3: "The principle of proportionality under the Treaty regards the policy initiative itself and needs to be distinguished from an IA which can be 'proportionate' in terms of the depth of the analysis provided. It means that the action of the EU must be limited in its content and form to what is necessary to achieve the objectives of the Treaties that it intends to implement"

3.4.5 Conclusion

Overarching conclusions

To address the above-mentioned problems, measures proposed under Option C are concluded to have very high uncertainties under the various impact indicators as well as in relation to effectiveness and efficiency. This is particularly true as long as it is not clear which measures would actually be implemented for M1 and N1 vehicles. Furthermore, there is a risk that measures will not sufficiently support the achievement of the objective: As to specific requirements under consideration for M1 and N1 vehicles as well as for new vehicles in scope, there are too many variants of measures, reaching from soft tools to far-reaching regulatory options, e.g., sub-options C2 (Design for circularity) or C4 (advanced traceability). Stakeholders have warned that separate recycling targets could jeopardize current repair and reuse practices as ATFs could compete with such operators to ensure fulfilment of the recycling target. Such argumentation could also be supported by Member States to avoid infringement proceedings. From the inputs of stakeholders (e.g., ACEM, ACEA, Swedish government agencies), it is assumed that if the same level of ambition proposed for passenger cars is proposed for new vehicles in scope that it will create distortions, e.g., as reuse seems to be highly established, high recycling targets would set the wrong incentive. This could affect the possibility to achieve a recycling and recovery target. The assessment shows that some measures in the various sub-options in Option C have the potential to beneficially contribute to achieving the objective, e.g., a reuse+recycling target (C3) or advanced traceability (C4) and export restrictions (C5). However, ambition levels cannot be set at this point due to the lack of data. In addition, at this point of the assessment and with the information and data that is available, it is unclear whether the benefits will be higher than the burden.

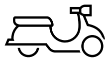
Option A is not recommended, as it is inherent to the nature of information requirements that economic burdens, i.e., costs for reporting and administrative burden, are high but benefits are not directly expected (highly inefficient). Indirectly, benefits from an increase of circularity can be expected, if the information gathered through these provisions will be used to design and implement measures based on the findings in the future. However, this is not foreseen in Option A. Compared to the problems described and the extent of impacts in the baseline, measures of Option A are considered not proportionate (low effectiveness), i.e., insufficient to contribute to the objectives in appropriate way.

Option B is considered the preferred option. The strongest argument is the cost-benefit ratio (efficiency): The Option includes the information requirements (A1-3) for which economic burden in the form of administrative costs can be expected to be comparable to those of Option A. However, measures B1-B3 result in environmental benefits, namely benefits from heavy metal restrictions and from formalized treatment. These measures will have an additional medium economic burden, i.e., costs for supply chain management and authorization of dismantling facilities. However, the total economic burden of Option B is considered appropriate in light of the objective it will reach and the problems that it will solve. At the same time, measures provide initial environmental benefit, contribute to EU-wide harmonization and points the way that the sector of vehicles other than M1 and N1 shall follow in order to address the problems identified in all vehicle subsectors. This is described in detail below for all vehicle categories individually.

The finding, that sub-options of **Option C** are assessed as generally beneficial provided that data is available to tailor them accordingly to the vehicle specifications, suggests, that these provisions might be considered for the future. This will include any new provisions to have been introduced for passenger cars.

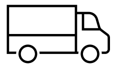
Another general finding is that regardless of the option chosen, it is important to align the scope of ELVD and 3R Directive, vehicle related aspects of this conclusion are referred to below.

Vehicle specific conclusions



PTW:

- Option A is even more inefficient for PTWs as in the sector, many companies are expected to be SMEs thus, reporting will burden them proportionally more than it does bigger companies.
- Some of the measures in Option B are already implemented at MS level, e.g., Italy[339]. It is considered appropriate to follow MS approaches to achieve more harmonisation.
- Not enough information is available on PTW, in particular for circularity-related measures and for traceability-related measures in Option C, to conclude on a meaningful setup of targets/ambition level nor on respective impacts.
- When aligning the scopes of 3R Directive and ELVD, for PTW in particular, the question is whether the spare parts that are currently in the scope of the 3R Directive will also be in the ELVD scope.[340]



Lorries (base-vehicle):

- Option A is considered inefficient, e.g., compared to other vehicles, as industry already exchanges information with recyclers (via IDIS).
- As to the requirements in Option B, here too some MS have measures in place, e.g., Spain has established ATFs for dismantling of lorries. For the heavy metals, it will be proportionate to establish an individual Annex II, or vehicle category specific exemptions. Thus, a medium effort is expected to be needed to comply with measures proposed in Option B.
- The biggest problem in relation to lorries is the lack of control on extra-EU export (~74% of expected ELVs) and transboundary shipment of ELVs within the EU. Measures to address these problems are not part of Option B but only of Option C. Though considered an important measure, the impacts cannot be ultimately quantified. Generally, it is assumed that such a measure has high impacts at macro-economic level.
- For the circularity-related measures in Option C, as for other vehicles, not enough information is available to conclude on a meaningful setup of targets/ambition level nor on respective impacts.
- For the base vehicle of a multi-stage-built vehicle, already today 3R Directive requirements are applicable. It is considered appropriate to continuously apply the rules to the base vehicle.

Small series, special purpose vehicles and multi-stage-built vehicles:

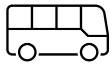
- These vehicles contribute to the problems only to a small extent, as the number of vehicles in these fleets is small and various small volume manufactures are involved. It is not proportionate to expect high administrative costs for the fact that overall (also in the future) these vehicles can be expected to make little contribution to solving the problem.
- In relation to these vehicles, it is of enormous importance to word-for-word align the scopes of 3R Directive and ELVD, see the various discrepancies described in Annex II.

[339] Though impacts of the Italian legislation are not yet evaluated due to the short time since the coming into force

[340] This aspect was identified late in the study and therefore not assessed.

- It is thus concluded to completely exclude small series, special purpose vehicles and multi-stage built vehicles from ELVD and 3R Directive.

Buses:



- Very little is known on the EoL of buses throughout the EU. Thus, information requirements under Option A might shed light on the unknowns.
- The impacts of any other measure/option are expected to be too uncertain to conclude on their efficiency. Whether as for the two vehicle categories above, Option B does (not) put so much additional burden on the sector and authorities, is unclear.
- Though export of buses is considered relevant on a relative scale, i.e., export of used vehicles compared to expected ELVs, in absolute numbers, fewer buses are concerned compared to the trailers and lorries. It is considered inappropriate to take measures related to traceability and export (as in option C) for such vehicles.

(Semi-)Trailers:

- See buses.

3.4.6 Reporting and monitoring requirements

Together with the investigation and decision on new provisions to apply to the vehicles newly in scope, it should also be considered how reporting is to be updated to accommodate any additional needs for information.

The reporting of relevant information for dismantlers and recyclers (A1) is a task for manufacturers of vehicles. At this point of time, the list of items to be informed about and the means to do so are not yet decided. The aspect has interrelations with other EU initiatives, such as the Digital Product Passport, and a comparable measure is proposed for M1 and N1 vehicles under 'circularity'. It is recommended to align the measures and initiatives in this regard. Reporting of ELVs (A2) will result in additional administrative burden for ATFs/dismantlers, national authorities, registration services and EU authorities, e.g., Eurostat. Setting up a new reporting system for waste PTW, lorries, buses and (semi-)tailers might be linked to and shall follow the same procedure than the reporting of waste cars and vans. The one-time reporting obligation (A3) is subject to considerable effort for the Commission and national authorities (development, collection of data, review of collected data) and to a lesser extend also for individual business operators who are responsible for providing the raw data, i.e., manufacturers reporting on their current circular design practices, and EoL stakeholders reporting the status quo of the treatment of PTW, lorries, buses and (semi-)trailers. As a first step, existing data on material flows of ELVs other than M1 and N1 vehicles shall be collected to identify the data gaps for which the one-off reporting of MS should provide additional insights. Effort for reporting can be massively reduced when based on online reporting or even tracking of vehicles, maybe for a representative collection of vehicles.

When looking at how the measures for heavy metal restrictions, ATF and CoD requirement are designed in the current ELVD, it is the responsibility of MS to ensure compliance, report and monitor. Where these measures are updated for M1 and N1 vehicles through measures discussed in other chapters/in relation to other objectives of this study, a harmonized approach might be taken for new vehicles in scope. Otherwise, current design of these measures in ELVD might be taken over for the new vehicle categories.

Provided that measure A3, the one-off reporting on EoL, is implemented with a time advantage over Option C, the developed format might be evaluated in relation to the suitability for reporting and monitoring for measures in Option C afterwards.

4. Overarching effects between the fields of action

For the final assessment of the combination of the preferred options it is important to crosscheck the preferred options assessed above on overarching effects and whether they Options have adverse impacts.

The figure below provides a qualitative overview of the interrelations between the areas assessed and the subsequent chapters a qualitative assessment of the overarching impacts.

Figure 4-1 Interrelations

Impact on: / Impact of:	Circularity	Missing Vehicles	EPR	Hazardous substances	ELVD Scope extension
Design for circularity (3R TA and other)		+/-	+	Currently n.a.	(+)*
High quality reuse and recycling		(-)	(-)	Currently n.a.	+
Missing vehicles	++		(-)	Currently n.a.	+
EPR	++	+		Currently n.a.	+
Hazardous substances	+	Currently n.a.	Currently n.a.		Currently n.a.
ELVD Scope extension	(+)			Currently n.a.	

*Will depend on which measures are implemented for other than M1 and N1 vehicles.

4.1 Impacts of design for circularity on the other fields of action

4.1.1 On Missing vehicles

An improved design for the circular economy could make dismantling parts for remanufacturing, disassembly and recycling more attractive, thus increasing the profitability of dismantlers. This might make it attractive to direct ELVs to ATFs. However, this could also apply to illegal dismantlers and the linkage will only take effect with a delay of 15 to 20 years after the ELV Regulation enters into force. Judgement: no direct impacts

4.1.2 On EPR schemes

In the long-term advanced design for recycling might reduce costs for obligatory dismantling (e.g. traction batteries of EV are easier to dismantle). The required cost compensation could then decline: judgement: positive impact

In the mid- to long-term, the data provided by OEMs to ATF could become more fit-for-purpose through its harmonisation as well as when OEMs realise through dismantling and shredding tests, they perform what information would facilitate quicker dismantling. This could reduce costs for obligatory dismantling and in turn lead to a decline in dismantling costs: judgement: positive impact.

4.1.3 On the Extension of the vehicle categories in scope of the ELV Directive

Even if the measures considered for "design for circularity" are not implemented for new vehicles in scope in the mid- to long-term, it could be expected that the circularity of "new vehicles in scope" shall increase, as some manufacturers of M1 an N1 vehicles also manufacture other vehicle types. These would be expected at least in some cases to apply similar practices to the design of "new vehicles in scope", leading in the far future at least to a small increase in circularity.

4.2 Impacts of high-quality reuse and recycling on the other fields of action

4.2.1 On Missing vehicles

Demanding requirements aimed at ensuring high-quality recycling, but which are not economical for dismantlers and shredders, may result in fewer end-of-life vehicles being sent to ATFs and more end-of-life vehicles being treated by illegal companies. This can only be avoided if these additional compliance costs are covered by an appropriate EPR system. In this respect, the combination with a compensation of compliance costs is inevitable if the objective of reducing the number of missing vehicles is not to be jeopardized.

4.2.2 On EPR schemes

Depending on the level of requirements EPR schemes and producers (and subsequently consumers) are exposed to higher cost compliance compensation. Therefore, the requirements need carful substantiation on efficiency and effectiveness.

4.2.3 On the Extension of the vehicle categories in scope of the ELV Directive

As it can be understood that at least some waste operators of passenger cars (ATFs but also shredder and subsequently recyclers) also treat some of the "new vehicle categories", it is likely that improvements in the quality of recycling will have an impact also on the recycling of such vehicles.

4.3 Impacts of reduced number of missing vehicles on the other fields of action

4.3.1 On circularity

The reduced export of old vehicles similar to ELVs will increase the volume of ELVs directed to ATFs and shredders and as such increase the circularity. If more ELVs are directed from illegal treatment within the EU to ATFs this will increase the potential for reuse, while it is assumed that this will not impact the volume treated by shredders as the depolluted carcass is currently sent to shredder too.

4.3.2 On EPR schemes

In combination with requirements regarding the quality of reuse and recycling the reduced export of old vehicles similar to ELVs will increase the demand for compliance cost to be compensated by producers and finally most likely to be covered by the consumers.

4.3.3 On the Extension of the vehicle categories in scope of the ELV Directive

As the problem of "missing vehicles" is understood to also be relevant for the "new vehicle categories", measures to reduce the number of missing vehicles are also relevant for such vehicles, and when implemented would lead to a decrease in the number of missing vehicles. Nonetheless, should such measures not be applied for new vehicle categories in scope, it is still possible that some small benefits would incur, due to the increase in awareness of e.g., authorities dealing with EU trade and extra-EU exports to such problems, and due to the implementation of new practices to address the problems of missing vehicles.

4.4 Impacts of EPR scheme on the other fields of action

4.4.1 On circularity

EPR schemes and in particular compliance cost compensation are an inevitable element, necessary for the functioning of challenging requirements aimed at ensuring high-quality recycling, but which are not economical for dismantlers and shredders.

4.4.2 On Missing vehicles

EPR schemes is a supportive element to reduce the number of missing vehicles and has additional positive effects.

5. References

2005/293/EC (2005): European Commission. COMMISSION DECISION of 1 April 2005 laying down detailed rules on the monitoring of the reuse/recovery and reuse/recycling targets set out in Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles, 2005/293/EC, Version of 1st April 2005. In: Official Journal of the European Commission (L 94/30).

345/2021 Coll. (2021): Czech Republic. Decree on details of the management of end-of-life vehicles. Provided to the consultant in English as Annex to a bilateral communication., 345/2021 Coll.

542/2020 Coll. (2020): Czech Republic. Act on End-of-Life Products. Provided to the consultant in English as Annex to a bilateral communication., 542/2020 Coll.

92/61/EEC (1992): European Council. Council Directive 92/61/EEC of 30 June 1992 relating to the type-approval of two or three-wheel motor vehicles, 92/61/EEC. In: *Official Journal of the European Union* 225, pp. 72–100.

Abdullah, Z. T. (2021): Remanufacturing end-of-life passenger car waste sheet steel into mesh sheet: A sustainability assessment (16(10)). PLoS One (ed.). Online available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8513846/#pone.0258399.ref002.

ACEA (2021a): Interview documentation - Part II, Interview held as part of the ELV IA Study on 15.11.2021. (The documentation was made available to the EC), 2021.

ACEA (2021b): Interview documentation Part I, Interview held as part of the ELV IA Study on 15.11.2021. (The documentation was made available to the EC). ACEA (ed.), 2021.

ACEA (2021c): Vehicles in use in Europe. European Automobile Manufacturers (ACEA). ACEA (ed.). Online available at https://www.acem.eu, last accessed on 12 Nov 2021.

ACEA (2022): Position paper on the 3R Directive.

ACEA/Volvo (2021): Interview Documentation - Part I: HDV, Interview held as part of the ELV IA Study on 15.11.2021. (The documentation was made available to the EC).

ACEM (2021): Interview Documentation, Interview held as part of the ELV IA Study on 09.11.2021. (The documentation was made available to the EC).

ACEM (2022): Market Data, The motorcycle industry in Europe. ACEM (ed.). Online available at https://acem.eu/market-data, last updated on 04/2022, last accessed on 18 Jul 2022.

ADEME (ed.) (2020): The Anti-Waste Law in the daily lives of the French people, what does that mean in practice?. Online available at https://circulareconomy.europa.eu/platform/sites/default/files/anti-waste_law_in_the_daily_lives_of_french_people.pdf, last accessed on 19 Jul 2022.

ADEME and SURPLUS MOTOS (2022): Study about dismantling of vehicles, Material compositions of motorcycles, quads and cars without licence provided as a contribution to the ELV IA.

ADEME, France (2015): ÉVALUATION ÉCONOMIQUE DE LA FILIERE DE TRAITEMENT DES VEHICULES HORS D'USAGE (VHU). In collaboration with TERRA SA - DELOITTE - BIOIS.

Al-Lami et al. (2018): Eco-efficiency assessment of manufacturing carbon fiber reinforced polymers (CFRP) in aerospace industry. In collaboration with Al-Lami, A., Hilmer, P. & Sinapius, M. (79 (2018) 669–678). Aerospace Science and Technology. Elsevier Masson SAS (ed.). Online available at https://elib.dlr.de/121124/1/1-s2.0-S1270963818300774-main.pdf.

Andersson et al. (2019): Challenges of recycling multiple scarce metals: The case of Swedish ELV and WEEE recycling. In collaboration with Andersson, M., Ljunggren Söderman, M., Sandén, B. (63. edition). Resources Policy. Online available at http://dx.doi.org/10.1016/j.resourpol.2019.101403.

Argonne National Laboratory. GREET Model: The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model. 2021. GREET2: vehicle manufacturing cycle model of vehicle technologies. Available online: https://greet.es.anl.gov

ANERVI/AETRAC (2021): Interview Documentation, Interview held as part of the ELV IA Study on 12.11.2021. (The documentation was made available to the EC).

ARN (2022a): Maltha Glasrecycling sees opportunities here, Endless recycling. ARN, Netherlands (ed.). Online available at https://arn.nl/en/endless-recycling/, last accessed on 10 Aug 2022.

ARN (2022b): The unexpected repercussions of the pandemic 2021 was a dynamic year for car recycling, The shredder company: HKS. Online available at https://duurzaamheidsverslag2021.arn.nl/en/car-recycling/2021-was-a-dynamic-year-for-the-car-recycling-sector/, last accessed on 14 Aug 2022.

ARN, Netherlands (2021): Documentation of Interview held on 12.11.2021 as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles', 12 Nov 2021.

Arnold et al. (2021): Economic Viability of Extracting High Value Metals from End of Life Vehicles. In collaboration with Arnold, M.; Pohjalainen, E.; Steger, S.; Kaerger, W. and Welink, J.-H. Sustainability, 13, 1902. Online available at https://doi.org/10.3390/su13041902.

Auto Recycling World (2021): SRN – 10 years of scooter recycling in the Netherlands. Auto Recycling World (ed.). Online available at https://autorecyclingworld.com/srn-10-years-of-scooter-recycling-in-the-netherlands/, last updated on 29 Sep 2021, last accessed on 20 Jul 2022.

Baron et al. (2020): Study to support the review of the list of restricted substances and to assess a new exemption request under RoHS 2 (Pack 15). In collaboration with Baron, Y., Koehler, A. Gensch, C.O, Loew, C., Moch, K., Moeller M., Deubzer, O. & Clemm, C. Oeko-Institit e.V & Fraunhofer IZM. Online available at https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_15/Final_Results/RoHS_Pack_15_Final_Report_2020_compressed_version.pdf.

Betz, J.; Buchert, M.; Dolega, P.; Bulach, W. (2021): Resource consumption of the passenger vehicle sector in Germany until 2035 – the impact of different drive systems. Oeko-Institut e. V. (ed.). Online available at https://www.oeko.de/fileadmin/oekodoc/Resource-demand-drive-systems.pdf.

Björkman, B.; Samuelsson, C. (ed.) (2013): Recycling of Steel. In Handbook of Recycling. In collaboration with Worrell, E., Reuter, M. Oxford, UK: Elsevier.

BMUV (2022): Written Comments of the Federal Republic of Germany as a follow-up to the workshop for member states on 31 March 2022 in support of the impact assessment to be carried out by the COM in the context of the joint review of Directive 2000/53/EC (ELV Directive) and Directive 2005/64/EC (“3R type-approval” Directive. In collaboration with Germany (MS). Federal Ministry for the Environment, Nature Conservation (ed.).

BMW (2021): EMISSION-FREE INTO THE FUTURE. BMW Group (ed.). Online available at https://www.bmw.ie/en/topics/fascination-bmw/bmw-i/sustainability.html, last accessed on 26 Oct 2021.

BMW Group (ed.) (2022): Bilateral meeting BMW & EC 14.06.2022, Consultants were provided with meeting documents.

Böni et al. (2014): Recycling of ICT Equipment in Industrialized and Developing Countries. In collaboration with Böni, H.; Schluep, M. and Widmer, R. (ICT Innovations for Sustainability. Advances in Intelligent Systems and Computing 310). Springer International Publishing (ed.). Hilty, L.M., Aebischer, B.

Bouter, A.; Emmanuel Hache; Cyprien Ternel; Sandra Beauchet (2020): Comparative environmental life cycle assessment of several powertrain types for cars and buses in France for two driving cycles: “worldwide harmonized light vehicle test procedure” cycle and urban cycle. In: *International Journal of Life Cycle Assessment* 25, pp. 1545–1565. Online available at https://www.researchgate.net/profile/Anne-Bouter-2/publication/341598523_Comparative_environmental_life_cycle_assessment_of_several_powertrain_types_for_cars_and_buses_in_France_for_two_driving_cycles_worldwide_harmonized_light_vehicle_test_procedure_cycle_and_urban_cycle/links/5ed608a692851c9c5e725925/Comparative-environmental-life-cycle-assessment-of-several-powertrain-types-for-cars-and-buses-in-France-for-two-driving-cycles-worldwide-harmonized-light-vehicle-test-procedure-cycle-and-urban-cycle.pdf, last accessed on 12 May 2022.

BOVAGandRAI (2022): Scotter Recycling Netherlands. BOVAG and RAI (ed.). Online available at https://scooterrecyclingnederland.nl/, last accessed on 20 Jul 2022.

Brahmst, E. (2006): Copper in End-of-Life Vehicle Recycling. Manufacturing, Engineering & Technology Group Center for Automotive Research. Copper Development Association (ed.). Online available at https://www.cargroup.org/wp-content/uploads/2017/02/Copper-in-End_of_Life-Vehicle-Recycling.pdf.

Buchner, H.; Laner, D.; Rechberger, H.; Fellner, J. (2017): Potential recycling constraints due to future supply and demand of wrought and cast Al scrap - A closed system perspective on Austria (122, pages 135-142). Resources, C. a. R. (ed.).

CEWASTE Consortium (2021): CEWASTE requirements for improving CRM recycling from WEEE and waste batteries, CEWASTE voluntary certification scheme for waste treatement. CEWASTE Consortium (ed.). Online available at https://cewaste.eu/wp-content/uploads/2021/04/CEWASTE-Normative-Requirements.pdf.

COM(2015) 614 final (2015): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Closing the loop - An EU action plan for the Circular Economy. Online available at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1453384154337&uri=CELEX:52015DC0614.

COM/2016/0782 final (2016): European Commission. Report from the Commission to the European Parliament and the Council on the operation of the system of access to vehicle repair and maintenance information established by Regulation (EC) No 715/2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, COM/2016/0782 final. Online available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0782#footnoteref7.

CPA (2021): Circular Plastics Alliance – Roadmap to 10 Mt recycled content by 2025. Circular Plastis Alliance (ed.).

Czech Ministry of Environment (2021): Written input to the ELV IA Open Public Consultation.

Daehn, K. E. (2019): Copper contamination in end-of-life steel recycling, developing a new strategy from million-tonnes to milligrams. University of Cambridge (ed.).

Daehn, K. E.; Cabrere Serenho, A.; Allwood, J. M. (2017a): How Will Copper Contamination Constrain Future Global Steel Recycling? Environmental Science & Technology: 51, Pages 6599-6606.

Daehn, K.; Cabrere Serenho, A.; Allwood, J. M. (2017b): How will copper contamination constrain future steel recycling? - Supplementary Information.

Deloitte & ADEME (2019): Annual report the End-of-Life Vehicle observatory – 2017 data. In collaboration with Véronique MONIER, Radia BENHALLAM, Florent MACCARIO, Rafael BASCIANO, Eric LECOINTRE. Deloitte Développement Durable & ADEME (ed.).

Deloitte (ed.) (2022): Impacts of international open standards on circularity in Europe. Online available at https://www2.deloitte.com/content/dam/Deloitte/pl/Documents/Reports/pl_Impact_of_international_open_standards_on_circularity_in_Europe_April2022_2.pdf, last accessed on 9 Jul 2022.

Dervisevic, D. (2021): Market of motorcycles and mopeds in the EU 2019, (based on ACEM study). motorradonline.de (ed.). Online available at https://www.motorradonline.de/ratgeber/eu-motorrad-studie-von-oxford-economics-arbeitsplaetze-oekobilanz-vorteile-fuer-pendler/, last updated on 13 Sep 2021, last accessed on 20 Mar 2022.

Destatis (9 Mar 2020): Press release: Motor vehicles, trailers and semi-trailers - Germany's most important export goods in 2019 for the tenth year in a row. Wiesbaden, Germany. Online available at https://www.destatis.de/EN/Press/2020/03/PE20_082_51.html, last accessed on 10 Mar 2022.

DexCraft (2015): Aluminium vs carbon fiber – comparison of materials. DexCraft (ed.). Online available at http://www.dexcraft.com/articles/carbon-fiber-composites/aluminium-vs-carbon-fiber-comparison-of-materials/.

Directive 2000/53/EC (2000): European Commission. DIRECTIVE 2000/53/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL DIRECTIVE 2000/53/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 September 2000 on end-of life vehicles, Directive 2000/53/EC. In: *Official Journal of the European Commission* (L 135).

Directive 2005/64/EC (2005): DIRECTIVE 2005/64/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 October 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC, Directive 2005/64/EC. In: *Official Journal of the European Union* (L310/12).

Directive 2008/98/EC (2008): European Parliament; European Council. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, Directive 2008/98/EC. Online available at https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32008L0098, last accessed on 18 Jul 2022.

Directive 2011/65/EU (2011): European Commission. Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, Directive 2011/65/EU. In: *Official Journal of the European* (L 174,).

Duwe, C.; Goldmann, D. (ed.) (2012): Stand der Forschung zur Aufbereitung von Shredder-Sanden., In: Recycling und Rohstoffe. Band 5: TK Verlag.

EC (2015): Light weighting as a means of improving Heavy Duty Vehicles' energy efficiency and overall CO2 emissions, Heavy Duty Vehicles Framework Contract – Service Request 2. Online available at https://nanopdf.com/downloadFile/light-weighting-as-a-means-of-improving-heavy-duty-vehicles_pdf.

ECHA (2022), Substances of Concern In articles as such or in complex objects (Products) - SCIP Database. ECHA (ed.). Online available at https://echa.europa.eu/de/scip, last accessed on 18 Jul 2022.

Ecoinvent (ed.): Data for motor scooter production, 50 cubic cm engine.

EGARA (2021): Documentation of Interview held on 27.10.2021 as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles'. Email with Oeko-Institut e. V., 17 Dec 2021.

EGARA (2022a): Feedback after day 1 of the Workshop on the supporting study to the impact assessment of the ELV Directive. Email with Oeko-Institut e. V., 24 Mar 2022.

EGARA (ed.) (2022b): Contribution to the ELV Directive Revision on Motorcycle dismantling, submitted 23.03.2022, 2022.

Elliott, T.; Hudson, J.; Gillie, H.; Watson, S.; Lugal L.; Almasi, A. (2019): Final Report on the Implementation of Directive 2000/53/EC on End-of-Life Vehicles, For the period 2014–2017.

Elwert, T.; Goldmann, D.; Roemer, F.; Schwarz, S. (2017): Recycling of NdFeB Magnets from Electric Drive Motors of (Hybrid) Electric Vehicles (3, pages 108-121). Journal of Sustainable Metallurgy.

EU Aluminium (ed.) (2022): Contribution to the ELV directive Revsision, submitted on 04.04.2022.

EU MS ELV IA Survey (2022): Evaluation of survey questionnaires from EU MS as part of ELV Impact Assessment Study, (unpublished).

EuRIC (2021): Interview Documentation, Interview held as part of the ELV IA Study on 15.11.2021. (The documentation was made available to the EC).

EuRIC (2022a): EuRIC call for recycled plastic content in cars, Position paper. EuRIC (ed.), 19 Apr 2022.

EuRIC (2022b): EuRIC feedback to the ELV Stakeholder Workshop (24-25 March 2022). EuRIC (ed.), 19 Apr 2022.

EuRIC MTR (2022): Meeting with European Commission on mandatory recycled content targets for rubber sourced from ELT, In the frame of the Revision of ELV and 3R Type Apprival Directives. Euric Mechanical Tyre Reccyling Branch. Virtual meeting, 4 Feb 2022.

EUROFER (2021a): Comments to Public Consultations.

EUROFER (2021b): Written input to the ELV IA Open Public Consultation.

EUROFER (27.10.21): Confirmed documentation of Interview held as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles'. Email with Oeko-Institut e. V. Virtual meeting, 27.10.21.

Euro 7 fleet data (Aeris Europe 2021 and ACEA 2021)

Eurometaux (21 Feb 2021): Interview held as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles'. Confimred documentation. Interview with Oeko-Institut e. V. Virtual meeting.

European Aluminium (2022): Written feedback - after the meeting on 24th/25th March 2022 on the review of the ELV Directive. European Aluminium (ed.), 12 Apr 2022.

European Commission (2015): Administrative Cost Model, According to BRG 2015. European Commission (ed.). Online available at https://ec.europa.eu/smart-regulation/impact/docs/eu_cost_model_report_sheet_v2.xls, last accessed on 7 Aug 2022.

European Commission (2022a): EU trade statistics database, Transport vehicles (HS) codes: 87042291, 87042299, 87042391, 87042399, 87043291, 87043299. Road tractor (HS) codes: 87012090, 87019050. Busses >10 persons (HS) codes: 87021019, 87021099, 87029019, 87029039. Trailer and semi-trailers (HS) code: 87163980. European Commission (ed.). Online available at https://trade.ec.europa.eu/access-to-markets/en/statistics, last accessed on 10 Jun 2022.

European Commission (ed.) (2019): The European Green Deal, COM (2019 640 final. Online available at https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF, last accessed on 17 May 2022.

European Commission (ed.) (2020a): A new Circular Economy Action Plan, COM(2020) 98 final.

European Commission (ed.) (2020b): EU Reference Scenario 2020. Online available at https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en, last accessed on 18 Jul 2022.

European Commission (ed.) (2022b): Fleets based on PRIMES-TREMOVE, as used in Euro 7 Impact Assessment (provided to the consultant). Online available at https://ec.europa.eu/clima/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en#PRIMES, last accessed on 18 Jul 2022.

European Commission (ed.) (2022c): Scoping study to assess the feasibility of further EU measures on waste prevention. Online available at https://op.europa.eu/en/publication-detail/-/publication/0778b2a8-b61d-11ec-b6f4-01aa75ed71a1, last accessed on 10 May 2022.

European Commission; OECD; United Nations (2019): Glossary for transport statistics 2019 5th edition (Manuals and guidelines). Luxembourg, Paris: Publications Office of the European Union; OECD Publishing. Online available at https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-19-004?inheritRedirect=true&redirect=%2Feurostat%2Fpublications%2Fmanuals-and-guidelines, last accessed on 21 Apr 2022.

Eurostat (ed.) (2021): Stock of vehicles by category, [tran_r_vehst], Last update: 06-05-2021. Online available at https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tran_r_vehst&lang=en, last accessed on 21 Apr 2022.

FEAD (2022): FEAD feedback on ELV stakeholder workshop. FEAD (ed.), 12 Apr 2022. European Federation for Waste Management and Environmental Services.

FERVER and Denuo (2022): Interview held on 5.11.2021 as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles'. E-Mail with Oeko-Institut e. V. Virtual meeting, 21 Jan 2022. Word document.

FORS (2021): Written input to the ELV IA Open Public Consultation.

Gardiner G. (2014): Recycled carbon fiber update: Closing the CFRP lifecycle loop. Composites World (ed.). Online available at https://www.compositesworld.com/articles/recycled-carbon-fiber-update-closing-the-cfrp-lifecycle-loop.

Gauß, R.; Burkhardt, C.; Carencotte, F.; Gasparon; Gutfleisch, O.; Higgins, I.; Karajic, M.; Klossek, A.; Mäkinen, M.; Schäfer, B.; Schindler, R.; Veluri, B. (2021): Rare Earth Magnets and Motors: A European Call for Action. Rare Earth Magnets and Motors Cluster. Online available at https://eit.europa.eu/sites/default/files/2021_09-24_ree_cluster_report2.pdf.

Glass for Europe (2022): A revised End-of-life Vehicles Directive that supports greater recycling of automotive glazing, Position paper. Glass for Europe (ed.).

Groke, M.; Kaerger, W.; Sander, K.; Bergamos, M. (2017): Optimierung der Separation von Bauteilen und Materialien aus Altfahrzeugen zur Rückgewinnung kritischer Metalle (ORKAM). In: *Umweltbundesamt, UBA Texte* (02/2017).

Hagelüken (2006a): Recycling of Electronic Scrap at Umicore. Precious Metals Refining. Acta Metall. SlovacaAt: Strbske Pleso, SlovakiaVolume: Waste - Secondaery Raw Materials III, 2006. Online available at https://www.researchgate.net/publication/284043293_Recycling_of_Electronic_Scrap_at_Umicore_Precious_Metals_Refining.

Hagelüken (2006b): Recycling of Electronic Scrap at Umicore's Integrated Metals Smelter and Refinery. In collaboration with Hagelüken, C. World of Metallurgy - ERZMETALL. Online available at https://www.researchgate.net/profile/Christian-Hagelueken/publication/290830173_Recycling_of_electronic_scrap_at_Umicore's_integrated_metals_smelter_and_refinery/links/608924e9881fa114b431cb4e/Recycling-of-electronic-scrap-at-Umicores-integrated-metals-smelter-and-refinery.pdf, last accessed on 21 Aug 2022.

Hill, N. (2020): Determining the environmental impacts of conventional and alternatively fuelled vehicles through Life Cycle Assessment, Final Stakeholder Meeting. Ricardo Energy Environment. Brussels, Belgium, 16 Jan 2020. Online available at https://www.upei.org/images/Vehicle_LCA_Project_FinalMeeting_All_FinalDistributed.pdf, last accessed on 14 Apr 2022.

Huismann, J. and Bobba, S. (2021): 'Available For Collection' study on alternative collection targets for waste portable and light means of transport batteries, EUR 30746 EN. EC JRC (ed.). Online available at https://publications.jrc.ec.europa.eu/repository/handle/JRC125615, last accessed on 18 Jul 2022.

INDRA (2021): Interview documentation.

Intertek RDC & OVAM (2013?): Technical and economic assessment of recycling routes for automotive glass. In collaboration with Caevel, B. de; Coppens, M. and Verlinden, L. a. L. Intertek RDC & OVAM. Public Waste Agency of Flanders (ed.).

IRT M2P (2021): Feasibility of aluminium component dismantling from ELV. European Aluminium (ed.). Online available at https://www.european-aluminium.eu/media/3172/irt-m2p-executive-sum-20210412-final.pdf.

ISO 1176:1990 (07.1990): Road vehicles — Masses — Vocabulary and codes. Online available at https://www.iso.org/standard/5760.html, last accessed on 20 May 2022.

ISO 22628:2002(E) (15 Feb 2002): Road vehicles — Recyclability and recoverability — Calculation method.

ISPRA (ed.) (2022): Bilateral communication with Letteria Adella (ISPRA, Italy) on 19.07.2022.

KAUTEX TEXTRON GMBH & CO. KG (2022): Fuel tank recycling. Email with Oeko-Institut e. V., 29 Mar 2022.

Kelly, S. M. (2018): Recycling of Passenger Vehicles: A framework for upcycling and required enabling technologies. Worcester Polytechnic Institute. Online available at https://web.wpi.edu/Pubs/ETD/Available/etd-042518-004455/unrestricted/skelly.pdf.

Løvik et al. (2021): Material composition trends in vehicles: critical raw materials and other relevant metals, Preparing a dataset on secondary raw materials for the Raw Materials Information System. Amund N. Løvik, Charles Marmy, Maria Ljunggren, Duncan Kushnir, Jaco Huisman, Silvia Bobba, Thibaut Maury, Theodor Ciuta, Elisa Garbossa, Fabrice Mathieux, Patrick Wäger. Joint Research Centre (ed.). Online available at https://op.europa.eu/o/opportal-service/download-handler?identifier=197dbe66-57de-11ec-91ac-01aa75ed71a1&format=pdf&language=en&productionSystem=cellar&part=.

Løvik, A. N.; Moderesi, R.; Müller, D. B. (2014): Long-Term Strategies for Increased Recycling of Automotive Aluminum and Its Alloying Elements (48, pages 4257-4265). Environmental Science and Technology (ed.).

Marklines (2015): Recent trends in CFRP development: Increased usage in European vehicles, BMW shows new technology, German companies jointly develop new plastic forming processes. Marklines (ed.). Online available at https://www.marklines.com/en/report_all/rep1419_201506, last accessed on 22 Jun 2022.

Maury et al. (2022): Towards recycled plastic content targets in new passenger cars, Technical proposals and analysis of impacts in the context of the review of the ELV Directive. In collaboration with Maury, T., Tazi, N., Torres de Matos, C., Nessi, S., Antonopoulos, I. (EUR 31047 EN) (JRC129008). JRC. Publications Office of the European Union (ed.). Lexembourg.

Mc Kenna (2014): European Auto Shredder List and Map, An interactive map of auto shredding plants in the 28 member states of the European Union plus Norway.

Mehlhart, G.; Kosinska, I.; Baron, Y.; Hermann, A. (2017): Assessment of the implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end of life vehicles of unknown whereabouts. Oeko-Institut e. V., Germany. European Commission (ed.). Freiburg, Germany.

Mehlhart, G.; Merz, C.; Akkermans, L.; Jordal-Jorgensen, J.; (Keine Angabe) (2011): European second-hand car market analysis, Final Report. Oeko-Institut e. V. (ed.). Darmstadt.

Mehlhart, G.; Möck, A.; Goldmann, D. (2018): Effects on ELV waste management as a consequence of the decisions from the Stockholm Convention on decaBDE. Oeko-Institut e. V. Online available at https://www.oeko.de/fileadmin/oekodoc/ACEA-DecaBDE-final-report.pdf, last accessed on 14 Jun 2022.

Ministerio para la Transición Ecológica y el Reto Demográfico, Italy (ed.) (2022): Bilateral communication with Fernando J. Burgaz Moreno (Ministerio para la Transición Ecológica y el Reto Demográfico, Italy), 20.07.2021.

Ministry of Environment of the Republic of Lithuania (ed.) (2022): Bilateral communication with Mindaugas Kauzonas (Ministry of Environment of the Republic of Lithuania)on 19.07.2022.

Mitic & Blagojevic (2018): Mobility & Vehicle Mechanics. In collaboration with Mitic, S. and Blagojevic, I. (Vol. 44, No. 3, (2018), pp 13-25).

Nakajima, K.; Takeda, O.; Miki, T.; Matsubae, K.; Nagasaki, T. (2011): Thermodynamic analysis for the controllability of elements in the recycling process of metals. 45(11), Pages: 4929-36 vol.: Environmental Science and Technology.

Nakamura, S.; Kondo, Y.; Kagawa, S. (2014): MaTrace: Tracing the Fate of Materials over Time and Across Products in Open-Loop Recycling (48(13)). Environmental Science and Technology.

Nedellec, V.; Rabl, A. (2016): Costs of Health Damage from Atmospheric Emissions of Toxic Metals. Part 1-Methods and Results. In: Risk analysis : an official publication of the Society for Risk Analysis 36 (11), S. 2081–2095. DOI: 10.1111/risa.12599.

Netherlands Ministry of Infrastructure and Water Management, Human Environment and Transport Inspectorate (ed.) (2020): Used vehicles exported to Africa, provided as part of the stakeholder consultation by ACEA. Online available at https://www.ilent.nl/binaries/ilt/documenten/rapporten/2020/10/26/rapport--used-vehicles-exported-to-africa/RAPPORT-+Used+vehicles+exported+to+Africa.pdf, last accessed on 10 Jun 2022.

O'Brien, O. (2021): European update: 360,000 e-scooters available across the continent. Zag Group (ed.), last updated on https://zagdaily.com, last accessed on 9 Nov 2021.

Oeko-Institut e. V. (2021): Resource consumption of the passenger vehicle sector in Germany until 2035 – the impact of different drive systems, Study on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. In collaboration with J. Betz, M. Buchert, P. Dolega & W. Bullach. Online available at https://www.oeko.de/fileadmin/oekodoc/Resource-demand-drive-systems.pdf.

Oeko-Institut e. V. (2022): Analysis of open public consultation results in the frame of "Study to support the impact assessment for the review of Directive 2000/53/EC on ELV". In collaboration with Oeko-Institut e. V.

OVAM (2012): Study into the processingof glass from End-of-LifeVehicles: Analysis of thelegislation and practice inEuropean countries,focusing on selectiveremoval. In collaboration with Eijkelenburg, L. V. an.

OVAM (2022): Answers Belgium questions Impact Assessment Review ELV and 3R Directive. Belgian Environment authorities (ed.), 21 Apr 2022.

Peck, D.; Huisman, J.; Loevik, A.; Ljunggren, M.; Chancerel, P.; Habib, H.; Wagner, M.; Sinha-Khetriwal, D. (2020): CRM Trends and Scenarios, Deliverable 2.4. Prospecting Secondary raw materials in the Urban mine and Mining waste. Online available at https://www.prosumproject.eu/sites/default/files/Final%20D2.4%20report%20CRM%20Trends%20and%20Scenarios%20Final%20Submitted.pdf.

Pinasseau, A.; Zerger, B.; Roth, J.; Canova, M.; Roudier, S. (2018): Best Available Techniques (BAT) Reference Document for Waste Treatment, Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) (EUR 29362 EN, JRC113018). Publications Office of the European Union (ed.). Luxembourg.

Plastics Europe (2022): Plastics Europe feedback to presentations at the European Commission “Stakeholder Workshop in the context of the impact assessment for the revision of the end-of-life vehicles Directive and the corresponding Directive on 3R type approval” (Plastics Europe (ed.), 12 Apr 2022.

Ramboll (2020): Summary of 'Plastic Parts from ELVS'. Ramboll Deutschland GmbH. ACEA, PlasticsEurope, BKV GmbH (ed.). Online available at https://www.bkv-gmbh.de/files/bkv-neu/studien/Summary_Ramboll_plastic_parts_ELV.pdf.

Regulation (EU) 2019/1021 (2019): European Parliament; European Council. Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (POP regulation), Regulation (EU) 2019/1021.

Regulation 168/2013 (2013): European Parliament; European Council. Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles, Regulation 168/2013. In: *Official Journal of the European Union* 60, pp. 52–128.

Restrepo et al. (2017): Stocks, Flows and Distribution of Critical Metals in Embedded Electronics in Passenger Vehicles. In collaboration with Restrepo E., Amund N. Løvik, Patrick Wäger, Rolf Widmer, Radek Lonka, and Daniel B. Müller. Environ. Sci. Technol.

Restrepo et al. (2018): Projekt "EVA": Elektronik – Verwertung - Altautos, "Zusammenfassung der Aktivitäten und Resultate". Zusammenfassung EVA und Schlussbericht zum Arbeitspaket C5. In collaboration with Restrepo E., Løvik, A., Haarman A. & Widmer, R. EMPA. Working-group EVA and Bundesamt für Umwelt (ed.).

Ricardo-AEA (ed.) (2015): Light weighting as a means of improving Heavy Duty Vehicles’ energy efficiency and overall CO2 emissions, Heavy Duty Vehicles Framework Contract – Service Request 2. Report for DG Climate Action. Online available at https://nanopdf.com/downloadFile/light-weighting-as-a-means-of-improving-heavy-duty-vehicles_pdf, last accessed on 12 May 2022.

Russo, P.; Birat, J. P.; Aboussouan, L. (2002): Upgrading scrap quality by improving shredder operation. IRSID-USINOR & CTRA. IARC 2002 Geneva (ed.).

Russo, P.; Husson-Tissier, B.; van de Winkel, F.; Schunicht, J. (2011): X-traction of copper from shredder scrap by means of TITECH XRF-sensor based sorting technology. ArcelorMittal. Budapest, 24 Mar 2011.

Saidani, M.; Yannou, B.; Leroy, Y.; Cluzel, F. (2018): Heavy vehicles on the road towards the circular economy: Analysis and comparison with the automotive industry. In: *Resources, Conservation and Recycling* 135, pp. 108–122. DOI: 10.1016/j.resconrec.2017.06.017.

Sander, K.; Kohlmeyer, R.; Rödig, L.; Wagner, L. (2017): ELV: Recovery Rates and High Grade Recycling. 17th international Automobile Recycling Congress IARC 2017. Ökopol, Germany; Umweltbundesamt, Germany. Hosted by: IARC 2017 Berlin. Berlin, Germany, 22 Mar 2017.

Sander, K.; Rödig, L.; Wagner, L.; Jepsen, D.; Holzhauer, R.; Baberg, L.; Spiecker, T.; Zwisele, B.; Winterstein, M. (2020): Evaluierung und Fortschreibung der Methodik zur Ermittlung der Altfahrzeug-verwertungsquoten durch Schredderversuche unter der EG-Altfahrzeugrichtlinie 2000/53/EG. Umweltbundesamt (ed.).

SCANIA - Frank Schlüter (2022): Challenges with possible inclusion of heavy-duty vehicles into the ELV legislation. Hosted by: IARC 2022, 5 Jul 2022.

Schneider, J.; Karigl, B.; Neubauer, C.; Tesar, M.; Oliva, J.; Read, B. (2010): End of life vehicles: Legal aspects, national practices and recommendations for future successful approach. European Parliament - Directorate General for Internal Policies (ed.). Brussels, Belgium.

SMOTO (2021): Study on the reuse level of motorized two-wheeled vehicles, provided as a written input to the ELV IA Open Public Consultation.

Stellantis (2022): Interview held on the 3R Directive on 17.12.2021 as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles'. Email with Oeko-Institut e. V., 21 Jan 2022.

Sukanto el al. (2020): Carbon fibers recovery from CFRP recycling process and their usage: A review. In collaboration with Sukanto, H., Raharjo, W.W, Ariawan, D. & Triyono, J. (1034 (2021)) (IOP Conf. Series, 012087). Materials Science and Engineering. Online available at https://iopscience.iop.org/article/10.1088/1757-899X/1034/1/012087/pdf.

Tabel, T.; Leistner, W.; Hollm, R. (2011): Einsatz einer Kompaktsortieranlage zur Metallausschleusung bei Schredderleichtfraktionen. Abschlussbericht. BMU-Umweltinnovationsprogramm.

U.S. Department of Energy (2013): WORKSHOP REPORT: Trucks and Heavy-Duty Vehicles Technical Requirements and Gaps for Lightweight and Propulsion Materials. Online available at https://www.energy.gov/sites/prod/files/2014/03/f13/wr_lorries_hdvehicles.pdf, last accessed on 20 Apr 2022.

van den Eynde, S.; Bracquene, E.; Diaz-Romero, D.; Zaplana, I.; Engelen, B.; Duflou, J. R.; Peeters, J. R. (2022): Forecasting global aluminium flows to demonstrate the need for improved sorting and recycling methods (137, pages 231-240). Waste Management (ed.).

Villanueva-Rey, P.; Belo, S.; Quinteiro, P.; Roja, A.; Dias, A. C.: Wiring in the automobile industry: Life cycle assessment of an innovative cable solution. (204, Pages 237-246.). Journal of Cleaner Production (ed.). 2018. Online available at https://doi.org/10.1016/j.jclepro.2018.09.017.

VITO & OVAM (2013?): Environmental impactassessment of recyclingroutes for automotiveglass. In collaboration with Manshoven, S.; an Vercalsteren; Vanderreydt, I.; Verlinden, L. and Loncke, P. OVAM (ed.).

VW/Porsche (2022): Interview held on the 3R Directive on January 2022 as part of the 'Study to support the impact assessment for the review of Directive 2000/53/EC on end-of-life vehicles' with Oeko-Institit e.V & Fraunhofer IZM, 24 Feb 2022.

Williams et. al (2020): Supporting the Evaluation of the Directive 2000/53/EC on end-of-life vehicles. under framework contract No. ENV.F.1.FRA/2014/0063. In collaboration with Williams, R., Mehlhart, G., Baron, Y. Keeling, W. and Petsinaris, F. Trinomics, Oeko-Institut e.V & Ricardo. European Commission, DG ENV (ed.). Online available at https://www.elv-evaluation.eu/fileadmin/elv-evaluation/user_upload/elvd_evaluation_final_report_aug2020.pdf.

Willman, A.; Wedberg, M.; Solheim, U. (2017): An evaluation of alloying elements in shredded steel scrap, Economic and environmental aspects of the recycling process for the steel scrap category E40. KTH Royal Institut of Technology.

Wolff, S.; Seidenfus, M.; Gordon, K.; Álvarez, S.; Kalt, S.; Lienkamp, M. (2020): Scalable Life-Cycle Inventory for Heavy-Duty Vehicle Production. In: *Sustainability* 12 (13), p. 5396. DOI: 10.3390/su12135396.

Workshop (2022): ELV IA Stakeholder Workshop 23/24.March 2022.

Yellishetty, M.; Mudd, G. M.; P.G., R.; Tharumarajah, A. (2011): Environmental life-cycle comparisons of steel production and recycling: sustainability issues, problems and prospects. Volume 14, Issue 6, Pages 650-663 vol.: Environmental Science & Policy.

Zhu, Y.; Chappuis, L. B.; Kleine, R. de; Kim, H. C.; Wallington, T. J.; Luckey, G.; Cooper, D. R. (2021): The coming wave of aluminum sheet scrap from vehicle recycling in the United States (164. edition). Resources, Conservation & Recycling.

6. Annexes

ANNEX I: ADDITIONS TO THE REPORT

6.1 Detailed current situation of Specific objective 1 (the scope of the Directive)

6.1.1 Scope of the ELVD and road vehicles not in scope of ELVD and their fleet

The ELVD covers passenger cars classified as M1[341], light (< 3,5 tons) commercial vehicles classified as N1[342] and three-wheel motor vehicles as defined in Directive 92/61/EEC but excludes motor tricycles (according to ELVD Art. 2.1). Other vehicles, such as buses with more than 9 seats, motorcycles, commercial vehicles for the transport of goods with a maximum mass of more than 3.5 tons, trailers, powered two- and three wheelers and other vehicles (e.g. trains, boats and airplanes) are currently not covered by the ELVD.

Table 6-1 lists additional vehicle categories: Lorries, motorcycles, (semi-)trailers, road tractors, special vehicles as well as coaches/buses as part of the Eurostat dataset for the stock of road vehicles by category. Thereby, a road vehicle is running on wheels and intended for use on roads (European Commission; OECD; United Nations 2019). These types of road vehicles which are currently not in scope of the ELV Directive are described in the following:

Table 6-1 Definition of types of road vehicles

Vehicle type	Definition	Classes and categories of type approval343
Bus	A bus is passenger road motor vehicle designed to carry more than 24 persons (including the driver), and with provision to carry seated as well as standing passengers	Categories M2 and M3, dependent on weight
Motor Coach	Passenger road motor vehicle designed to seat 24 or more persons (including the driver) and constructed exclusively for the carriage of seated passengers.	Categories M2 and M3, dependent on weight
Mini-Bus/-Coach	Passenger road motor vehicle designed to carry 10-23 seated or standing persons (including the driver).	Categories M2 and M3, dependent on weight
Heavy goods road vehicle	Goods road vehicle with a gross vehicle weight above 3 500 kg, designed, exclusively or primarily, to carry goods. ROAD TRACTOR/SEMI-TRAILER TRACTOR: Road motor vehicle designed, exclusively or primarily, to haul other road vehicles which are not power-driven (mainly semi-trailers)	Categories N2 and N3, dependent on weight

[341] Category M1: Motor vehicles designed and constructed primarily for the carriage of persons and their luggage and comprising not more than eight seating positions in addition to the driver's seating position. Vehicles belonging to category M 1 shall have no space for standing passengers. The number of seating positions may be restricted to one (i.e. the driver's seating position). See Regulation (EU) 2018/858.

[342] Category N1: Motor vehicles designed and constructed primarily for the carriage of goods and having a maximum mass not exceeding 3,5 tonnes. See Regulation (EU) 2018/858.

[343] According to Regulation 2018/858, if not specified differently

Vehicle type	Definition	Classes and categories of type approval343
	TRUCK/LORRY: Rigid road motor vehicle designed, exclusively or primarily, to carry goods.344 Agricultural tractors are excluded.	
Trailers (a) and Semi-Trailers (b)345	Goods road vehicle designed to be hauled by a road motor vehicle. Goods road vehicle with no front axle designed in such way that part of the vehicle and a substantial part of its loaded weight rests on a road tractor.	Category O1-O4, dependent on weight
Goods road motor vehicle	Any single road motor vehicle designed to carry goods (e.g. a lorry), or any coupled combination of road vehicles designed to carry goods (i.e. lorry with trailer(s), or road tractor with or without semi-trailer and with or without trailer).	Refers to categories N2, or N2+O (can be multiple types), or N3, or N3+O (can be multiple types).
Various powered two-/three- or four-wheelers	Includes mopeds and motorcycles, for details, see Figure 6-1.	Categories L1e – L7e (Regulation 168/2013)

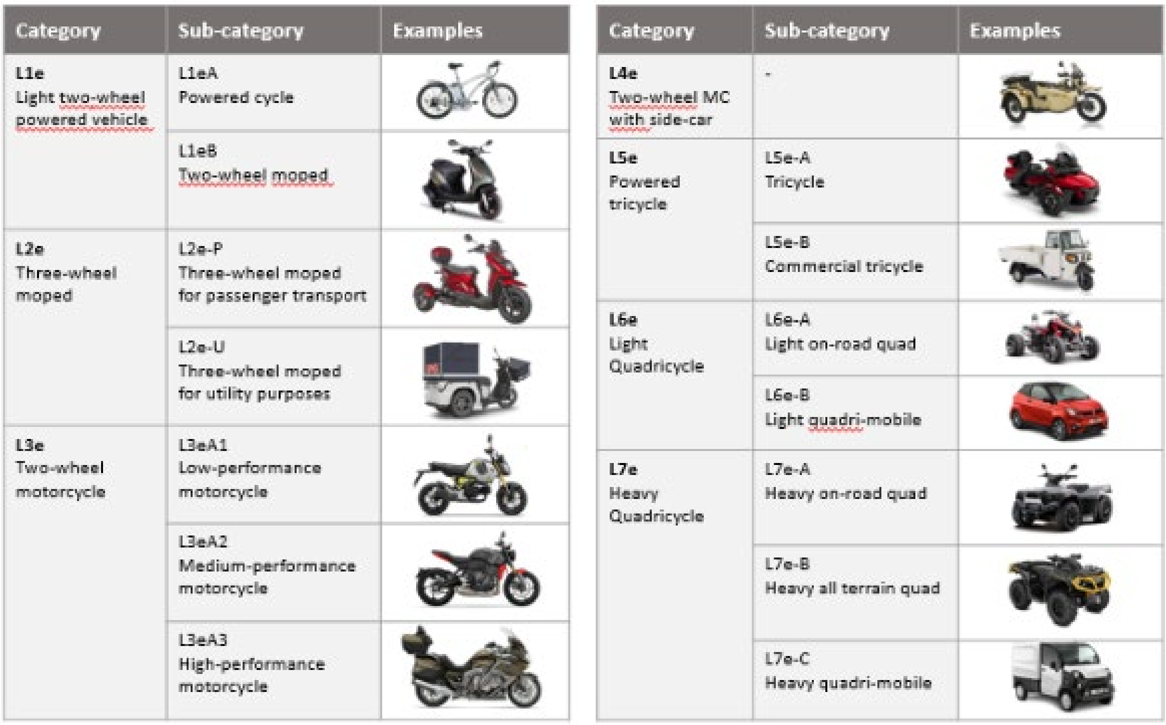
Source: (European Commission; OECD; United Nations 2019)

[344] See types of body of lorries in footnote 345.

[345] Types body of lorries or (semi-)trailers: Ordinary open box (with cover; flat), tipper, tanker (solid or liquid bulk), temperature controlled box, other closed box, skeletal container and swap-body transporter, livestock transporter, others.

The variety of types of powered two-/three- and four-wheelers is high, and the types are described and defined in a separate Type Approval Regulation, Regulation (EU) No 168/2013 (compared to the Type Approval Regulation No. 2018/858 for M, N, O, and T vehicles). The group of L-type approved vehicles, i.e., powered two-/three- and four-wheelers, consists of seven categories with sub-categories, see Figure 6-1.

Figure 6-1 Overview of different types of L-type approved vehicles according to Regulation (EU) No 168/2013



Category	Sub-category	Examples
L1e Light two-wheel powered vehicle	L1eA Powered cycle	
	L1eB Two-wheel moped	
L2e Three-wheel moped	L2e-P Three-wheel moped for passenger transport	
	L2e-U Three-wheel moped for utility purposes	
L3e Two-wheel motorcycle	L3eA1 Low-performance motorcycle	
	L3eA2 Medium-performance motorcycle	
	L3eA3 High-performance motorcycle	

Category	Sub-category	Examples
L4e Two-wheel MC with side-car	-	
L5e Powered tricycle	L5e-A Tricycle	
	L5e-B Commercial tricycle	
L6e Light Quadricycle	L6e-A Light on-road quad	
	L6e-B Light quadri-mobile	
L7e Heavy Quadricycle	L7e-A Heavy on-road quad	
	L7e-B Heavy all terrain quad	
	L7e-C Heavy quadri-mobile	

Source: ACEM 2021

Some vehicles that share similar elements and components with L-category vehicles are still outside the scope of EU Regulation No. 168/2013. These are off-road vehicles and vehicles intended for use by physically disabled people which are covered by the Machinery Directive (Directive 2006/42/EC), vehicles exclusively intended for sports competition (excluded from both the scope of the Machinery Directive and that of the Type Approval Regulation (EU) 168/2013) and non-type approved e-bikes. These are defined as road vehicles with two or more wheels and are often propelled by the muscular energy of the persons on that vehicle, in particular by means of a pedal system, lever or handle (e.g., bicycles, tricycles, quadricycles and invalid carriages). Type Approval Regulation (EU) 168/2013) includes cycles with a supportive power unit (e.g., E-bikes and pedelecs with a cut-off speed above 25 km/h).

Assessment of robustness and completeness of fleet data

Different data sources for fleet data for vehicles other than M1 and N1 have been checked. Different references show individual characteristics or inconsistencies which makes it difficult to display an overview based on one data source:

- The fleet, based on PRIMES Data (European Commission 2022b) is available with a time interval of 5 years, i.e., for 2010, 2015, 2020 etc., for cars, vans, heavy duty trucks and buses. The categories of trailers, powered-two wheelers and special-purpose vehicles are not included, as a consequence, to provide a full picture for road vehicles is not possible to be based on this data source only.

- Data is available for all vehicle categories in the Eurostat dataset 'stock of vehicles by category' (tran_r_vehst). However, for studies in relation to the implementation of Green Deal's activities, the European Commission has been using specific modelling tools other than Eurostat datasets[346]. Further, the Eurostat dataset is not consistent with the L-type-approval categories of (EU) 168/2013. If it is assumed that motorcycles stand for all powered two- and three wheelers (all L categories), as a result, it must be assumed to be an underestimate.
- The following references have been checked to substantiate the fleet data, especially in terms of L-type approved vehicles:
  - Additional data (ACEA (2021c) and O'Brien (2021) cited in EC (2022c)) suggests that there is a higher number of PTWs than the number reported from Eurostat. [347] For this study, it is assumed that the motorcycles' number from Eurostat stand for all powered two- and three wheelers (all L categories), assuming that this is an underestimation in order not to mix references with possibly different ways of collecting the data. In this recent report by the European Commission (2022c), data provided for L-type-approved vehicles is 26.963.668 motorcycles, 10.972.219 mopeds, 444.544 others, and 360.000 small scale e-scooter for 2019 except for small scale e-scooters which is data from 2021. This sums up to 38,7 million units whereas the Eurostat data reports 22, 3 million units in stock in 2019. All numbers are based on statistical releases of industry associations, thus, for this report, the numbers shall not be used but only data available from EU modelling. This is to maintain consistency with other EC interventions under the Green Deal.
  - In the stakeholder consultation, the consultants were provided with motorcycle and moped registration data for 2018 and 2019 which is available online (ACEM 2022). But, on the one hand side, calculating the stock based on registrations involves considering various assumptions, thus, such data would not be considered very profound, and on the other side, again, using statistical releases of industry associations contradicts the consistency with the existing models for EU interventions under the Green Deal.
  - There is data on powered two wheelers available from the EU modelling in the EU Reference Scenario 2020 (European Commission 2020b). There, data is presented as the 'activity' in giga passenger kilometre (Gpkm). It was not possible to convert the data into PTW in units. Though, the trend in these data shall be used to calculate how the fleet evolves in the future. Thus, projections are fully compatible with the EU reference scenario.
  - To fill the gap in terms of L-category vehicles, available stock data for electric L-category vehicles from Huismann and Bobba (2021) has been checked. Vehicle units and tonnage is provided for small personal light electric vehicles (PLEVs), e-scooters, e-bikes, e-mopeds and e-motorcycles[348]. It should be noted that PLEVs, e-scooters and the majority of e-bikes[349] are non-type approved. Using the data provided, in 2020, the sum of type-approved e-bikes, e-mopeds and e-motorcycles accounts for 1,79 – 2,04 million units or 8 766 – 10 245 tons. This number can rarely be compared

[346] https://ec.europa.eu/clima/eu-action/climate-strategies-targets/economic-analysis/modelling-tools-eu-analysis_en (last accessed 18.07.2022)

[347] (2022c) cites (ACEA 2021c) which reports about 27 million motorcycles and 11 million mopeds, and (O'Brien 2021) reports about 360,000 small-scale e-scooters.

[348] Tables S 17 and S18 in Huismann and Bobba (2021)

[349] Huismann and Bobba (2021): In terms of e-bikes, 'the majority of products is represented by EPAC25' (<250W, classified as conventional [non-type approved] e-bikes. For this study, it shall be assumed that 10% of the e-bikes are type-approved.

to the Eurostat number for motorcycles (22,3 million units and ~ 4 million tons in 2019), as the drive trains for these motorcycles counted in the Eurostat data is not available. It can be expected that type-approved e-bikes and e-mopeds (1,69 – 1,94 million units, + ~8% on top of the Eurostat data) are not included in the Eurostat data, thus, theoretically might be added, numbers for the same vehicles with combustion engines are not available separately. It can be assumed that in 2019/20 mopeds with combustion engines were more common than e-mopeds, however, for e-bikes, there exists no version with combustion engines. The number of unreported L-cat vehicles in addition to the reported motorcycles (via Eurostat) can be expected to be ~10-15% more.

- For trailers, no information other than EUROSTAT data is available.

To conclude, a mix of Eurostat data and PRIMES data is used for the description of the current situation (cells in bold in Table 6-2). This is concluded to be able to set in context and compare all vehicle categories not in scope of ELVD but not only trucks and buses for which fleet data is available from PRIMES. A comparison of data sources is provided in Table 6-2 and Table 6-3 below. From the data below, based on PRIMES fleet where possible and Eurostat where PRIMES data is not available, it can be concluded that 17% by unit, ~ 47 million, or 33% by mass, 159 million tons of vehicles are not in scope of ELVD. For the forecast and development of the fleet, PRIMES data is used for the buses and lorries. For L-type approved vehicles, the forecast is modelled in line with the trend for PTW as in EU Reference Scenario 2020 starting with the stock data for motorcycles obtained from Eurostat (as explained above). The data from Huismann and Bobba (2021) suggests that at least ~10% of additional PTW (by number) could be in the stock, however, exact data is lacking. For trailer no other data than Eurostat is available. The future stock was extrapolated based on the trend in Eurostat data from 2015-2019.

Table 6-2 Share of vehicle type in EU 27 (black writing – currently in scope; blue writing – currently not in scope)

Vehicle type	Frequency, Eurostat 2019 [1]	% by unit (Eurostat, 2019)	Frequency Euro 7 IA/PRIMES where available 2020 [2]	% by unit (PRIMES, 2020)	typical weights [tons]	total weight in 2019 based on Eurostat [tons]	total weight in 2020 based on PRIMES where available [tons]	% by weight 2019	% by weight
Passenger cars (M1 type)	241.713.654	74,4%	**238.189.752**	74,0%	1,2 [a]	290.056.385	285.827.702	54,0%	54,1%
Lorries N1 type [3]	28.822.549	8,9%	**30.047.145**	9,3%	2,4 [b]	69.174.117	72.113.148	12,9%	13,6%
Lorries N2, N3 type (road tractor, lorries above 3,5t)	6.995.989	2,2%	**6.218.833**	1,9%	8,25 [c]	57.716.913	51.305.372	10,8%	9,7%
Motorcycles	22.296.012	6,9%	**see Eurostat**	6,9%	0,183 [c]	4.080.170	4.080.170	0,8%	0,8%
other L-cat. Vehicles [4]	2.229.601 (assumed)	0,7%	**assumed**	0,7%	0,183 [c]	408.017	408.017	0,1%	0,1%
Trailers and semi-trailers	18.250.515	5,6%	**see Eurostat**	5,7%	5,25 [c]	95.815.204	95.815.204	17,8%	18,1%
Motor coaches, buses and trolley buses	775.375	0,2%	**703.368**	0,2%	10,75 [c]	8.335.281	7.561.206	1,6%	1,4%
Special vehicles	3.743.390	1,2%	**see Eurostat**	1,2%	3 [b]	11.230.170	11.230.170	2,1%	2,1%
Sum	324.827.085		**321.678.616**			536.816.257	528.340.990		

[1] Most recent data is from 2019. Compared to data from 2016 which was shown in the Evaluation Report, i.e., Williams et. al (2020), shares of vehicle types vary maximum ±1%.
[2] The PRIMES Model provides data for every 5 years, thus, data for 2019 is not available.
[3] "10.0 % of which 90 % are "light" (N1 type)" Williams et. al (2020) resulting in ~9 % of lorries being under the scope of the current ELVD
[4] assumed 10% of motorcycles, see explanation in the text above.

Source: Eurostat 2021, downloaded 20.04. 2021; PRIMES: European Commission 2022b
Note: (a) average based on Table 6-34; (b) personal estimate; (c) based on data displayed in chapter 6.1.3..

Table 6-3 Comparison of data from Eurostat and PRIMES

	in scope of ELVD_unit	in scope of ELVD _weight	not in scope of ELVD_unit	not in scope of ELVD_weight
EUROSTAT	83,3%	66,9%	16,7%	33,1%
PRIMES	83,4%	67,7%	16,6%	32,3%

Source: calculated based on Table 6-2.

6.1.2 Argumentation for scope of the assessment

In addition to M, N, O and L-type approved road vehicles, other vehicles exist for the purpose of transportation of goods and passengers. These are ships, planes and trains, agricultural and mobile machinery, military and space vehicles, and non-type approved (electric) bicycles. These vehicles have in common the characteristic that they are non-road vehicles, with the exemption of non-type approved (electric) bicycles.

Against the background of the objective of the study, i.e., to derive and assess measures to tackle identified shortcomings of the current ELV Directive, it is worth looking at these other vehicles. However, the relevance of non-road vehicles for the ELV Directive, specifically planes, was already discussed in the context of the ELV Directive Evaluation Study (Williams et. al 2020).

Current regulation of non-road vehicles:

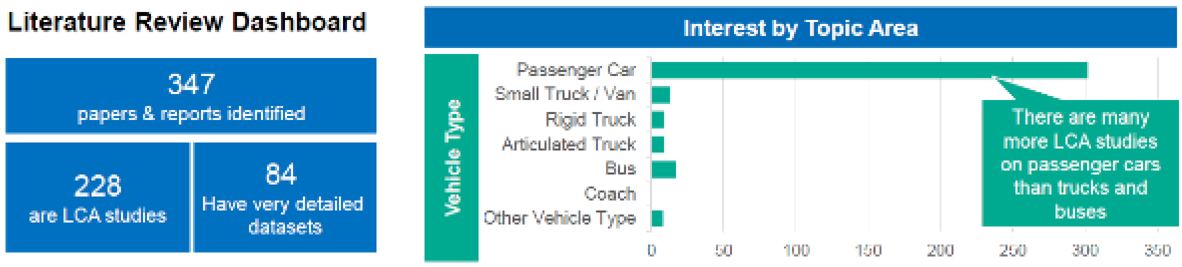
- Non-type approved e-bikes: Regulated under RoHS and WEEE, and its batteries to be regulated with the Battery Regulation proposal
- Ships: The end of life of ships is addressed in an own regulation,
- Planes: often planes are not disposed of in the EU; a lot of parts are leased so there is a huge remanufacturing scene/market; high shares of composites, GLARE, titanium and specific alloys (corrosion resistant, high strength, low weight like Al-Li, etc.)
- Trains are few, e.g., there are ~300 operating long-distance trains in Germany that run for 40 years approximately. That is considerably less than the annual limits of the definition in the type approval of what are small series, which are specially exempted. Generally, there is little waste, and a high recyclable fraction is expected
- Agricultural and non-road mobile machinery (NRMM): These are low volume, high variety vehicles, meaning that it is typical for such vehicles to be produced in small series and in a wide range of models for specific purposes. Vehicles are for the most part heavy duty with long service life. These are difficult to address with “general”, overarching measures, Vehicles used in agricultural and forestry activities such as all-terrain vehicles (ATVs) and Side-by-sides (SbS) belong to the so called “T-category” and are subject to a specific type approval regulation (EU Regulation 167/2013)
- Military purposes & space: RoHS und REACH do not apply to applications designed solely for military purposes and/or for space.
- For all of the above vehicle types: Their type approval is separate from that of road vehicles and in particular does not address objectives of the 3R type approval. Potential changes to the current provisions of 3R type approval regulation will not impact the increase of circularity of these vehicle categories.

With the vision to ELV regulation introducing reuse and recycling targets, etc., and 3R type approval for the new vehicles in scope in a mid-term perspective, it is important that ISO 22628 applies. This ISO standard is for road vehicles, so far unclear if other recyclability calculation methods exist; even if so, this increases complexity, and it is questionable whether an ELV regulation will be the most efficient to regulate non-road vehicles.

6.1.3 Material composition of motorcycles, trucks and buses at their end-of-life

There is no general comprehensive summary of data on the material composition of the vehicles not in scope of ELVD available but only compositions of individual models in specific studies, e.g., LCA. An overview of LCA studies in the automotive sector is provided in Figure 6-2, showing that only few (84) out of 347 reports identified contain detailed datasets. The Figure also shows that few papers were found for vehicles other than passenger cars. Thus, the conclusions drawn in relation to material-specific & weight-related materials not covered by the ELVD are subject to high uncertainties.

Figure 6-2 Overview of a literature research of LCA studies in the automotive sector.



Source: (Hill 2020)

It is not only the case that there is no general comprehensive summary of data on material composition, but there is also no specific data for the different drivetrain technologies. The analysis in this problem area therefore has shortcomings in the sense that only one material composition is available for calculation of material-specific and weight-related conclusions despite data for the fleet that can distinguish, at least for buses and lorries, between different drivetrains.

PTW

Table 6-4 Material composition of PTW 1: Data for motor scooter (50 cubic cm engine)

Material	Amount	Unity
alkyd paint, white, without solvent, in 60% solution state	0,39	kg
aluminium, cast alloy	4,55	kg
aluminium, wrought alloy	9,67	kg
chromium	0,15	kg
copper, cathode	0,64	kg
ethylene	1,17	kg
lead	0,82	kg

Material	Amount	Unity
nickel, class 1	0,09	kg
Palladium	0,00	kg
platinum	0,00	kg
polyethylene, high density, granulate	14,50	kg
polypropylene, granulate	6,97	kg
polyvinylchloride, emulsion polymerised	0,29	kg
polyvinylchloride, suspension polymerised	1,98	kg
reinforcing steel	42,23	kg
steel, low-alloyed, hot rolled	6,28	kg
sulfuric acid	0,05	kg
synthetic rubber	2,80	kg
wire drawing, copper	0,64	kg
zinc	0,37	kg
Sum	93,62	kg

Source: Ecoinvent Database

Table 6-5 Material composition of PTWs 2

components	main material	L1e-B; average (n=7)	L3e-A1; average (n=7)	L3e-A2+A3; average (n= 15)	L5e; average(n=2)	L6e; average (n=4)
Example vehicles		Scooter (50cubic cm engine)	Scooter (125 cubic cm engine)	Motorcycles	Three-wheelers	Quadricycles
Fluids (Oil, breaking fluids, Cooling fluids,…) in kg	irrelevant for 3R	1,57	2,54	4,41	2,70	2,98
Batteries in kg	irrelevant for 3R	1,37	2,71	3,87	4,30	5,92
Bulbs in kg	irrelevant for 3R	0,20	0,20	0,18	0,25	0,19
Steel in kg	steel	40,59	60,49	96,48	93,40	134,30
Aluminium in kg	aluminium	17,90	38,59	65,83	75,70	83,54

components	main material	L1e-B; average (n=7)	L3e-A1; average (n=7)	L3e-A2+A3; average (n= 15)	L5e; average(n=2)	L6e; average (n=4)
Copper in kg	copper	0,17	0,29	0,16	0,00	0,20
Wire harnesses in kg	copper (+plastic)	0,99	2,61	4,62	3,90	4,39
Catalytic converter in kg	varying	1,29	3,17	2,13	6,90	0,80
Screws in kg	steel	1,21	2,26	3,25	1,75	2,98
Tyres in kg	rubber	6,89	9,47	11,07	8,35	17,53
Rubber seals and others in kg	elastomeric	0,62	1,36	1,69	1,75	1,15
ABS polymers (fairings, lighting devices…) in kg	thermoplastic	9,69	19,57	15,15	31,50	23,99
Saddle (upholstery) in kg	foam	1,10	2,29	2,25	4,25	3,16
Saddle (cladding) in kg	textile/ leather	0,43	0,46	0,43	0,35	0,48
Lighting devices in kg	glass	0,14	0,09	0,55	0,00	0,10
average total weight		84,16	146,09	212,09	235,10	281,71

Source: (ADEME and SURPLUS MOTOS 2022)

Buses

Table 6-6 Material composition of different bus models

	Midibus (12t GVW) [kg]	Coach (19t GVW) [kg]
Iron	449	1273
Steel	1999	5667
High strength (HS) steel	117	476
Aluminium	2940	2544
Copper	20	34
Plastics	1200	1174

Rubber	211	388
Glass	367	300
Water	36	120
Lead	90	156
glass-fibre reinforced plastics	0	0
Other	621	1269
TOTAL	8050	13400

Source: EC 2015

Trucks

Table 6-7 Material composition of different truck models (in kg)

	Van (5t GVW) [kg]	Rigid Truck 1 (12t GVW) [kg]	Rigid Truck 2 (12t GVW) [kg]	Artic Truck (Curtainsider) (40t GVW) [kg]
Steel	1279	3204,8	3466	9215
Aluminium	141	152,3	55	519
Iron	232	400	517	1543
Copper	23	119,3	20	70
Glass	14	159,1	41	43
Plastics	249	728,5	214	815
Rubber	69	280,7	350	844
Other	294	88,7	1537	1501
Total	2.301	5.133	6.200	14.550

Source: EC 2015 for rigid truck 1; Wolff et al. 2020 for other truck models.

Trailers

Body types of lorries or (semi-)trailers:

- Ordinary open box (with cover; flat)
- tipper
- tanker (solid or liquid bulk)
- temperature controlled box
- other closed box
- skeletal container and swap-body transporter
- livestock transporter
- others

Main materials of trailers: steel, plastics, light metals such as aluminium, textiles (for curtains), wood.

Table 6-8 Overview of (semi-)trailers' weights

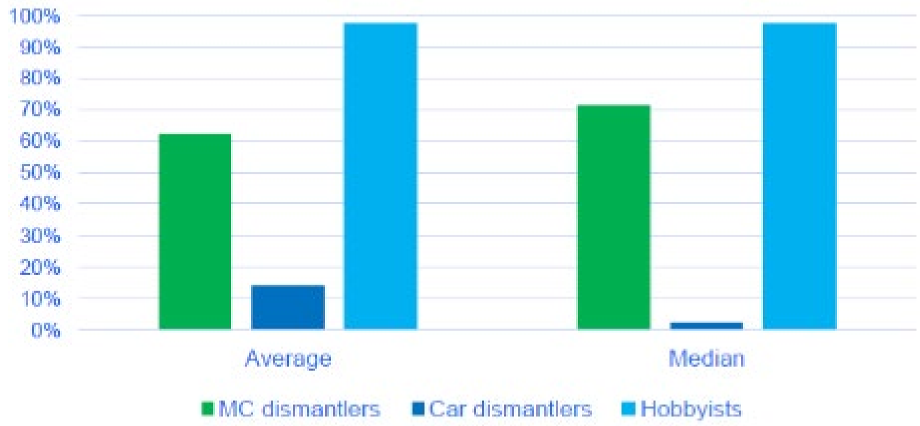
Type of (semi-)trailer	Weight in kg
Volume trailer in sliding curtain design	7600
Profi Liner for steel transport with drop sides	6660
Profi Liner 5 in sliding curtain design	5940
Chassis with appropriate locks for the transport of containers	4760
Profi Liner (long truck type 1)	6800
Steel swap body	2640
2-axle refrigerated trailer	7720
3-axle refrigerated semi-trailer in double-decker design	7840
2-axle platform trailer in sliding curtain design	4530
2-axle platform trailer in building material design	3710
Average	5820

Source: Factsheets downloaded from https://www.krone-trailer.com/download/datenblaetter/ (12.05.2022)

6.1.4 Practise of reuse

Compared to passenger cars, stakeholders interviewed reported that the practice of reuse is more established for PTW, trucks and buses (ACEM 2021; ACEA/Volvo 2021; ANERVI/AETRAC 2021). This is supported through reuse statistics for PTW in Finland (SMOTO 2021) and best-practice examples for heavy duty vehicles from literature (Saidani et al. 2018). The reuse rate of the parts for PTW at Finish operators specialized in the handling of motorized two-wheeled vehicles ('MC dismantlers') was found between 60 and 70%. At around 95%, the reuse rate is even higher for practitioners at motorcycle clubs ('hobbyists'). On the other side, at operators specialized in car handling the reuse of parts from PTW is low at around 10% (Figure 6-3) Statistics are based on 720 motorized two-wheelers dismantled in 11 motorcycle and 20 car dismantling facility, 1 builder, 1 motorcycle club.

Figure 6-3 Reuse level of motorized two-wheelers in Finland



Source: SMOTO (2021) based on 720 PTW dismantled in 11 motorcycle and 20 car dismantling facility, 1 builder, 1 motorcycle club.

Looking at lorries, according to ANERVI/AETRAC (2021), ‘there is a specialized market for parts from lorries across Europe. There is a high demand for spare parts, there is good communication around the spare parts established.’ A flowering market for spare parts suggests that repair and reuse play an important role in the end-of-life treatment. A study by Saidani et al. (2018) supports this statement:

- ‘Redistribution of second-hand components is a profitable business, e.g., when a Volvo FH Globetrotter is dismantled properly (95% of its weight, i.e., 7,000 kg), the overall resale of spare parts can reach 40,000 euros.’
- ‘In 2012 Caterpillar’s remanufacturing programme took back over 2.2 million end-of-life units for remanufacturing, representing 73,000 tons of materials, and including 6,000 different remanufactured products.’
- ‘In the UK, 50% of all heavy vehicles reaching their end-of-life are reused or resold in other countries with major refurbishment; 43% are remanufactured to extend their lifespan in the UK.’
- ‘More than 93% of all materials in a standard DAF lorry can be reused.’

6.1.5 Analysis of exports of vehicles

Table 6-9 Extra-EU Export (incl. GB)

	Jan.-Dec. 2010	Jan.-Dec. 2011	Jan.-Dec. 2012	Jan.-Dec. 2013	Jan.-Dec. 2014	Jan.-Dec. 2015	Jan.-Dec. 2016	Jan.-Dec. 2017	Jan.-Dec. 2018	Jan.-Dec. 2019	Jan.-Dec. 2020	Jan.-Dec. 2021	Sum	Yearly average
Used road tractors*	128659	73207	90576	81295	71163	89173	57144	51247	57216	87358	83579	90822	961439	80120
Used vehicles for transport*	71351	71458	89066	93728	76231	69739	55363	54666	94103	112637	66410	67311	1145955	76839
Used buses for > 10 persons	35921	8722	9838	7226	6944	5661	5901	5450	5705	7339	3993	9218	111918	9327
Used trailer and semi-trailer	152020	138968	73628	69194	64024	58052	77331	52074	55570	57502	50935	51589	900887	75074

Note: (*) for ‘lorries’, road tractors and vehicles for transport have been added.
Source: EU trade statistics, European Commission (2022a), , Product Codes: 87012090 (used road tractor); 87021019, 87021099, 87029019, 87029039 (used buses); 87042299, 87042399, 87043299 (used lorries); 87163980 (used trailers) --> see

Table 6-10.

Table 6-10 Declaration of trade statistic numbers evaluated

87012090	Road tractor	Road tractors for semi-trailers, used
87042299	Used vehicle for transport	Motor vehicles for the transport of goods, with compression-ignition internal combustion piston engine "diesel or semi-diesel engine" of a gross vehicle weight > 5 t but <= 20 t, used (excl. dumpers for off-highway use of subheading 8704.10, special purpose motor vehicles of heading 8705 and special motor vehicles for the transport of highly radioactive materials)
87042399	Used vehicle for transport	Motor vehicles for the transport of goods, with compression-ignition internal combustion piston engine "diesel or semi-diesel engine" of a gross vehicle weight > 20 t, used (excl. dumpers for off-highway use of subheading 8704.10, special purpose motor vehicles of heading 8705 and special motor vehicles for the transport of highly radioactive materials)
87043299	Used vehicle for transport	Motor vehicles for the transport of goods, with spark-ignition internal combustion piston engine, of a gross vehicle weight > 5 t, used (excl. dumpers for off-highway use of subheading 8704.10, special purpose motor vehicles of heading 8705 and special motor vehicles for the transport of highly radioactive materials)
87021019	Bus	Motor vehicles for the transport of >= 10 persons, incl. driver, with only diesel engine, of a cylinder capacity of > 2.500 cmÂ^{3}, used
87021099	Bus	Motor vehicles for the transport of >= 10 persons, incl. driver, with only diesel engine, of a cylinder capacity of <= 2.500 cmÂ^{3}, used
87029019	Bus	Motor vehicles for the transport of >= 10 persons, incl. driver, with spark-ignition internal combustion piston engine, of a cylinder capacity of > 2.800 cmÂ^{3}, used (excl. with electric motor for propulsion)
87029039	Bus	Motor vehicles for the transport of >= 10 persons, incl. driver, with spark-ignition internal combustion piston engine, of a cylinder capacity of <= 2.800 cmÂ^{3}, used (excl. with electric motor for propulsion)
87163980	Trailers	Trailers and semi-trailers for the transport of goods, used (excl. self-loading or self-unloading trailers and semi-trailers for agricultural purposes, tanker trailers and semi-trailers, and trailers and semi-trailers not designed for running on rails for the transport of highly radioactive materials [Euratom])

A more detailed analysis can be found in Annex I, section 6.10.2.

6.1.6 Multi-stage type-approval processes

The manufacturing practices of trucks, lorries, semi-trailer tractors and trailers require the multi-stage type approval as referred to in Regulation 2018/858/EU. ACEA/Volvo (2021) explains (Excerpt from Interview Documentation):

“General information

- Manufacturers applying for a whole-vehicle type-approval may choose the **multi-stage procedure** (*article 22(1))*, namely a procedure where “one or more approval authorities certify that […] an incomplete or completed type of vehicle satisfies the relevant administrative provisions and technical requirements” (*article 3(8)*).
- The procedure may be used both by **single and multiple manufacturers**. When used by single manufacturers, it should not be a way to circumvent the requirements applicable to vehicles built in a single stage (article 22(6)).
- **Multi-stage type approval shall be granted for**:
  - an incomplete or completed type of vehicle, as long as it conforms to the particulars in the information folder detailed in the Regulation’s *article 24* and that it meets the technical requirements laid out in *Annex II*;
  - complete vehicles that have been converted or modified by another manufacturer after their completion.
- Annex IX sets out the specific obligations for manufacturers and approval authorities to be followed during multi-stage type-approval procedures.

Application procedure for multi-stage EU-type approval

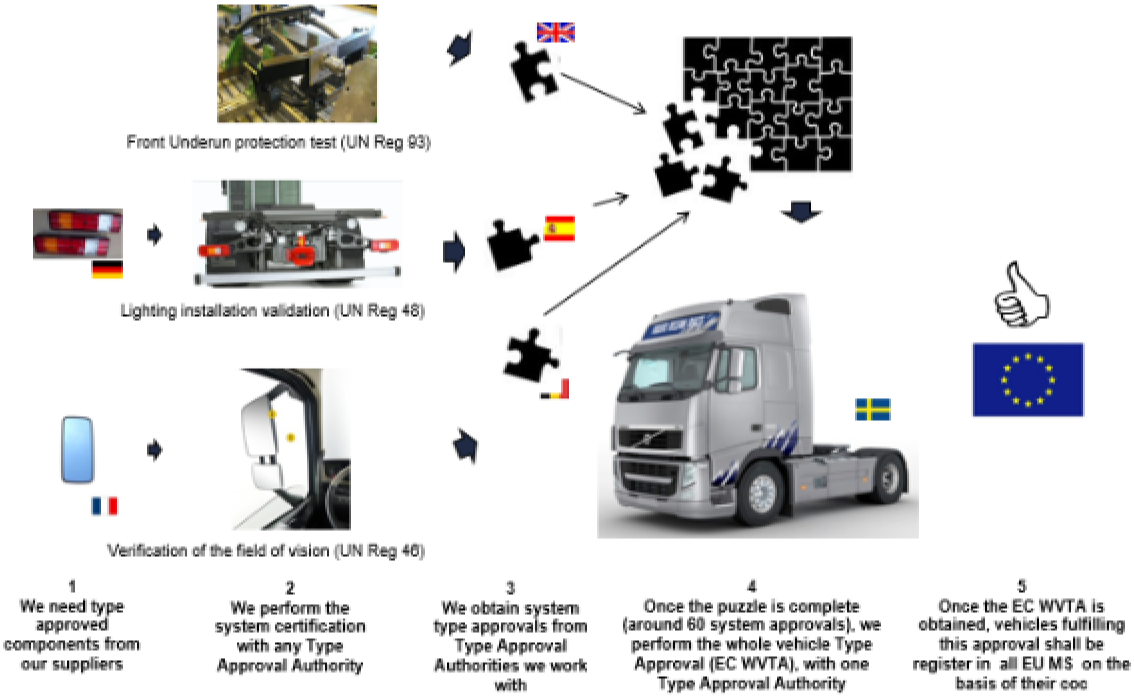
- Each manufacturer should apply for EU type-approval in respect of a particular type of vehicle to one approval authority within one Member State (*article 23*).
- The application should include the information folder set out by article 24 and a declaration by the manufacturer certifying that:
  - the manufacturer has not applied for an EU type-approval for the same type to any other approval authority, and no other approval authority granted the manufacturer such an approval;
  - no approval authority has refused to grant type-approval of that type;
  - no approval authority has withdrawn type-approval of that type;
  - the manufacturer has not revoked an application for a type-approval of that type.
- In addition, applications for multi-stage approval should also include:
  - For the first stage: the information folder (detailed in *article 24*) and the EU type-approval certificates, UN type-approval certificates or, if applicable, the test reports that are relevant to the state of completion of the base vehicle;
  - For the second and subsequent stages: the information folder (detailed in *article 24*) and the EU type-approval certificates or UN type-approval certificates relevant to the current stage of completion, along with a copy of the EU whole-vehicle type-approval certificate that was issued at the preceding stage of construction, as well as full details of any changes or additions that the manufacturer has made to the vehicle.
- The **EU type-approval** for the final stage of completion **shall only be granted** after the approval authority has verified, in accordance with the procedures laid down in *Annex IX*, that the type of vehicle approved at the final stage meets **all applicable technical requirements at the time of the approval**.

Procedures to be followed during multi-stage type approval:

- Obligations and responsibilities of manufacturers (*Article 13 and Annex IX*)
- In the case of multi-stage type-approval, and in addition to ensuring that vehicles, systems, components and separate technical units have been manufactured and approved in accordance with *article 5* and *Annex II*, **manufacturers are also responsible** for the approval and conformity of production of the systems, components or separate technical units they may have **added and/or modified** (*article 13*).
- **Manufacturers of the previous stage** shall provide information to manufacturers of the subsequent stage regarding any change that may affect component type-approval, system type-approval or separate technical unit type-approval or the whole-vehicle type-approval (*article 13*).
- Given the degree of cooperation required the multi-stage type-approval procedure, manufacturers involved in the process should be able to **supply and exchange relevant information and documents between them**, including details of relevant system, component and separate technical unit type-approvals and of vehicle parts that form part of the incomplete vehicle but have not yet been type-approved. Before granting first and subsequent stage type-approvals, **approval authorities should ensure that arrangements enabling the sharing of this information exist between manufacturers** (*Annex IX*).
- Each manufacturer is responsible for its **own stage of construction** and **not for the ones before it**, except where the manufacturer modifies relevant parts to such an extent that the previously granted type-approval is not valid anymore (*Annex IX*).

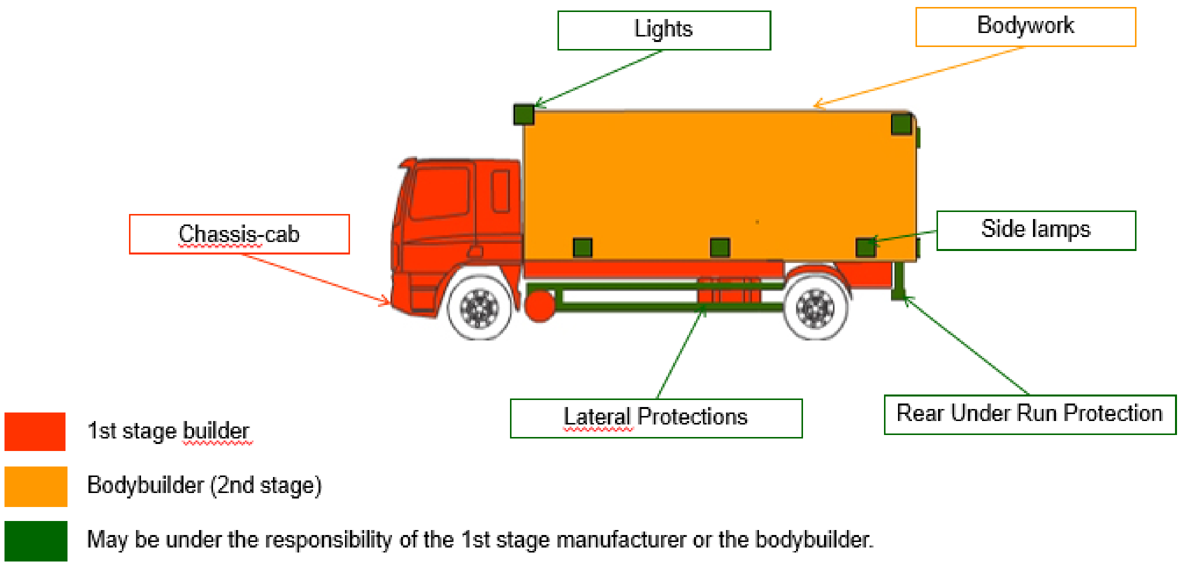
- Selected obligations of the approval authority (*Annex IX*)
    - The approval authority should **verify** that all issued EU type-approval certificates correspond to the **prescribed requirements** and should make sure that the vehicle specifications and data are included in the data in the information packages and in the EU type-approval certificates issued in accordance with the relevant regulatory acts.
    - The approval authority should carry out **inspections of vehicle parts and systems** on a selected sample of vehicles to be approved to verify that they are built in accordance with the vehicles' information package (including the information folder as per article 24, test reports and other relevant documents).
- Other selected applicable requirements (*Annex IX*)
    - Multi-stage type-approvals **shall be granted** on the basis of the state of completion of the type of vehicle and shall incorporate all type-approvals granted at earlier stages.
    - For the whole-vehicle approval, the Regulation applies in the same manner as if the approval would have been granted to the manufacturer of the base vehicle, namely the vehicle that is used at the initial stage of procedure."

Figure 6-4 Step 1 of multi-stage type approvals: Base vehicle



Source: ACEA/Volvo Interview

Figure 6-5 Step 2 of multi-stage type approval: Bodybuilder



Source: ACEA/Volvo Interview

6.2 Detailed results of the impact analysis for Specific objective 1 (the scope of the Directive)

6.2.1 List for selected impacts

Based on the list of key impacts to be considered displayed elsewhere in this annex 6.6.2.5. the following list of impacts has been selected for the impact assessment of the scope.

- Administrative burden for public authorities
- Benefits through reporting
- Environmental benefits from formalized treatment & heavy metal restrictions/less (hz) waste in receiving countries of export
- Health benefits from formalized treatment and heavy metal restrictions
- Administrative burdens on businesses: Costs for OEM and ATFs for Reporting and providing information
- Impacts for businesses:
  - Costs for OEMs for change of design
  - Burden for ATFs for authorization
  - Revenues for dismantlers from spare parts
  - Revenues for dismantlers and recyclers from recycling
  - Revenues from exported used lorries <-> lost revenues from missing vehicles and exported used lorries
  - Burden on stakeholders in the field of vehicles that are currently exempted
- Environmental benefits from increase of increase reuse and recycling
- Distribution effect: informal jobs to be formalized Employment -> Social/benefits for health and safety in receiving countries of export
- Distribution effect (economic): EPR + externalized costs will be internalized
- Additional burden for consumers in managing an ELV

6.2.2 Quantification of material streams

Table 6-11 Material compositions of example lorries, buses, and L-type approved vehicles in kg (Summary of tables in chapter 6.1.3)

[kg]	**Lorries**				**Buses**		**L-type-approved vehicles**					**Car**
	Rigid Truck 1 (12t GVW)	Van (5t GVW)	Rigid Truck 2 (12t GVW)	Curtain-sider (40t GVW)	Midibus (12t GVW)	Coach (19t GVW)	L1e-B	L3e-A1	L3e-A2+A3	L5e	L6e	Passenger car
n=	1	1	1	1	1	1	7	7	15	2	4	1
Steel	3204,8	1279	3466	9215	2116	6143	41,8	62,7	99,7	95,2	137,3	608,4
Aluminium	152,3	141	55	519	2940	2544	17,9	38,6	65,8	75,7	83,5	108
Iron	400	232	517	1543	449	1273	0,0	0,0	0,0	0,0	0,0	114
Copper	119,3	23	20	70	20	34	1,2	2,9	4,8	3,9	4,6	10,8
Glass	159,1	14	41	43	367	300	0,1	0,1	0,6	0,0	0,1	28,8
Plastics*	728,5	249	214	815	1200	1174	9,7	19,6	15,2	31,5	24,0	240
Rubber	280,7	69	350	844	211	388	6,9	9,5	11,1	8,4	17,5	25,2
Other	88,7	294	1537	1501	747	1545	3,4	7,3	6,5	13,3	5,6	69
Total	5133,4	2301	6200	14550	8050	13401	81,0	140,6	203,6	227,9	272,6	1204,2
Based on data from	(Wolff et al. 2020)		(Ricardo-AEA 2015)		(Ricardo-AEA 2015)		(ADEME and SURPLUS MOTOS 2022)					(Bouter et al. 2020)

Note: Material compositions represent an average based on 'n' examples (see line 2).
(*) it is assumed that this represents thermoplastics. Foams and elastomers were included in "others" where primary data indicated these materials specifically.
Source: as indicated in last line.

Table 6-12 Quantification of materials out of scope for stock 2020, expected ELVs in 2020 and expected ELVs in 2030

	for Stock 2020							
	min (Van)	max (curtainsider)	min(midibus)	max (coach)	min (L1eB)	max (L6e)	min_total	max_total
total weight	2301	14550	8050	13401	81,0	272,6		
Steel	8947,9	64468,0	1640,7	4763,1	932,0	3060,9	11520,5	72292,0
Aluminium	986,4	3630,9	2279,6	1972,6	399,1	1862,6	3665,1	7466,1
Iron	1623,1	10794,8	348,1	987,1	0,0	0,0	1971,2	11781,9
Copper	160,9	489,7	15,5	26,4	25,8	102,3	202,2	618,3
Glass	97,9	300,8	284,6	232,6	3,2	2,2	385,7	535,7
Plastics	1742,0	5701,7	930,5	910,3	216,1	535,0	2888,6	7147,0
Rubber	482,7	5904,6	163,6	300,8	153,5	390,9	799,9	6596,4
Other	2056,8	10501,0	579,2	1198,0	76,6	124,6	2712,6	11823,6

	for ELVs expected in 2020							
	min (Van)	max (curtainsider)	min (midibus)	max (coach)	min (L1eB)	max (L6e)	min_2019	max_2019
total weight	2301	14550	8050	13401	81,0	272,6		
Steel	271,2	1953,8	59,4	172,4	55,9	183,5	386,4	2309,7
Aluminium	29,9	110,0	82,5	71,4	23,9	111,7	136,3	293,1
Iron	49,2	327,2	12,6	35,7	0,0	0,0	61,8	362,9
Copper	4,9	14,8	0,6	1,0	1,5	6,1	7,0	21,9
Glass	3,0	9,1	10,3	8,4	0,2	0,1	13,5	17,7
Plastics	52,8	172,8	33,7	32,9	13,0	32,1	99,4	237,8
Rubber	14,6	178,9	5,9	10,9	9,2	23,4	29,8	213,3
Other	62,3	318,2	21,0	43,4	4,6	7,5	87,9	369,1

	for ELVs expected in 2030							
	min (Van)	max (curtainsider)	min(midibus)	max (coach)	min(L1eB)	max (L6e)	min_2030	max_2030
total weight	2301	14550	8050	13401	81,0	272,6		
Steel	336,6	2425,0	66,4	192,6	65,1	213,8	468,0	2831,4
Aluminium	37,1	136,6	92,2	79,8	27,9	130,1	157,2	346,4
Iron	61,1	406,1	14,1	39,9	0,0	0,0	75,1	446,0
Copper	6,1	18,4	0,6	1,1	1,8	7,1	8,5	26,6
Glass	3,7	11,3	11,5	9,4	0,2	0,2	15,4	20,9
Plastics	65,5	214,5	37,6	36,8	15,1	37,4	118,3	288,6
Rubber	18,2	222,1	6,6	12,2	10,7	27,3	35,5	261,6
Other	77,4	395,0	23,4	48,5	5,3	8,7	106,1	452,2

Source: Material compositions: Table 6-11; vehicle stock in 2019: Eurostat (2021); expected ELVs: Oeko Model.

Table 6-13 Shares that vehicle categories have in the total sum of material quantities from waste lorries, buses and PTW (data for Figure 3-41)

	Av_Lorry	Av_bus	Av_PTW	%_lorry	%_bus	%_PTW
Alu_2020	69,96825	76,943262	67,79012361	33%	36%	32%
Alu_2030	86,84204055	85,98713018	78,97537168	34%	34%	31%
Copper_2020	9,8591625	0,757647	3,838364164	68%	5%	27%
Copper_2030	12,23683299	0,846700407	4,471687325	70%	5%	25%
Glass_2020	6,0427125	9,3583435	0,163021282	39%	60%	1%
Glass_2030	7,499994411	10,45831799	0,189919499	41%	58%	1%
Iron_2020	188,1721875	24,160521	0	89%	11%	0%
Iron_2030	233,5524575	27,00033519	0	90%	10%	0%
Other_2020	190,2924375	32,157906	6,031406466	83%	14%	3%
Other_2030	236,1840345	35,93772837	7,02657765	85%	13%	3%
Plastics_2020	112,7973	33,308407	22,51209189	67%	20%	13%
Plastics_2030	139,9998957	37,22345862	26,22654643	69%	18%	13%
Rubber_2020	96,7894125	8,4042695	16,31926212	80%	7%	13%
Rubber_2030	120,1314894	9,392102659	19,01191092	81%	6%	13%
Steel_2020	1112,495175	115,8778995	119,6784395	83%	9%	9%
Steel_2030	1380,788445	129,4981233	139,425166	84%	8%	8%

Averages calculated based on minimal and maximal values in Table 6-12. Shares were calculated using the average amount of the lorries compared to the total average.

Table 6-14 Material quantities from vehicles arriving at EoL in 2030 (variant with 40% reuse quota)

tons	Reuse			High Quality Recycling			Energy Recovery			Losses		
	Baseline/ 1A	1B	1C	Baseline/ 1A	1B	1C	Baseline/ 1A	1B	1C	Baseline/ 1A	1B	1C
Powered Two wheeler (L3e-A2)												
Steel	27953	27953	37271	64572	64572	55347	0	0	0	652	652	559
Aluminium	30750	30750	41000	60987	60987	55349	10224	10224	6150	538	538	0
Iron	0	0	0	0	0	0	0	0	0	0	0	0
Copper	2233	2233	2977	4429	4429	4019	0	0	0	782	782	447
Glass	258	258	345	0	0	233	0	0	0	603	603	284
Plastic	7079	7079	9438	4955	4955	4955	10984	10984	9202	578	578	0
Rubber	0	0	0	0	0	0	15518	15518	17242	1724	1724	0
Other	0	0	0	0	0	0	9128	9128	10142	1014	1014	0
Bus (12 GVW)												
Steel	19907	19907	26542	45985	45985	39416	0	0	0	464	464	398
Aluminium	27659	27659	36879	54857	54857	49786	9197	9197	5532	484	484	0
Iron	4224	4224	5632	9758	9758	8364	0	0	0	99	99	84
Copper	188	188	251	373	373	339	0	0	0	66	66	38
Glass	3453	3453	4604	0	0	3107	0	0	0	8056	8056	3798
Plastic	11289	11289	15052	7903	7903	7903	17517	17517	14676	922	922	0

tons	Reuse			High Quality Recycling			Energy Recovery			Losses		
Misc.	0	0	0	0	0	0	21083	21083	23425	2343	2343	0
rubber	0	0	0	0	0	0	6617	6617	6617	0	0	0
Lorry (12 GVW)												
Steel	253010	253010	337347	584454	584454	500960	0	0	0	5904	5904	5060
Aluminium	12024	12024	16032	23847	23847	21643	3998	3998	2405	210	210	0
Iron	31579	31579	42105	72947	72947	62526	0	0	0	737	737	632
Copper	9418	9418	12558	18680	18680	16953	0	0	0	3296	3296	1884
Glass	12561	12561	16747	0	0	11304	0	0	0	29308	29308	13817
Plastic	57513	57513	76684	40259	40259	40259	89241	89241	74767	4697	4697	0
Misc.	0	0	0	0	0	0	73868	73868	73868	0	0	0
Rubber	0	0	0	0	0	0	21008	21008	23342	2334	2334	0

Source: calculations by Oeko-Institut (2022)

6.2.3 Quantification of impacts

Table 6-15 GWP benefits as discussed in chapter 0 (in million tons of CO_2 equivalents)

Reuse quota	PTW (weighted average)			Lorry (12t GVW)			Bus (12t GVW)		
40%	**BAU/1A**	**1B**	**1C**	**BAU/1A**	**1B**	**1C**	**BAU/1A**	**1B**	**1C**
re-use	-0,857	-0,867	-1,173	-1,027	-1,027	-1,369	-0,606	-0,606	-0,808
high quality recycling	-1,196	-1,210	-1,109	-1,263	-1,263	-1,123	-0,840	-0,840	-0,763
energy recovery	-0,233	-0,236	-0,174	-0,237	-0,237	-0,199	-0,182	-0,182	-0,135
Sum	-2,287	-2,312	-2,456	-2,527	-2,527	-2,691	-1,628	-1,628	-1,706
Delta BAU-C			0,169			0,165			0,078
70%	**BAU/1A**	**1B**	**1C**	**BAU/1A**	**1B**	**1C**	**BAU/1A**	**1B**	**1C**
re-use	-0,857	-0,867	-2,052	-1,027	-1,027	-2,396	-0,606	-0,606	-1,415
high quality recycling	-1,196	-1,210	-0,555	-1,263	-1,263	-0,562	-0,840	-0,840	-0,381
energy recovery	-0,233	-0,236	-0,113	-0,237	-0,237	-0,130	-0,182	-0,182	-0,089
Sum	-2,287	-2,312	-2,720	-2,527	-2,527	-3,088	-1,628	-1,628	-1,885
Delta BAU-C			0,433			0,562			0,257

Table 6-16 Expected losses of material and revenue due to unknown whereabouts and Extra EU Exports in 2020

	expected losses due to unknown whereabouts in 2020						Extra EU Exports				
	Motorcycles		lorries		buses		used motor-cycles	used lorries		used buses	
	[tons]	Euro	[tons]	Euro	[tons]	Euro		[tons]	Euro	[tons]	Euro
Steel	39.260	7.344.755	305.985	57.243.763	38.971	7.290.693	no data	673.542	126.006.324	38.512	7.204.772
Aluminium	25.311	8.815.618	15.461	15.854.001	25.877	26.534.988		34.033	34.898.201	25.572	26.222.272
Iron	-	-	47.988	No data	8.125	No data		105.633	No data	8.030	No data
Copper	1.557	9.789.924	4.141	26.031.227	255	1.601.737		9.115	57.300.551	252	1.582.860
Glass	79	1.454	4.583	83.963	3.147	57.659		10.089	184.822	3.110	56.979
Plastics	8.982	3.593	35.769	14.307	11.202	4.481		78.735	31.494	11.070	4.428
Rubber	4.793	No data	27.519	No data	2.826	No data		60.574	No data	2.793	No data
Other	3.242	No data	60.979	No data	10.815	No data		134.227	No data	10.688	No data
Sum	83.225	25.955.344	502.425	99.227.261	101.219	35.489.557	-	1.105.949	218.421.391	100.026	35.071.312

Assumptions: 70% cast, 30% wrought aluminium. Revenues from materials as in table xx (under circularity), 34% unknown whereabouts according to (Mehlhart et al. 2017), export data as provided in the problem description

Table 6-17 Administrative cost (recurrent) according to BRG model, scope extension

ELV Impact assessment - subsection on scope						**Tariff (€ per hour)**	**Time (minutes)**	**Price (per action)**	**Freq**	**Number of entities**	**Total number of actions**	**Equipment costs (per entity & per year)**	**Total Administrative Costs**	**Business As Usual Costs (% of AC)**	**Total Administrative Burdens (AC - BAU)**
No.		Concrete activity	Type of obligation	Description of required action(s)	Target group										
Policy Option 1A															
1a	A1	Information to waste operators	Submission of (recurring) reports	Filing forms and tables	HDV manufacturers and their suppliers	25,73	480,00	206	0	14	0		0	100%	0
1b	A1	Information to waste operators	Submission of (recurring) reports	Filing forms and tables	L-cat manufacturers	25,73	480,00	206	3	16	48		9.869	0%	9.869
2	A2	Reporting on treated ELVs to MS authority	Submission of (recurring) reports	Filing forms and tables	ATFs/ dismantlers	25,73	480,00	206	1	4.500	4.500		925.200	0%	925.200
3	A2	Reporting on treated ELVs to Eurostat	Submission of (recurring) reports	Filing forms and tables	Member States- waste authorities	25,73	960,00	411	1	27	11.102		11.102	75%	2.776
Policy Option 1B															
4a	B1	Supply chain management	Notification of (specific) activities or events	Retrieving relevant information from existing data	HDV manufacturers and their suppliers	25,73	480,00	206	1	14	14		2.878	0%	2.878
4b	B1	Supply chain management	Notification of (specific) activities or events	Retrieving relevant information from existing data	L-cat manufacturers	25,73	480,00	206	1	16	16		3.290	0%	3.290
5	B2	Authorisation process	Certification of products or processes	Filing forms and tables	ATFs/ dismantlers	25,73	1.920,00	822	1	4.500	4.500		3.700.800	0%	3.700.800
6	B2	Authorisation of dismantling facilities	Submission of (recurring) reports	Inspecting and checking (including assistance to inspection by public authorities)	Member States- waste authorities	25,73	1.440,00	617	0,1	4.500	450		277.560	0%	277.560

ELV Impact assessment - subsection on scope						Tariff (€ per hour)	Time (minutes)	Price (per action)	Freq	Number of entities	Total number of actions	Equipment costs (per entity & per year)	Total Administrative Costs	Business As Usual Costs (% of AC)	Total Administrative Burdens (AC - BAU)
7	B3	Notify vehicle registers	Notification of (specific) activities or events	Submitting the information (sending it to the designated recipient)	Business owners	25,73	5,00	2	1	400.000	400.000		856.667	33%	573.967
8	B3	Notify vehicle registers	Notification of (specific) activities or events	Submitting the information (sending it to the designated recipient)	ATFs/ dismantlers	25,73	10,00	4	1	2.024.242	2.024.242		8.670.504	33%	5.809.237
9	B3	Notify vehicle registers	Notification of (specific) activities or events	Submitting the information (sending it to the designated recipient)	Citizen owners	25,73	5,00	2	1	1.624.242	1.624.242		3.478.585	33%	2.330.652

New administrative costs - Business (€)	**11.025.241**
New administrative costs – citizens (€)	**2.330.652**
New administrative costs – Member States (€)	**280.336**
Total new administrative costs (€)	13.636.229

Assumptions

1a Information to waste operators, 8 truck manufacturer in the EU (https://www.eea.europa.eu/data-and-maps/daviz/hdv-market-share-for-vehicle#tab-chart_1); BAU is assumed to be 100% of annual costs as reporting is already established on a voluntary basis; 3 new models per year; unclear whether already voluntarily existent for buses and trailers, therefore assuming 6 "others" entities

1b 16 motorbike manufacturers in the EU according to ACEM interview

2 Taking into account that 15% (per unit) of vehicles are not in scope today and assuming the identical additional share for ATFs might be required for the dismantling of PTW, lorries, buses and (semi-) trailers, this results in a number 4.500 ATFs being required for vehicles other than M1 and N1 (~ 30 000)

3 Reporting on treated ELV to Eurostat, MS already report on M1 and N1 ELVs, the format can be the same for other vehicles, thus, 75% of the costs occur in the baseline

4a For number of HDV manufacturers, see no 1a

4b For number of L-cat manufacturers, see no 1b

5 For number of ATFs, see no 2

6 Authorisation of dismantling facilities, assuming 10% of the ATFs being checked per year for number of ATFs, see no 2

7 Vehicle owners to receive and store CoD documents, 0,4 Mio = sum of expected waste lorries, buses and trailers; Business owners assuming that in 1/3 of the EU MS CoD requirements exist in the national legislation

8 ATFs to print and provide CoD to vehicle owners & notify vehicle registers

9 Vehicle owners to receive and store CoD documents, 1.62 Mio = sum of expected waste L-cat; Citizen ownerships assuming that in 1/3 of the EU MS CoD requirements exist in the national legislation

Table 6-18 Administrative cost (one off) according to BRG model, scope extension **Fehler! Keine gültige Verknüpfung.**

Table 6-19 Prices (Euro) per kilo of HDVs exported from Netherlands

Exported HDV, Price per kilo

Region	count	Q1	Median	Q3
Western Africa	12324	0.64	0.99	1.5
Ukraine region	7513	1.65	2.72	3.7
Central Europe	4600	0.84	1.49	2.5
Middle East	4408	1.84	4.66	8.4
Western Europe	3649	3.67	9.79	12.1
Rest of South America	2747	0.78	1.20	2.1
Russia region	2221	0.94	1.65	6.4
Northern Africa	1064	0.78	2.36	4.1

Source: (Netherlands Ministry of Infrastructure and Water Management, Human Environment and Transport Inspectorate 2020)

Examples of low-price used HDVs exported to African countries from the same study (Dutch Ministry of Infrastructure and Wastewater) are:

- a Mercedes-Benz 1622 truck from 1994, with a weight of 7,500 kilos and a price of 2,950 (39 Eurocents/kilo)
- a DAF truck from 1996, with a weight of 6,720 kilos, exported for a price of 8,300 Euros to Ghana (1.24 Euro/kilo)
- a Scania truck from 1997, with a weight of 12,825 kilos, exported for a price of 18,300 Euros to The Gambia (1.43 Euros/kilo)
- a Renault Truckhead Premium 400 from 1999, with a weight of 6,430 kilos and a price of 6,000 Euros (93 Eurocents/kilo) to Côte D'Ivoire
- a DAF truck AE65CC from 2002 with a weight of 11,180 kilos and a price of 7,250 Euros (65 Eurocents/kilo) to Burkina Faso.

6.3 Detailed current situation of Specific objective 2 (circularity)

6.3.1 Additional information on materials used in vehicles

6.3.1.1 Glass

Different types of flat glass are used in the production of vehicles (Glass for Europe 2022).

- Windshields are usually made of laminated safety glass, which consists of two or more curved sheets of glass sealed together with a plastic interlayer (polyvinyl butyral, PVB) inserted between them, which keeps the windshield intact in the event of a collision. Laminated safety glass is more complex to get recycle-ready, since the plastic sheet needs to be removed prior to recycling.
- Side and rear windows are generally made of tempered glass, which is stronger than ordinary glass. Tempered glass provides enhanced safety as it fractures into small, relatively harmless pieces when it breaks. This type of glass is ‘purer’ as there is no plastic laminate to remove, however its collection is more difficult as it can shatter in small fragments during its dismantling from the car.

The removal of the glass pieces from the vehicle is the first essential step (Glass for Europe 2022) towards recycling. When removal is undertaken, it requires several minutes of manual work because fixed glazing is bonded to the vehicle body. Once removed from the vehicle, glass needs to be sorted by type, i.e. laminated, tempered, silver printed rear windows, etc. This separation must be with an adequate size, purity, and colour sorting system, to avoid contamination. The average time for this operation is of the order of 30-40 minutes per vehicle and involves a cost of approximately €1,000 per tonne. The decision regarding the treatment of end-of-life vehicles lies in the hands of dismantlers (Authorised Treatment Facilities, ATFs) which balance time, costs, and benefits. Currently, most of the glass in end-of-life vehicles is not recovered

According to FEAD (2022), “the manual dismantling of glass in an end-of-life vehicle is time-consuming and at the end of the process it is deposited in a container, where it breaks. The same result is obtained when separation is carried out destructively. In this case, however, collecting all the fragments can be more difficult and losses increase”. FEAD confirmed the 20% loss rate assumed by the consultants when glass windows are dismantled destructively. “There are technologically more advanced systems that can achieve better results, but these technologies can only be afforded by large plants capable of processing a large number of vehicles (> 10,000 per year), and thus amortise the investment costs. Most Authorised Treatment Facilities (ATFs), however, are Small Medium Enterprises (SMEs) and work in a completely different way and with smaller equipment.”

EGARA (2021) also referred to the advantages of destructive dismantling, stating that “the 80%-20% percent rule may be wise to apply in some cases. Taking out most for low costs is much better than taking out 100% for sky high costs”.

OVAM (2012?) performed an analysis of the legislation and practice in other European countries that shows that selective glass removal is not widely applied. A few examples of the situation in various Member States:

- In most member states the shredder option is the preferred choice and glass is recycled mainly in the road construction sector.

- In Flanders and Belgium, glass currently follows the PST route: after shredding of the discarded vehicle, which still contains the glass, the glass ends up in the mineral fraction which is then recycled into construction material.
- Denmark: The government claims that removal was applied in the past because two out of three shredder facilities could not demonstrate convincingly that their post shredder glass fraction was being recycled. As a result of technological improvements, today almost all of the glass passes through the shredder facilities. The post shredder fraction containing the glass is recycled in the road construction industry. Shredder facility HJ Hansen confirms that glass currently goes into the shredder. They ask about 100 Kroner (roughly € 12) extra for ELV including glass and plastic. According to HJ Hansen this is not enough to cover the costs for manually removing the glass and plastics prior to shredding the ELV.
- Germany: Some sources indicated that certain companies remove glass from ELV, but this was not confirmed (no response from these companies). Removed glass originating from glass repair companies is being processed at glass recycling facilities, which might create the assumption that this includes ELV glass. The different responses seem to indicate that removal took place in the past but is not widely practised today because in modern cars the windscreens usually are glued to the frame, which makes them hard to remove. One contact stated that the price offered by glass processing companies, whilst already receiving a large amount of glass from other sources, is not high enough to justify the costs (a so-called fee gate of € 0). Another contact mentioned a removal time of 30 minutes for glass (own estimate), but he referred to Carglass, which feeds the assumption that this involves the removal time for reuse. A 2008 calculation carried out by the regional authorities for the Baden-Württemberg region puts glass removal costs at an amount between € 4.60 and € 8 per ELV for the dismantler. This equals € 225 to € 350 per tonne of glass. PST is available in Germany (e.g. in Eppingen) at a cost between € 2.80 and € 4.20 per ELV.
- France. In general it appears that ELV glass is not being removed. In France ELV glass will have to be removed in the future, namely as from 1 July 2013. However, there are signals that even after that date the obligation will not be enforced because additional research is required to organise the removal process. Some people indicate that glass is already being removed from ELV within the INDRA network, the French key player in ELV recycling (500 000 wrecks handled in 2010), but this was not confirmed by INDRA (no response). France has had several studies carried out, among other things about glass removal. For reasons of confidentiality not all the information was revealed, but it was indicated that removal costs range between € 6.00 and € 8.00 per ELV. These costs consist of € 1.00 to € 1.25 for collecting and processing; € 5.00 to € 6.75 for labour involved in the dismantling procedure (based on an hourly wage of € 15 to € 20 and 15 to 20 minutes removal time). The costs are exclusive of tools and storage costs. The calculation is based on a study carried out in 2003 and 2004. The figures are not totally reliable, first of all because they are outdated and secondly because government officials use different figures in several communications.
- Hungary: Information from Hungary came from one source only, namely a member of Egara. He stated that Hungary recently adopted legislation that makes glass removal prior to shredding mandatory, but that the follow-up to the legislation is currently being investigated. In view of the fact that Hungary only just managed to meet the recycling targets laid down in the ELV Directive and of the even higher targets to be met as from 2016, it is not unlikely that Hungary has imposed the obligation so as to be able to comply with the 2016 targets.
- Netherlands: The Netherlands is one of the few countries where the removal of flat glass from ELV occurs on a large scale thanks to financial support from ARN. ARN has estimated the removal time of ELV glass at 18 minutes and pays the dismantling centres

a contribution of € 19. the system has resulted in large-scale removal of glass from car wrecks. In September 2011 the law was changed, abolishing the previously mandatory removal of glass prior to shredding. The key premise of the new legislation is that the recovered material must be recyclable and that in terms of environmental effects, shredding glass must be a proper alternative for removal prior to shredding. The centres indicate that if the financial support from ARN should be discontinued, they will stop removing the glass.

- Austria applies a legal obligation to at least remove the windscreen prior to shredding. As a general rule, the law allows other solutions provided that they are similar in terms of environmental impact. Despite existing PST, Austrian ELV processing companies do remove the ELV glass. As far as we know they do not receive a financial contribution. The sector does not oppose to the legislation which came into being in consultation with the industry.
- In Poland it is mandatory to remove glass prior to shredding. This has been confirmed by both the government and the federation of ELV recyclers/dismantlers. In practice it involves a system of manufacturer responsibility which is comparable to the Dutch system. A contribution for ELV treatment of 500 Polish Zloty per tonne applies, roughly € 120. Manufacturers and importers must pay the contribution for each newly produced or imported vehicle. The same amount is transferred to the authorised treatment facilities per tonne of processed ELV. The source of the calculation method for this contribution was not revealed. For comparison: in the Netherlands a payment applies of € 55 for all materials.
- Portugal: National legislation dictates removal of glass prior to shredding the ELV. Manufacturer responsibility has been set up to organise the processing of ELV. Glass is being removed and recycled at a large scale. All of the glass has to be removed. In newer cars with glued windscreens, the glass is removed using a jig saw which cuts into the glass itself. In older cars either the same technique is used, or the rubber is cut. No contribution is provided for glass removal (the same applies to other fractions to be removed or depolluted). However, the umbrella organisation Valorcar has negotiated a ‘good' price for glass removed from ELV: € 0 instead of a negative value of about € 35 - € 50 per tonne. Transport costs are borne by the ELV recyclers. Portugal has four shredder facilities, but no PST. PST is expected to be introduced in the future, after which glass most likely will no longer be removed.
- Spain: Glass removal is not mandatory in Spain if the glass is recycled after shredding. However, some regions impose an obligation of glass removal prior to shredding the ELV. According to Sigrauto (the Spanish association for treatment of discarded vehicles) these regions apply a stricter interpretation of the European Directive when it comes to glass processing. In view of the limited number of PST facilities in Spain, it is not unlikely that some regions impose glass removal prior to shredding in view of the absence of sufficient geographic spread of those facilities. There is neither financial compensation for glass removal, nor a positive gate fee for processing the removed glass.
- Sweden: Legislation dictates that glass has to be removed from ELV but to which extent this actually occurs is unclear. PST was not available at the time the legislation entered into force.

There are technical obstacles to allow reuse of ELV glass cullet in the manufacture of new vehicle glass (flat glass). According to Glass for Europe (2022), the Automotive glass products necessitate the highest quality and purity to ensure unaltered visibility and safety. Contaminants in raw materials and cullet generate production defects but can also jeopardise the glazing structure and make serious damage to the industrial equipment7. For these reasons, the flat glass industry has the most stringent quality specifications for sourcing cullet. (Glass for Europe 2022)

Because quality specifications for recycled glass are not as strict in other glass sectors as in the flat glass sector, for instance in container glass or glass fibre, for which visibility and transparency are not essential selling points, some flat glass cullet of automotive origin may be used by these glass sectors at a lower quality level and cost than what could be possible in flat glass manufacturing. (Glass for Europe 2022)

6.3.1.2 EEC

Groke et al. (2017) explains that based on their research, 30 most relevant components were identified to focus on in their study as having the highest priority for dismantling and 10 alternative components which could be subject to dismantling if other parts of the list are not present in a vehicle, as well as the electric inverter of hybrid vehicles. He list of components is reproduced below.

Table 11: List of 30 priority vehicle components containing strategic metals for dismantling trials including additional components ("List of 30")

Sub-system	#	Component	Prio *)	Sub-system	#	Component	Prio *)
Motor/ magnetic application	1	heating fan	2	Control devices	22	chassis control	1
	2	power assisted steering	2		23	steering control	1
	3	starter	1		24	anti theft control	2
	4	air fan motor	2		25	air conditioning control	2
	5	Speaker	2		26	airbag control	1
	6	door closing motor	2	Junction boxes	27	smart junction box	1
	7	generator	2		28	passive junction box with printed circuit boards	2
	8	closing motor of hatch	3	Light	29	backlight	1
	9	seat adjustment	2		30	headlight	2
	10	fuel pump	3		31	blinker	1
	11	washer system pump	3	Sensors	32	wheel rotation sensor	3
	12	window washer motor	2		33	camshaft sensor	3
	13	window lifter	2		34	crank shaft sensor	3
	14	mirror adjusting motor	3		35	oxygen sensor	1
Screens	15	navigation system	1		36	radar sensor	1
	16	combination screen	2		37	long distance radar sensor	1
	17	LCD	2		38	airbag sensor	1
Control devices	18	inverter (hybrid vehicle)	1		39	HVAC sensor	3
	19	motor control	1	Actu-ators	40	spark plug	1
	20	gear control	2		41	injection device	3
	21	drive control	2				

*) Priority for dismantling (related to respective subsystem)

Restrepo et al (2017) analyses critical metals (CM) in passenger vehicles that are contained in electronic control systems (ECS). For analysis purposes, ECSs are structured into sub-layers comprising EE devices embedded in vehicles (sensors, controls and actuators). The ECS consist of electronic/electric parts that in turn contain EE components. The metals Ag, Au, Pd, Ru, Dy, La, Nd, and Co represent the endpoint of the analysis. The flow of ELV analysed refers to reference year 2014 – from the perspective of 2017, the publication year of the analysis, the situation in 2022 may correspond to the material composition of ECS in vehicles newly put on the market by then.

The authors calculated the average (median) content of CM per selected EEC in passenger vehicles. Results (see Table 6-20) show that rare earth elements and cobalt reside almost exclusively in permanent magnets, which are predominantly used in actuators (electric motors). Other precious metals in turn occur in PWBs, that function as controllers in vehicles.

Table 6-20 Distribution of CM mass in EE devices in an average passenger vehicle.

Table S24. Distribution of CM mass in EE devices in an average passenger vehicle. All values in %

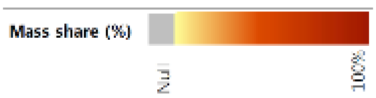
Selected electric and electronic devices			Distribution of critical metal mass in EE devices in an average passenger vehicle - in percentage (%)-							
			A) Average new vehicle (cohort 2014)							
			Ag	Au	Pd	Ru	Dy	La	Nd	Co
Actuators	Permanent magnets	Speakers (only woofer)	-	-	-	-	0.002	0.2	0.01	0.06
		Throttle actuator	-	-	-	-	0.001	0.05	0.003	0.02
		Hydraulic modulator	-	-	-	-	0.001	0.04	0.003	0.02
		Power windows motors	-	-	-	-	0.001	0.1	0.005	0.03
		Radiator fan motor	-	-	-	-	0.001	0.1	0.01	0.04
		Electronic power steering motor	-	-	-	-	0.1	-	0.4	0.5
		Windscreen wiper motor	-	-	-	-	0.0004	0.03	0.002	0.01
		Windscreen wiper fluid pump	-	-	-	-	0.0001	0.004	0.0003	0.001
		Alternator	-	-	-	-	0.002	0.2	0.01	0.1
		Starter motor	-	-	-	-	0.001	0.1	0.01	0.04
		Drive motor/Generator HEV	-	-	-	-	0.6	-	0.3	0.2
		Drive motor/Generator EV	-	-	-	-	0.2	-	0.1	0.05
		NiMH Battery HEV	-	-	-	-	0.0005	0.3	0.2	-
Controllers	Printed Circuit Boards	Airbag controller	0.03	0.03	0.03	0.03	0.00002	0.00004	0.00005	0.0002
		ABS/ESP/EBD/VDC/HHC/DSR/TCS/CBC contro.	0.1	0.1	0.1	0.1	0.0004	0.0001	0.01	0.000
		Sound system controller (incl. Radio/CD)	0.2	0.2	0.2	0.2	0.0001	0.003	0.003	0.001
		Navigation System controller (incl. DVD)	0.1	0.1	0.1	0.1	0.0004	0.0001	0.01	0.001
		Central locking/Keyless access controller	0.02	0.02	0.02	0.02	0.000003	0.00002	0.00002	0.0001
		Power windows controller	0.02	0.02	0.02	0.02	0.0001	0.00002	0.001	0.0001
		Power mirrors controller	0.0004	0.0004	0.0004	0.0004	0.000000005	0.00000002	0.00000002	0.000002
		Light assistance system controller	0.0002	0.0002	0.0002	0.0002	0.000001	0.0000002	0.00001	0.0000
		Electronic power steering controller	0.1	0.1	0.1	0.1	-	0.00002	0.00002	0.001
		Parking assistance controller	0.02	0.02	0.02	0.02	0.0001	0.00002	0.001	0.0001
		Automatic H/AC controller	0.01	0.01	0.01	0.01	0.0000	0.00001	0.001	0.0000
		Adaptive cruise control (ACC) controller	0.02	0.02	0.02	0.02	0.0001	0.00002	0.001	0.0001
		Engine/Motor controller	0.1	0.1	0.1	0.1	0.0015	0.00001	0.00001	0.001
		Daytime running lamps controller	0.02	0.02	0.02	0.02	0.0001	0.00002	0.001	0.0001
		Dashboard	0.1	0.1	0.1	0.1	0.0003	0.0001	0.005	0.000
		Electrical system controller	0.2	0.2	0.2	0.2	0.0008	0.0002	0.01	0.001
		Total mass per average vehicle (in g)	1	0.3	0.06	0.001	5	40	40	50

Source: Restrepo et al (2017 SI)

Note: All values in %

Further, Restrepo et al (2017):

ECS-parts in Vehicles	Material composition	Number of occurrences per car
Airbags		3
Vehicle dynamics control systems*		2,6
Sound system (incl. Radio/CD)		1,3
Power windows		0,9
Central locking/keyless access		0,9
Power mirrors		0,75
Driver information system/OBDS		0,55
Daytime running lamps		0,55
Electronic power steering		0,5
Navigation system (incl. DVD)		0,5
Electronic immobilizer		0,5
De-activation of co-driver airbag		0,5
Fog lights1		0,5
Adaptive cruise control		0,45
Light assistance		0,45
Adaptive lights		0,4
Stop-start system		0,4
Manual H/AC		0,4
Automatic H/AC		0,3
Tire pressure monitoring system		0,3
Multifunction steering wheel1		0,3
Parking assistance		0,3
Multifunction display1		n.a.
Multimedia socket1		n.a.
Pre-installation kits		n.a.
Third brake light1		n.a.



The CMs are located in various ECSs in vehicles, the most important of which (by mass per unit) are listed in the following table:

Device type	Device name	Main component containing CMs	Number of parts per car	Qualitative mass estimation*
Actuator	Radiator fan motor	Magnet		xl
Actuator	Alternator	Magnet		xl
Actuator	Air dam	Others		l
Actuator	Starter motor	Magnet		l
Actuator	Battery	Others		l
Actuator	Motor/Generator	Magnet		xl
Actuator	Multifunction display	LCD		m
Actuator	Flaps in front splitter and/or rear diffuser	Magnet		m
Actuator	Rear airbrakes	Others		m
Actuator	Rear spoiler	Magnet		m
Actuator	Grill shutters	Magnet		m
Actuator	Speakers	Magnet		m
Actuator	Shock absorbers	Solenoid		m
Actuator	Hydraulic modulator	Magnet		m
Actuator	Dashboard	PWB		m
Actuator	Wheel brakes	Others		m
Actuator	AC Compressor			m
Actuator	Electrical radiator blowers	Magnet		m
Actuator	Electronic power steering motor	Magnet		m
Actuator	Steering column adjuster	Magnet		m
Actuator	Charge and discharge actuator	PWB		
Actuator	Power inverter	PWB		
Actuator	Radio	PWB		
Actuator	Brake master cylinder	Others		
Actuator	Headlights	Others		
Actuator	2-4 wheel drive actuator	Magnet		
Actuator	Windscreen wiper motor	Magnet		
Actuator	Rear wiper motor	Magnet		
Actuator	Defogger motor	Magnet		
Actuator	DC brushless motors	Magnet		
Controller	Battery Management System	PWB		
Controller	Convertible Top Control	PWB		
Controller	Electronic Power Steering	PWB		
Controller	Electronic Valve Timing	PWB		
Controller	Energy management (EM)	PWB		
Controller	ICE Control Module	PWB		
Controller	Entertainment Systems	PWB		
Controller	Lane keeping assistance	PWB		
Controller	Motor/Generator Control Unit	PWB		
Controller	On-Board Diagnostic Systems	PWB		
Controller	Power source management	PWB		
Controller	Transmission Control	PWB		

Device type	Device name	Main component containing CMs	Number of parts per car	Qualitative mass estimation*
Controller	Engine Data Scan	PWB		

Restrepo et al (2017) recommend "Dismantling these devices before ELV shredding, as well as post-shredder treatment of automobile shredder residue may increase the recovery of CMs from ELVs. Environmental and economic implications of such recycling strategies must be considered."

6.4 Detailed results of the impact analysis for Specific objective 2 (circularity)

6.4.1 Screening measures and separate discarded options

The table below displays the criteria for screening.

III. Screen your options and separate discarded options	
Why?	To focus the analysis on the viable options. In choosing the options, it is important to focus on those elements that are most critical for the Commission to decide on (i.e., those with significant impacts). As with the problem analysis, you must ensure that the report remains focused and that it does not drown the major issues in a 'flood' of minor issues.
How?	Excluding options at this stage should be clearly justified. Reasons should be as clear, self-evident and indisputable as possible. The report should explain when it had to discard policy options favoured by stakeholders. This should be done in a separate section on discarded options (if necessary, with further details in the annexes).
	The key **criteria for screening** the viability of your options are:
	Legal feasibility
	Options should respect the principle of conferral[350]. They should also respect any obligation arising from the EU Treaties (and relevant international agreements) and ensure respect of fundamental rights. Legal obligations incorporated in existing primary or secondary EU legislation may also rule out certain options.
	Technical feasibility
	Technological and technical constraints may not allow for the implementation, monitoring or enforcement of theoretical options.
	Previous policy choices

[350] Under this fundamental principle of EU law, laid down in Article 5 of the Treaty on European Union, the EU acts only within the limits of the competences that EU countries have conferred upon it in the Treaties. These competences are defined in Articles 2–6 of the Treaty on the Functioning of the EU. Competences not conferred on the EU by the Treaties thus remain with EU countries.

III. Screen your options and separate discarded options	
	Certain options may be ruled out by previous policy choices or mandates by EU institutions. Unless there is compelling evidence that these choices should be revisited, there is no point in reinventing the wheel.
	Coherence with other EU policy objectives
	Certain options may be ruled out early due to poor coherence with other general EU policy objectives.
	Effectiveness and efficiency
	It may already be possible to show that some options would with certainty achieve a worse cost-benefit balance than some alternatives.
	Proportionality
	Some options may clearly restrict the scope for national decision-making over and above what is needed to achieve the objectives satisfactorily.
	Political feasibility
	Options that would clearly fail to garner the necessary political support for legislative adoption or implementation could also be discarded. This, however, does not mean that such options should not be mentioned or not be subject to at least a minimal assessment. Options superior to other options but lacking political feasibility may still be discussed at the legislative stage, which may increase their chances of being politically feasible.
	Relevance
	There is no point in retaining options that do not address the needs of the policy intervention as identified in the problem definition.
	Identifiability
	When it can be shown that two options are not likely to differ materially in terms of the proposed measures, their significant impacts or their distribution, only one should be retained.

Source: Better Regulation toolbox Tool #16, Textbox page 114 – 115

In the following the potential measures for circularity objectives 2.1 through 2.3 are assessed against these criteria and a justification is given for the case that an option is considered as discarded. The numbers in the column "Viability screening" refer to the numbering of the key criteria for screening as displayed in the table above.

Table 6-21 Initial assessment of measures to identify discarded and short-listed measures

Measure	Viability screening	Effectiveness	Comment, Discard justification
addressing Specific Objective No 2.1			
2.1.a) OEM voluntary pledges campaign to increase circularity	✓ 5. & 9.	Low, as assumed to mainly motivate actions of OEMs already more advanced in circularity and has a risk of not leading to continuous improvements and benefits	Higher results expected by enforcing measure 2.1.c → **discarded**
2.1.b) EC non-binding guidelines on how to improve circularity in vehicles	✓ 5. & 9.	Unclear to what degree such guidance is applied and leads to improvements	Higher results expected by enforcing measure 2.1.c → **discarded**
2.1.c) Obligation for OEMs to develop and implement circularity strategy	✓	Flexibility related to how OEMs develop strategy and implement expected to increase efficiency	→ **Short list**
2.1.d) Improving the relation between the 3R Type approval process and ELV waste management performance:	✓ General feasibility	Effectiveness could vary between the sub-measures	
Revision of 3R Type Approval calculation	✓ 4.(*)	Expected to ensure use of non-recyclables only when justified environmentally	→ **Short list**
Multi-stage vehicle inclusion in 3R Type Approval	✓ feasibility differs for vehicle categories	Limited effectiveness expected for some vehicle categories	→ **Short list for trucks**
Dismantling and shredding tests	✓	Low effectiveness:	→ **Short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
		impacts will incur slowly as only few vehicles tested	
2.1.e Submission of carbon footprint LCA data as part of the 3R type approval process to justify use of non-recyclables	✓ Transition period will delay incurring benefits	Only effective in combination with measure 2.1.d	→ **Short list**
2.1.f) Obligatory reporting requirements on the use of materials that affect dismantling and recyclability to facilitate identification of incompatible practices	✓	Improving communication on (in)compatible materials and techniques expected to lead to more effective design for circularity	→ **Short list**
2.1.g) Establishment of mandatory recycled content targets for materials used in cars	✓ 2 for rubber	Effective only for some materials	Short-list - Feasible for plastic and possibly also for NdFeB magnets (**) in the longer term. Situation for glass could be revisited in the further future → **Short list** Situation for rubber unclear as recycling technologies are under development → **discarded**
2.1.h) Obligatory due diligence for materials used in vehicles	✓ 8. & 9.	Low at vehicle level	Partially covered by other legislation, horizontal legislation more appropriate → **discarded**
2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars, either through existing platforms of digital product passport	✓	Effectiveness will depend on the level of harmonisation, means of access and actual use of data by profiting stakeholders	Supportive measure – will only result in improvements in combination with other measures → **Short list**
addressing Specific Objective No 2.3			
2.3.a) Clarify definition of re-use in the ELV Directive vs re-use and preparing for re-use in the Waste Framework Directive	✓	Moderate	Alignment of the definition and clarity on the status of the removed components shall reduce administrative burdens of (trans-national) shipment. → **Short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
2.3.b) Introduce a definition of remanufacturing and specific provisions to support remanufacturing	✗ 1., 2. & 7.	Moderate to high	A clear definition shall promote remanufacturing and help distinguish it from practices that do not achieve a minimum quality. Similarly, to measure 2.2.a it shall reduce administrative burdens of (trans-national) shipment. A possible limitation of use of remanufactured components may occur in the case of their application in damaged newly manufactured vehicles and in construction of new vehicles since this issue is not legally clarified and for some OEMs is not considered as an option (due to definition of new vehicle). As described above, it is unclear if assembling an entire car from remanufactured parts is technically feasible. Additionally, some components of ELVs cannot easily be installed in new vehicles, once outdated. These technical aspects may limit the viability of some of the sub-measures, influencing the option to use remanufactured/used components in new vehicles. The option is still considered for assessment as it is considered to have a high effectiveness. → **Short list**
2.3.c) Voluntary activities of OEMs and their suppliers to promote the application of reused and remanufactured components	✗ 5.	Low	It might be possible to achieve similar results by enforcing measure 2.2.b → **discarded**
2.3.d) Voluntary activities of Member States to promote circularity	✗ 5.	Low	Good Public Procurements may have an added benefit of raising employee awareness to reuse and remanufacturing practices. However, implementation of GPP rules is an individual decision of MS. → **discarded**
2.3.e) Establish provisions to support the market of used spare parts	✗ 1.	Moderate to High (when combined with measures 2.2.f and 2.3.b)	The market for reused components is dynamic – increasing demand is assumed to provide more flexibility to ATFs to decide on components to be dismantled as opposed to measures for increasing supply which could result in a high burden for storage without significant impact on the actual reuse/remanufacturing of components. → **Short list**
2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing	✓	Moderate to High (when combined with measure 2.2.e and 2.3.b)	Harmonising monitoring will allow understanding the actual volume of reuse in different MS on a comparable basis and could allow identifying where reuse could further be facilitated in the future through component specific targets. → **Short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
addressing Specific Objective No 2.4			
2.4.a) Align definition of 'recycling' with the WFD	✓	Moderate to high	Alignment of the definition 'recycling' with WFD could potentially lead to higher quality recycling, however in some MS also requiring investments in such developments. → **Short list**
2.4.b) Making it mandatory to remove certain parts/components before shredding to encourage their recycling	✓	Moderate to High (when combined with measures 2.3.a, 2.3.c, 2.3.d, 2.3.e)	The selection of a single measure or a set of measures shall be concluded for each material separately in order to find the most suitable approach for increasing reuse and recycling of that material and related components. In the first screening all of measures are selected for the short list. Further specification will be performed in the next section or each material and at vehicle level and the impact analysis will support the final selection. → **Short list**
2.4.c) Set material-specific recycling targets for a selection of materials	✓	Moderate to High (when combined with measures 2.3.a, 2.3.c, 2.3.d, 2.3.e)	
2.4.d) Regulate shredder/post shredder facilities to ensure higher quality of recycling	✓	Moderate to High (when combined with measures 2.3.a, 2.3.c, 2.3.d, 2.3.e)	
2.4.e) Increase (?) current re-use and recycling targets and/or ban disposal or landfilling of waste from ELVs	✓	Moderate to High (when combined with measures 2.3.a, 2.3.c, 2.3.d, 2.3.e)	
2.4.f) Revision of Commission Decision 2005/293/EC on the circularity aspects	✓	Moderate	→ **Short list**

*) Changes to the 3R Type approval that go beyond the requirements established in Regulation UN ECE 133 could affect the current equivalence of type approvals performed to comply with these legislations. This would either require the EC to promote a similar change in the international legislation or to withdraw from it, possibly affecting the movements of vehicles between the EU and other countries.

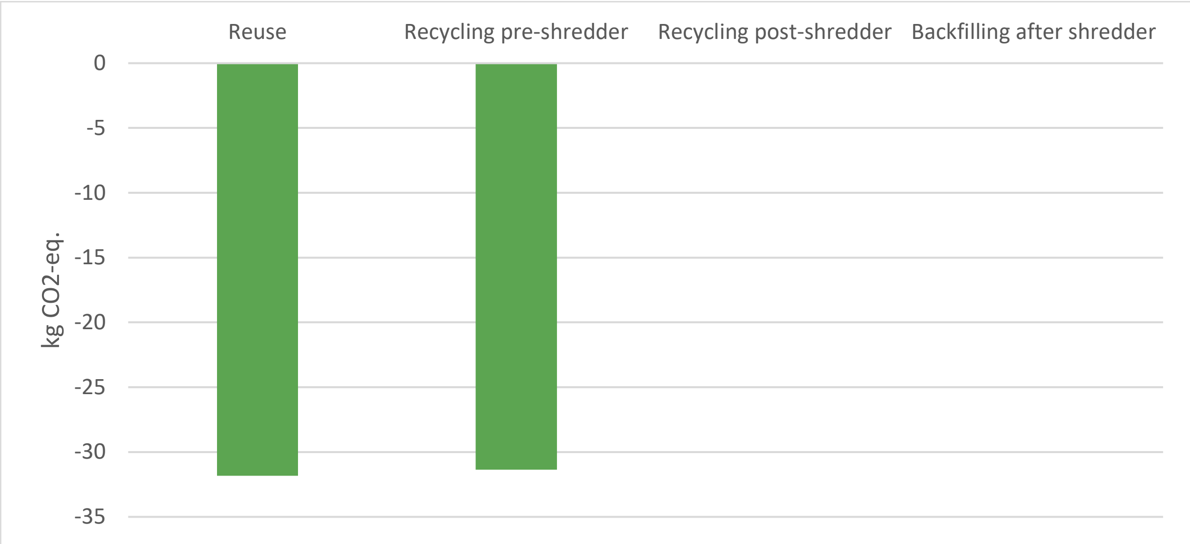
**) Investigation for plastic has been conducted by the JRC, who will also lead a separate study where this measure may be considered for NdFeB magnets. This study shall not present the assessment in detail but only refer to such measures in terms of possible combinations with other measures, synergies and antagonistic relations.

6.4.2 Additional results of the impact analysis

6.4.2.1 Glass

The figure below shows the related impacts of sending glass to different treatment routes. This calculated for the functional unit (all vehicle glass of a typical passenger car) in terms of global warming potential.

Figure 6-6 Credits for Global warming potential (GWP) of different treatment routes for all windows, as compared to primary production (kgCO_2eq) – functional unit: all vehicle glass of a typical vehicle (tCO_2eq)



Source: Own illustration

6.4.3 Administrative costs for objective 2: circularity:

Table 6-22 Administrative costs (recurrent) according to BRG model, circularity

No.	New administrative obligations: Type of obligation (see below for typology)	Description of required action(s)	Target group	SMEs affected (Y/N)	Tariff (€ per hour)	Time (minutes)	Price (€ per action) (P)	Freq (per year)	Override cost per entity used	Number of entities	Total number of actions (Q)	P*Q (€)	Override costs where P*Q not used (€)	Equipment costs (€ per entity	Total Administrative Costs	Business As Usual Costs	Total Administrative Burdens	Comments
								Businesses										
SV11 SV2	Submission of (recurring) reports	Filing forms and tables	ATFs	Y	26	480,00	206	1	0	12.000	12.000	2.467.200	0		2.467.200	95%	123.360	Aligning recycling definition with WFD, ATF Reporting on vehicle glass treatement to MS authority, Waste operators already report to MS on M1 and N1 vehicles, reporting of values shall not change signifiacntly, but more documentation will need to be provided
SV1a	Submission of (recurring) reports	Filing forms and tables	ATFs	Y	26	960,00	411	1	0	12.000	12.000	4.934.400	0		4.934.400	60%	1.973.760	Monitoring reuse, ATF Reporting to MS authority on dismanteled parts/components for reuse/remanufactoring , Waste operators already report to MS on M1 and N1 vehicles, but the new reporting on reuse will be much more detailed
SV2a	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	ATFs	Y	26	180,00	77	52	0	270.000	14.040.000	1.082.484.000	0		1.082.484.000	100%	0	Not to be included: Considered to be part of the baseline as operational costs as the revenues that are not precisely quantified certainly will outweight the reporting costs. Support reuse market, Repair shops, We know that in some cases repair shops already apply reused parts, anyway the obligation could lead to an increase in such activities.
SV3a	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	ATFs	Y	26	960,00	411	1	0	12.000	12.000	4.934.400	0		4.934.400	70%	1.480.320	Obligatory dismantling, ATF Reporting to MS authority on mandatory dismantled parts/components either for reuse/remanufacturing or for recycling, ATFs already report but will have additional effort to provide data on weight and kind of dismantled components for reuse/remanufacturing and recycling. It is assumed that ATFs will dismantle more, thus higher effort.
SV4b	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	Shredders/ PST operators	Y	26	960,00	411	1	0	140	140	57.568	0		57.568	0%	57.568	PST - general, Reporting obligation on PST capacities, We assume that the PRO will report on PST activities under its membership and that non-members will report individually
SV4c	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	Steel recyclers	Y	26	480,00	206	12	0	200	2.400	493.440	0		493.440	75%	123.360	PST - copper level, Recycler reporting on quality of smelted steel batches, We assume that recyclers will report over time about the changing level of copper in steel smelted bateches - once a month. We assume that they test batches anyway and just need to compile and submit the data.
SV4b	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	Shredders/ PST operators	Y	26	960,00	411	1	0	140	140	57.568	0		57.568	0%	57.568	Disposal ban (PST plastic), Reporting obligation on the quality of residues (POP content), We assume that the PRO will report on PST activities under its membership and that non-members will report individually - currently not reported
SV11 SV2	Submission of (recurring) reports	Submitting the information (sending it to the designated recipient)	Shredders/ PST operators	Y	26	2.400,00	1.028	1	0	200	200	205.600	0		205.600	10%	185.040	Mutual RRR targets, Waste operators/PROs reporting on treated ELVs to MS authorities ("calculation point"), The effort of the waste operators that will need to report will depend on how the reporting is determined. The calculation assumes involvement of all parties (conservative). The reporting also covers any burden for reporting related to material specific targets
4A	Submission of (recurring) reports	Inspecting and checking (including assistance to inspection by public authorities)	ATFs	Y	26	0,00	0	1	2,50	6.310.435	6.310.435	0	15.776.087		15.776.087	20%	12.620.869	2.4 Monitoring of material flows and compliance with RRR targets, Based on indication from Belgium (febelauto), Netherlands (ARN) and Ireland (ELVES) we conclude that the effort for this task is between less than 1 € and in maximum 5 € per new and used car first registered; share of the ATFs
4A	Submission of (recurring) reports	Inspecting and checking (including assistance to inspection by public authorities)	Shredders	Y	26	0,00	0	1	2,50	6.310.435	6.310.435	0	15.776.087		15.776.087	20%	12.620.869	2.4 Monitoring of material flows and compliance with RRR targets, Based on indication from Belgium (febelauto), Netherlands (ARN) and Ireland (ELVES) we conclude that the effort for this task is between less than 1 € and in maximum 5 € per new and used car first registered; share for the shredders
4A	Submission of (recurring) reports	Inspecting and checking (including assistance to inspection by public authorities)	Recyclers	Y	26	0,00	0	1	1,00	15.776.087	15.776.087	0	3.155.217		3.155.217	20%	2.524.174	2.4 Monitoring of material flows and compliance with RRR targets, Based on indication from Belgium (febelauto), Netherlands (ARN) and Ireland (ELVES) we conclude that the effort for this task is between less than 1 € and in maximum 5 € per new and used car first registered; share for the recyclers/ end-processors.
								Public authorities										
SV11 SV2	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	480,00	206	1	0	27	27	5.551	0		5.551	100%	0	Aligning recycling definition with WFD, MS Reporting on treated ELVs to Eurostat, MS already report on M1 and N1 ELVs, the format will not change from the baseline but only what values are reported under which part, all costs occur in the baseline.
SV1a	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	480,00	206	1	0	27	27	5.551	0		5.551	60%	2.220	Monitoring reuse, MS Reporting on treated ELVs to Eurostat, MS already report on M1 and N1 ELVs, the format will change from the baseline but still MS just need to compile the data they get from ATFs and validate it.
SV2a	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	720,00	308	3	0	27	81	24.980	0		24.980	0%	24.980	Support reuse market, MS Reporting on treated ELVs to Eurostat, To implement enforcement against illegal sales of reused components, MS would need to inspect online sale platforms to ensure no illegal activities.
SV3a	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	480,00	206	1	0	27	27	5.551	0		5.551	70%	1.665	Obligatory dismantling, MS Reporting on treated ELVs to Eurostat, MSs already report and will use same format, however those not yet reporting. It is assume that ATFs will dismantle more, thus higher effort.
SV4e	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	960,00	411	1	0	27	27	11.102	0		11.102	0%	11.102	PST - general, MS Reporting on treated ELVs to Eurostat, There is currently no reporting on PST capacities
SV4b	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	960,00	411	1	0	27	27	11.102	0		11.102	0%	11.102	PST - copper level and quality of steel fractions, MS Reporting quality of steel recyclates to MS, Newly introduced reporting based on recycler submitted data
SV4f	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	720,00	308	1	0	27	27	8.327	0		8.327	0%	8.327	Disposal ban (PST plastic), MS Reporting on treated ELVS to Eurostat, There is currently no reporting on the quality of PST residues
SV5b	Submission of (recurring) reports	Filing forms and tables	MS competent authorities waste	N	26	300,00	129	1	0	27	27	3.470	0		3.470	10%	3.123	Mutual RRR targets, MS Reporting on treated ELVS to Eurostat ("calculation point"), MS will have higher costs as the reporting format will need to be udpated based on the calculation point principal and is expected to be slighlty more specific.

New Administrative costs - Business	37.301.089
New Administrative costs - public bodies	62.520
Total new administrative costs (€)	**37.363.609**

6.5 Detailed current situation of Specific objective 3 (missing vehicles)

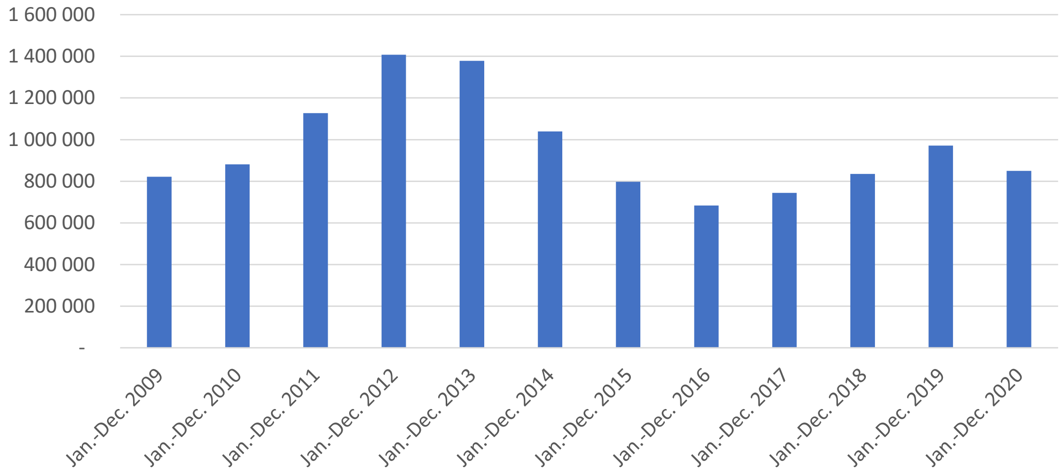
6.5.1 Facts on extra EU Export

6.5.1.1 Destinations, numbers, and value of the exported used vehicles

As displayed in Figure 6-7, the total number of exported used vehicles from EU-27 to non-EU Countries is, according to customs data reported by Eurostat, changing from year to year. In the past decade the export peaked in 2012 with 1.4 million exported used vehicles, dropped to 680 000 in 2016 and the last available number for the export in 2020 is 870 000 used vehicles.

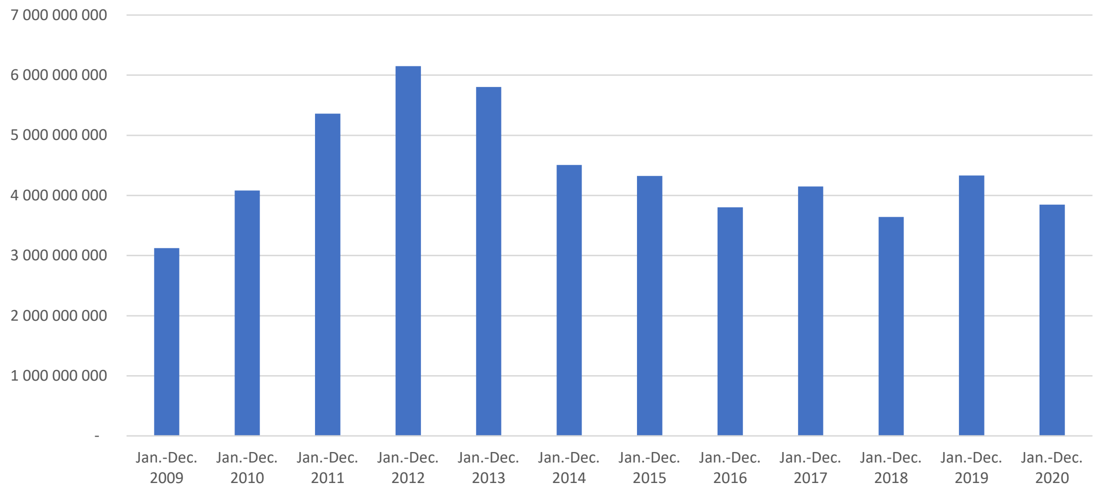
As displayed in Figure 6-8 the total value of the exported used vehicles to non-EU Countries is € 6.14 billion in 2012 and dropped to € 3.85 billion in 2020.

Figure 6-7 Number of exported used vehicles from EU-27 to non-EU Countries



Source: Eurostat, COMEXT (download 27.1.2022)
CN codes considered: 87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).

Figure 6-8 Total value of exported used vehicles from EU-27 to non-EU Countries

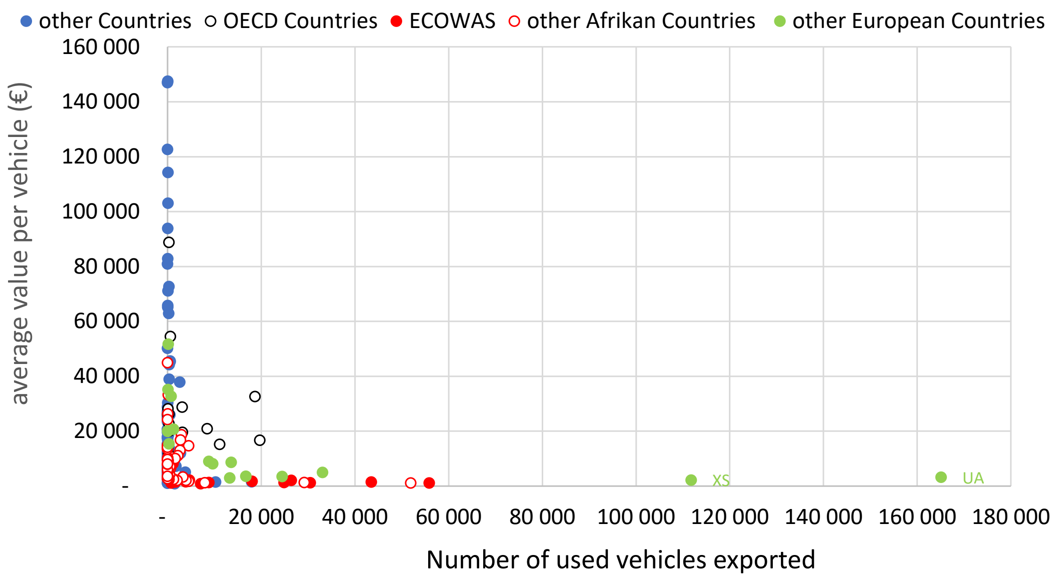


Source: Eurostat, COMEXT (download 27.1.2022); CN codes considered: see Figure 6-7 above

Figure 6-9 displays the number and average value per country of destination for the year 2020. It demonstrates high discrepancies in the characteristics of the exported vehicles:

Very high numbers (more than 100 000 used vehicles per year) with comparable low value (less than 4000 €) are exported to Ukraine (UA) and Serbia (XS).

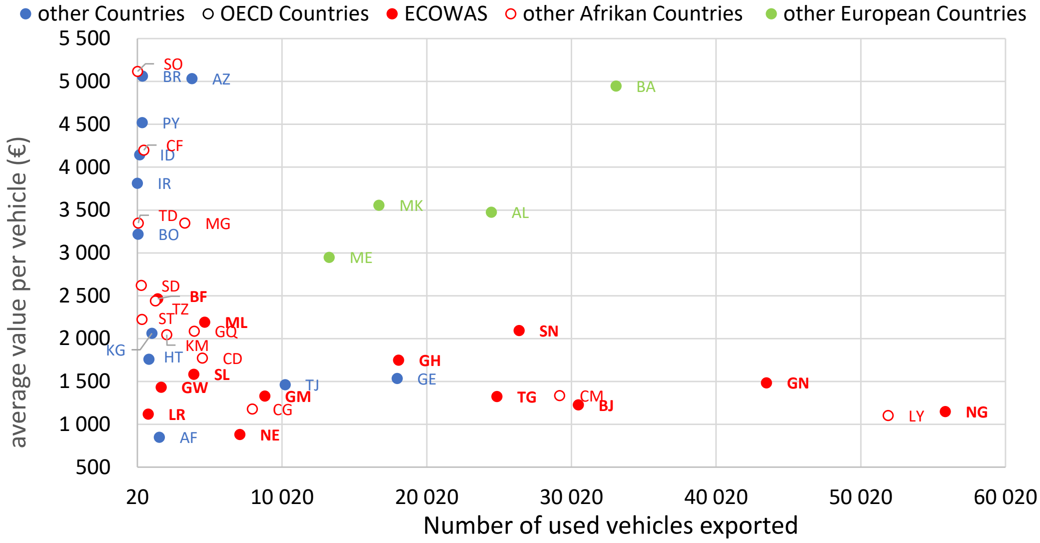
Figure 6-9 Extra-EU exports of used vehicles in numbers and average value for 2020



Source: Eurostat, COMEXT (download 27.1.2022); CN codes considered: see Figure 6-7 above

Figure 6-10 displays more details for the countries with more than 20 used vehicles exported to (excluding Serbia and Ukraine mentioned before) and for the countries where the average value per used vehicles is reportedly less than 5500 €. The full details, displaying the country names and all data are displayed in Table 6-25 more below in this section.

Figure 6-10 Extra-EU exports of used vehicles in numbers and average value (zoom) for 2020



Source: Eurostat, COMEXT (download 27.1.2022); CN codes considered: see Figure 6-7 above

6.5.1.2 Regulations for the import in receiving countries and share of used vehicles directed to these countries

Africa and Eastern Europe, the Caucasus, Central Asia, and Middle East are the main destination for the EU 27 Export, representing 91% of the total exported used vehicles. According to (UNEP 2020) [351,] 5 countries out of 83 in these regions have established an import ban for used vehicles. 17 importing countries have defined a minimum level regards the emission standard and 38 importing countries have established age limits for the import of used vehicles.

The UNEP 2020 report applied the following assessment regards the ranking of the regulation:

[351] Baskin, J. et al. (2020), Used vehicles and the Environment. A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation, published by United Nations Environment Programme (UNEP), 10/2020

Regulatory Environment Ranking

Regulatory Environment Ranking

- Very Good - a used LDV Euro 5 or more emissions standard adopted and/or age limit of 3 years or below
- Good - a used LDV Euro 4 emissions standard adopted and/or age limit of 4 or 5 years
- Weak – a used LDV Euro 3 emissions standard adopted and/or age limit of between 6- 8 years
- Very weak - No used LDV Euro emissions standard adopted and/or age limit of 9 years plus or no age limit
- Banned - represents a complete restriction on used vehicle imports
- Countries not included in the analysis

Source: UNEP, based on data collected from the 146 countries studied as at July 2020

29 countries are assessed by the UNEP 2020 report to have a very good or good regulation, or the import of used vehicles is banned.

The Economic Community of West African States (ECOWAS) adopted on 5 September 2020 a Directive, limiting the import of used vehicles to those with a minimum Euro 4/IV emission standard. The age limit for importing vehicles into the ECOWAS region is 5 years for light duty vehicles, two-wheel motor vehicles, tricycles and quadricycles and 10 years for heavy-duty vehicles. A period of 10 years is granted to ECOWAS countries to adopt step by step.[352]

In result the 15 ECOWAS countries can be considered as very good regulated as well.

Table 6-23 below displays the share of used vehicles directed to differently regulated counties, and Table 6-24 displays the total and average value of the exported used vehicles in 2020.

Table 6-23 Share of used vehicles exported in 2020 from EU-27 to differently regulated countries

	Countries mentioned as destination	Share of the total number of EU-27 export
Total export to Africa and Eastern Europe, the Caucasus, Central Asia, and Middle East	82	91%
Ban of import of used vehicles	5	0.4%
Good, very good regulated or the import of used vehicles is banned (UNEP 2020)	29	29%
Good, very good regulated or the import of used vehicles is banned (UNEP 2020) + ECOWAS Countries	43	55%
At least any regulation for the import of used vehicles by age or emission class (including ECOWAS Countries)	59	82%

Source: UNEP 2020; Eurostat: COMEXT (download 27.1.2022); CN codes considered: see Figure 6-7 above

[352] Directive C/Dir.2/09/20 relating to the harmonization of the limits of gas and exhaust particle emission for light and heavy vehicles, two wheel vehicles, tricycles and quadricycles within the ECOWAS region.

Table 6-24 Value of used vehicles exported in 2020 from EU-27 to differently regulated countries

	Total value of the EU-27 Export (Million €)	Average value of the EU-27 Export (€ per vehicle)
Total export to Africa and Eastern Europe, the Caucasus, and Central Asia and Middle East	2 558	3 226
Ban of import of used vehicles	46	13 684
Good, very good regulated or the import of used vehicles is banned (UNEP 2020)	1 371	5 462
Good, very good regulated or the import of used vehicles is banned (UNEP 2020) + ECOWAS Countries*	1 703	3 553
At least any regulation for the import of used vehicles by age or emission class (including ECOWAS Countries*)	2 340	3 279

** Regulations not enforced yet for all ECOWAS countries for the displayed year 2020.*
'Source: UNEP 2020; Eurostat: COMEXT (download 27.1.2022); CN codes considered: see Figure 6-7 above

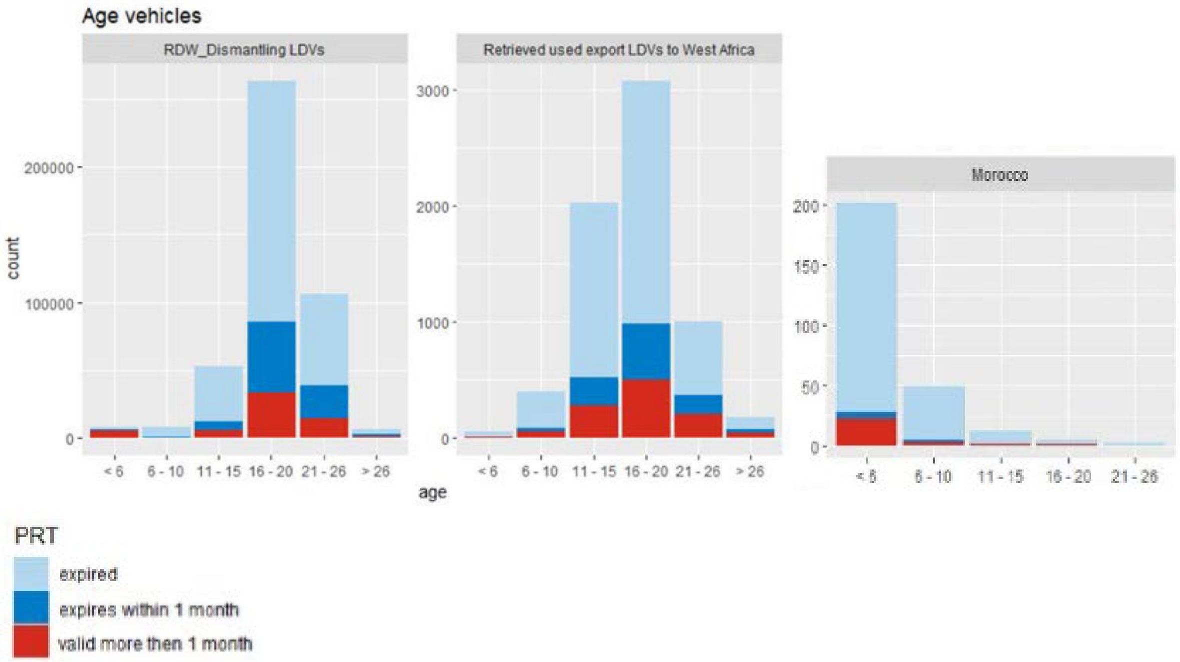
6.5.1.3 Age and periodic roadworthiness test of exported used vehicles from the Netherlands

A Dutch study[353] assessed the characteristics of vehicles dismantled (=ELVs) in the Netherlands and vehicles exported to the top 12 countries in West Africa for the period 2017 / 2018. As displayed in Figure 6-11 for both groups ELV and exported to West Africa, the peak is on vehicles aged between sixteen and twenty years. This is quite different compared to Morocco: The youngest vehicles go to Morocco which introduced in 2011 an age restriction of five years and Euro 4 vehicle emission standards for imports of used vehicles.

Only a minority of all exported used vehicles, also the youngest ones have roadworthiness certificate, valid for more than one month. The characteristics regarding the valid roadworthiness test is similar for the vehicles dismantled in the Netherlands and the vehicles exported to 12 Countries in West Africa.

[353] Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management (2020): Used vehicles exported to Africa: A study on the quality of used export vehicles

Figure 6-11 Age of dismantled (RDW_Dismantling LDVs) versus retrieved vehicles exported to West Africa.



PRT: periodic roadworthiness test

RDW: Netherlands Vehicle Authority

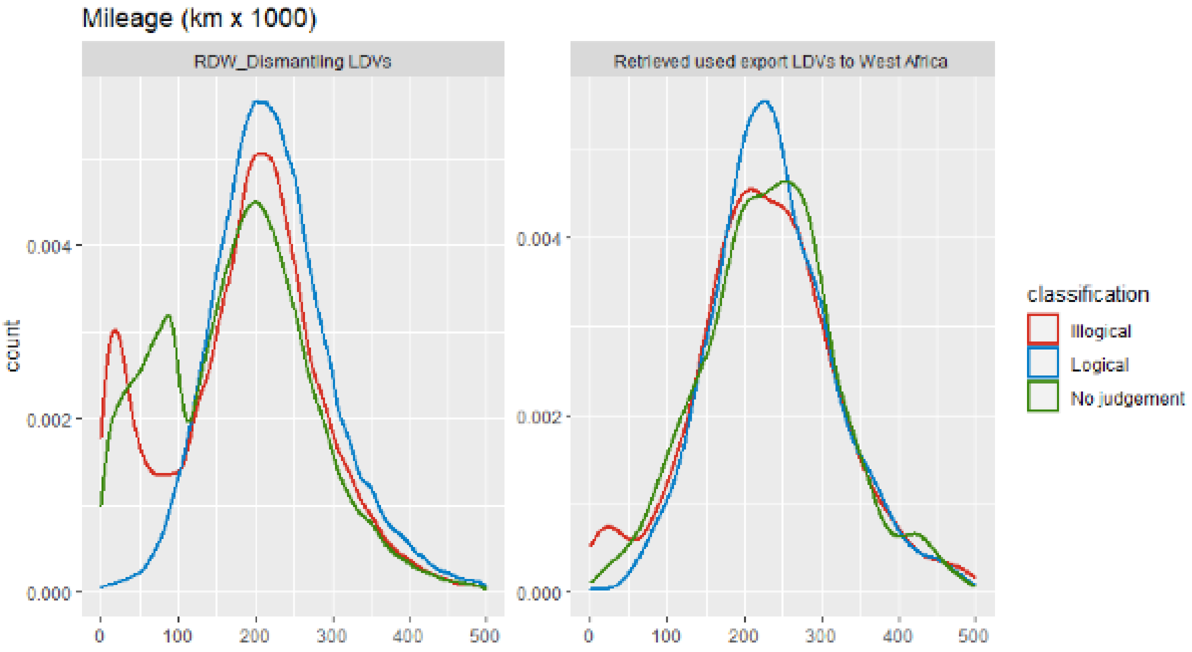
LDV: are motor vehicles with at least four wheels for the carriage of passengers (no more than eight seats in addition to the driver's seat) and for the carriage of goods (and having a maximum mass not exceeding 3.5 tonnes. HDVs are motor vehicles with at least four wheels for the carriage of goods or passengers and having a maximum mass exceeding 3.5 tonnes

Source: Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management (2020): Used vehicles exported to Africa: A study on the quality of used export vehicles
Data: combined Customs and RDW. © ILT-IDlab

6.5.1.4 Milage of exported used vehicles from the Netherlands

As displayed in Figure 6-12 the peak in mileage for the dismantled vehicles is around 200,000 km. For the export used vehicles to West Africa the milage is even a bit higher.

Figure 6-12 Relative distribution of mileage of dismantled (RDW_Dismantling LDVs) versus retrieved vehicles exported to West Africa



Source: Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management (2020): Used vehicles exported to Africa: A study on the quality of used export vehicles
Data: combined Customs and RDW. © ILT-IDlab

6.5.1.5 Regulatory aspects in the receiving countries

More and more receiving countries established regulations for the import of used vehicles. When looking for the most relevant markets for the EU, Africa and Eastern Europe, the Caucasus, and Central Asia 5 out of (54 + 18) have established an import ban for used vehicles. 17 importing countries have defined a minimum level regards the emission standard and 28 importing countries have established age limits for the import of used vehicles. Details regard the selected level of emission standard and the selected threshold by age are displayed in the table below.

Table 6-25 Export of Used Vehicles to non-EU-Countries in 2020: Numbers and Value per Country, Source: Eurostat, COMEXT (download 27.1.2022); Compilation: Mehlhart Consulting

CN codes considered: *87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (* equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).

REPORTER	EU27_2020		
PRODUCT	(Mehrere Elemente)	**--> see CV codes above**	
FLOW_LAB	EXPORT		
PERIOD_LAB	Jan.-Dec. 2020		
Country of destination	**Numbers**	**€ (total)**	**€ (average per vehicle)**
Ukraine	165 132	527 284 953	3 193
Serbia	111 789	242 977 003	2 174
Nigeria	55 866	64 155 805	1 148
Libya	51 916	57 230 338	1 102
Guinea	43 506	64 572 643	1 484
Bosnia and Herzegovina	33 105	163 795 574	4 948
Benin	30 491	37 394 960	1 226
Cameroon	29 202	38 963 135	1 334
Senegal	26 402	55 256 366	2 093
Togo	24 873	32 925 299	1 324
Albania	24 479	85 020 189	3 473
Finland	19 711	329 428 079	16 713
Switzerland (incl. Liechtenstein)	18 651	608 681 589	32 635
Ghana	18 079	31 592 891	1 747
Georgia	17 972	27 600 423	1 536
North Macedonia	16 717	59 436 007	3 555
Belarus (Belorussia)	13 594	117 106 177	8 615
Montenegro	13 276	39 141 751	2 948
Israel	11 134	169 569 211	15 230
Tajikistan	10 235	14 968 721	1 463
Moldova, Republic of	9 666	78 214 370	8 092
Gambia	8 835	11 761 161	1 331
Kosovo	8 822	79 408 378	9 001
United States	8 440	176 645 710	20 930
Congo	7 963	9 390 390	1 179
Niger	7 098	6 251 698	881
Mali	4 676	10 244 517	2 191
Congo, Democratic Republic of	4 520	8 014 374	1 773
Tunisia	4 511	66 153 624	14 665
Equatorial Guinea	3 953	8 245 217	2 086
Sierra Leone	3 923	6 214 141	1 584
Azerbaijan	3 792	19 085 266	5 033
Madagascar	3 298	11 040 763	3 348
United Kingdom	3 199	62 656 750	19 586
Norway	3 154	90 717 401	28 763
Morocco	2 993	56 114 744	18 749

CN codes considered: ***87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (*** equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).			
REPORTER	EU27_2020		
PRODUCT	(Mehrere Elemente)	**--> see CV codes above**	
FLOW_LAB	EXPORT		
PERIOD_LAB	Jan.-Dec. 2020		
Country of destination	**Numbers**	**€ (total)**	**€ (average per vehicle)**
Algeria	2 775	46 531 155	16 768
Jordan	2 757	32 920 920	11 941
Egypt	2 678	34 858 245	13 017
United Arab Emirates	2 603	98 522 850	37 850
Ethiopia (incl. Eritrea)	2 225	24 694 034	11 098
Comoros (incl. Mayotte)	2 051	4 196 370	2 046
Lebanon	1 791	12 977 006	7 246
Guinea-Bissau	1 669	2 392 883	1 434
Mauritania (incl. Spanish Sahara)	1 657	16 630 932	10 037
Afghanistan	1 535	1 302 033	848
Burkina Faso	1 419	3 497 179	2 465
Tanzania, United Republic of	1 271	3 102 836	2 441
Russian Federation (Russia)	1 270	26 352 467	20 750
Côte d'Ivoire (Ivory Coast)	1 207	9 885 156	8 190
Kyrgyzstan	1 031	2 126 629	2 063
Haiti	821	1 444 077	1 759
Andorra	779	25 511 970	32 750
Liberia	771	863 478	1 120
Cabo Verde	685	4 922 060	7 185
Djibouti	673	4 426 172	6 577
Japan	624	34 015 258	54 512
Taiwan	583	26 589 290	45 608
Saudi Arabia	564	25 575 986	45 347
San Marino	540	14 005 843	25 937
Rwanda	506	3 644 444	7 202
Central African Republic	472	1 981 172	4 197
Myanmar (Burma)	435	3 238 289	7 444
Occupied Palestinian Territory	427	5 866 189	13 738
Brazil	367	1 857 521	5 061
Iceland	361	7 233 623	20 038
Cambodia	359	13 984 516	38 954
Uzbekistan	353	3 819 824	10 821
Paraguay	350	1 582 156	4 520
Kuwait	349	15 463 255	44 307
Sao Tome and Principe	334	743 217	2 225
Turkey	331	8 684 013	26 236

CN codes considered: ***87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (*** equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).

REPORTER	EU27_2020		
PRODUCT	(Mehrere Elemente)	**--> see CV codes above**	
FLOW_LAB	EXPORT		
PERIOD_LAB	Jan.-Dec. 2020		
Country of destination	**Numbers**	**€ (total)**	**€ (average per vehicle)**
China	326	23 714 188	72 743
Canada	309	7 028 196	22 745
Kazakhstan	305	4 690 240	15 378
Korea, Republic of (South Korea)	299	26 545 437	88 781
Sudan (incl. South Sudan 'SS')	292	764 990	2 620
Iraq	284	17 875 013	62 940
Curaçao	277	1 950 215	7 040
Suriname	267	2 882 779	10 797
Bonaire, Sint Eustatius and Saba	222	1 351 431	6 088
Chile	191	2 255 248	11 808
New Caledonia	184	1 847 651	10 042
Malaysia	182	3 386 422	18 607
Indonesia	180	746 027	4 145
Liechtenstein	163	8 422 217	51 670
Ceuta (incl. Melilla 'XL')	148	1 849 974	12 500
Angola	138	4 587 447	33 242
Gabon	132	1 218 261	9 229
Armenia	131	813 167	6 207
Australia	109	3 072 666	28 190
Hong Kong	102	10 508 975	103 029
Malta	98	3 443 415	35 137
Qatar	93	10 623 400	114 230
Chad	84	281 291	3 349
Aruba	80	5 689 664	71 121
Colombia	74	1 934 605	26 143
Faroe Islands	72	1 450 268	20 143
South Africa (incl. Namibia 'NA')	69	1 816 126	26 321
Bolivia, Plurinational State of	64	205 858	3 217
Mongolia	61	902 676	14 798
Ecuador	60	1 097 449	18 291
Sint Maarten (Dutch part)	57	608 528	10 676
Cuba	55	856 828	15 579
Mexico	53	726 493	13 707
Uruguay	50	1 518 354	30 367
Argentina	50	1 357 793	27 156
Thailand	50	3 257 638	65 153

CN codes considered: ***87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (*** equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).

REPORTER	EU27_2020		
PRODUCT	(Mehrere Elemente)	**--> see CV codes above**	
FLOW_LAB	EXPORT		
PERIOD_LAB	Jan.-Dec. 2020		
Country of destination	**Numbers**	**€ (total)**	**€ (average per vehicle)**
Greenland	48	1 283 307	26 736
Dominican Republic	42	613 045	14 596
Oman	42	2 761 911	65 760
Burundi	39	403 067	10 335
Somalia	39	199 532	5 116
Kenya	37	326 535	8 825
Melilla	36	596 851	16 579
Bahrain	34	2 817 420	82 865
Philippines	32	3 004 153	93 880
Gibraltar	28	557 944	19 927
Singapore	28	4 129 776	147 492
New Zealand	27	705 387	26 125
Iran, Islamic Republic of	25	95 289	3 812
French Polynesia	24	285 091	11 879
Costa Rica	24	561 582	23 399
Uganda	21	126 769	6 037
Panama	21	531 345	25 302
Namibia	20	269 213	13 461
Saint Barthélemy	18	353 386	19 633
Viet Nam	16	2 352 044	147 003
Syrian Arab Republic (Syria)	14	34 667	2 476
Zambia	14	136 488	9 749
Mozambique	14	37 300	2 664
Venezuela, Bolivarian Republic of	12	79 411	6 618
Peru	10	251 180	25 118
Pakistan	9	124 681	13 853
Guyana	9	131 108	14 568
Guatemala	8	42 169	5 271
India	8	401 429	50 179
Mauritius	7	103 432	14 776
St Pierre and Miquelon	7	107 161	15 309
Turkmenistan	6	485 750	80 958
Brunei Darussalam	6	20 649	3 442
Botswana	5	39 800	7 960
Dominica	5	17 800	3 560
Macao	5	613 400	122 680

CN codes considered: *87032190, 87032290, 87032390, 87032490, 87033190, 87033290, 87033390, (* equivalent to vehicle category M1; 87042139, 87042199, 87043139, 87043199 for the transport of goods with a gross vehicle weight of < 5 t (while the N1 category covers such vehicle with a gross vehicle weight of < 3.5 t only).			
REPORTER	EU27_2020		
PRODUCT	(Mehrere Elemente)	**--> see CV codes above**	
FLOW_LAB	EXPORT		
PERIOD_LAB	Jan.-Dec. 2020		
Country of destination	**Numbers**	**€ (total)**	**€ (average per vehicle)**
El Salvador	5	14 853	2 971
Bahamas	5	69 976	13 995
Nicaragua	5	15 960	3 192
Cayman Islands	4	70 459	17 615
Yemen	4	11 530	2 883
Wallis and Futuna	4	15 500	3 875
Sri Lanka	3	19 050	6 350
Honduras	3	30 800	10 267
Bermuda	3	16 178	5 393
Niue	3	11 932	3 977
South Sudan	3	10 826	3 609
St Lucia	3	28 500	9 500
Zimbabwe	3	72 800	24 267
Jamaica	3	32 887	10 962
Trinidad and Tobago	3	20 890	6 963
Solomon Islands	3	3 700	1 233
French Southern Territories	3	81 933	27 311
Montserrat	2	35 000	17 500
Lao People's Democratic Republic (Laos)	2	41 374	20 687
Seychelles	2	19 450	9 725
United States Minor Outlying Islands	2	24 826	12 413
Belize	2	14 753	7 377
Eritrea	2	28 300	14 150
Fiji	2	41 500	20 750
Maldives	2	57 773	28 887
Vanuatu	2	30 400	15 200
Antigua and Barbuda	2	30 502	15 251
Malawi	1	8 000	8 000
Micronesia, Federated States of	1	4 858	4 858
Papua New Guinea	1	5 000	5 000
Grenada	1	1 000	1 000
Northern Mariana Islands	1	17 900	17 900
Lesotho	1	45 000	45 000
Marshall Islands	-	-	#DIV/0!

Table 6-26 Regulatory limitations for the import of used vehicles for African countries (Source: UNEP (Baskin et al., 2020) [354]

Africa = 54 countries included

Country	Vehicle EURO Emission Standards	Used Vehicles Banned	LDV Age Limit	Ranking
Algeria		No	3	Very Good
Angola		No	6	Weak
Benin		No		Very Weak
Botswana		No		Very Weak
Burkina Faso		No		Very Weak
Burundi		No	10	Very Weak
Cameroon		No		Very Weak
Cape Verde		No		Very Weak
Central African Republic		No		Very Weak
Chad		No	5	Good
Comoros		No		Very Weak
Congo		No		Very Weak
Congo, Democratic Republic		No	20	Very Weak
Cote D'Ivoire		No	5	Good
Djibouti		No	8	Weak
Egypt		Yes		Banned
Equatorial Guinea		No		Very Weak
Eritrea		No		Very Weak
Eswatini		No		Very Weak
Ethiopia		No		Very Weak
Gabon		No	5	Good
Gambia		No		Very Weak
Ghana	Euro 2	No	10	Very Weak
Guinea		No		Very Weak
Guinea-Bissau		No		Very Weak
Kenya		No	8	Weak
Lesotho		No	5	Good
Liberia		No		Very Weak
Libyan Arab Jamahiriya		No	10	Very Weak
Madagascar		No		Very Weak
Malawi		No		Very Weak
Mali		No		Very Weak
Mauritania		No	5	Good
Mauritius		No	3	Very Good
Morocco	Euro 4	No	5	Good
Mozambique		No		Very Weak
Namibia		No	8	Weak
Niger		No		Very Weak
Nigeria	Euro 2	No	15	Very Weak
Rwanda	Euro 4	No		Good

Africa = 54 countries included

Country	Vehicle EURO Emission Standards	Used Vehicles Banned	LDV Age Limit	Ranking
Sao Tome and Principe		No		Very Weak
Senegal		No	8	Weak
Seychelles		Yes		Banned
Sierra Leone		No		Very Weak
Somalia		No		Very Weak
South Africa	Euro 2 *	Yes		Banned
South Sudan		No		Very Weak
Sudan		Yes		Banned
Tanzania		No		Very Weak
Togo		No		Very Weak
Tunisia		No	5	Good
Uganda		No	15	Very Weak
Zambia		No		Very Weak
Zimbabwe		No		Very Weak

* Only new vehicles as used vehicles are banned

[354] Baskin, J. et al. (2020), Used vehicles and the Environment. A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation, United Nations Environment Programme

Table 6-27 Regulatory limitations for the import of used vehicles for Eastern Europe, the Caucasus, and Central Asia (Source: UNEP (Baskin et al., 2020) [355]

Eastern Europe, the Caucasus, and Central Asia = 18 countries

Country	Vehicle EURO Emission Standards	Used Vehicles Banned	LDV Age Limit	Ranking
Albania	Euro 5	No	10	Very Good
Armenia		No		Very Weak
Azerbaijan	Euro 4	No		Good
Belarus	Euro 4	No		Good
Bosnia and Herzegovina	Euro 3	No	10	Weak
Macedonia	Euro 3	No	12	Weak
Georgia		No		Very Weak
Kazakhstan	Euro 4	No	5	Good
Kyrgyz, Republic		No	10	Very Weak
Moldova, Republic Of		No		Very Weak
Montenegro	Euro 3	No	10	Very Weak
Russian Federation	Euro 5	No	5	Good
Serbia	Euro 3	No		Weak
Tajikistan	Euro 4	No	10	Good
Turkey		Yes		Banned
Turkmenistan		No		Very Weak
Ukraine	Euro 5	No		Very Good
Uzbekistan	Euro 3	No		Weak

[355] Baskin, J. et al. (2020), Used vehicles and the Environment. A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation, United Nations Environment Programme

Table 6-28 Regulatory limitations for the import of used vehicles for Middle East (Source: UNEP (Baskin et al., 2020) [356]

Middle East = 11 countries

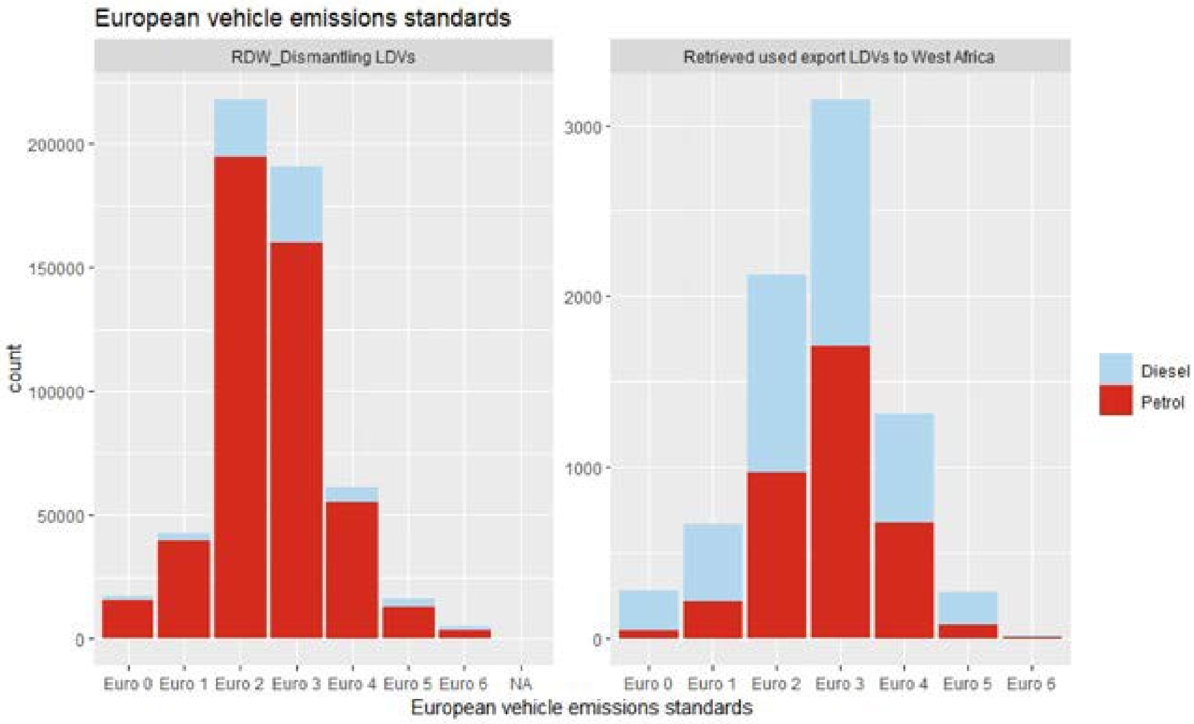
Country	Vehicle EURO Emission Standards	Used Vehicles Banned	LDV Age Limit	Ranking
Bahrain		No	5	Good
Iran		No	3	Very Good
Iraq		No	2	Very Good
Israel		No	2	Very Good
Jordan		No	10	Very Weak
Kuwait		No	5	Good
Lebanon		No	8	Weak
Oman		No		Very Weak
Qatar		No	10	Very Weak
Saudi Arabia		No	5	Good
United Arab Emirates		No	2	Very Good

[356] Baskin, J. et al. (2020), Used vehicles and the Environment. A Global Overview of Used Light Duty Vehicles: Flow, Scale and Regulation, United Nations Environment Programme

6.5.1.6 Emission standard of exported used vehicles from the Netherlands

As displayed in Figure 6-13 most of the ELVs dismantled in the Netherlands have an emissions standard of Euro 2 or Euro 3 and by far most are petrol ICVs. For the used vehicles exported to West Africa the share of Euro 3 is higher, but the share of Euro 5 and Euro 6 is marginal. Compared to the ELV much more Diesel ICV are exported than Petrol ICVs.

Figure 6-13 European emissions standards of dismantled (RDW_Dismantling LDVs) versus retrieved vehicles exported to West Africa



Source: Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management (2020): Used vehicles exported to Africa: A study on the quality of used export vehicles
Data: combined Customs and RDW. © ILT-IDlab

6.5.1.7 Global air pollution related health impacts of transportation sector

Figure 6-14 Global $PM_{2.5}$ and ozone concentrations in 2010

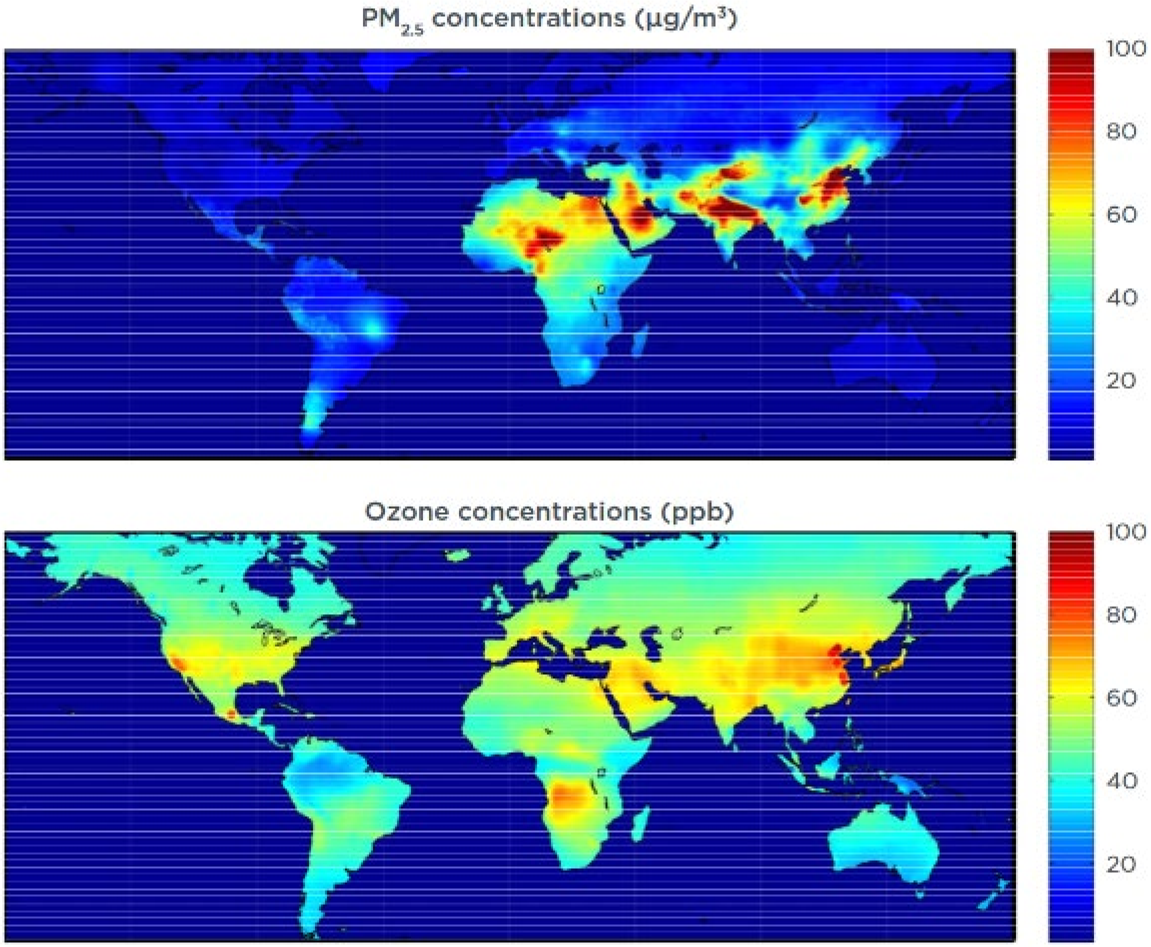


Figure 1. Total $PM_{2.5}$ (annual average) and ozone concentrations (6-month average of the 8-hour daily maximum) in 2010. $PM_{2.5}$ concentrations are from Shaddick et al. (2018). Ozone concentrations are from Chang et al. (2018). Maximum concentrations globally are 387 μg/m³ for $PM_{2.5}$ and 94 ppb for ozone.

Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

Figure 6-15 global $PM_{2.5}$ and ozone concentrations in 2015

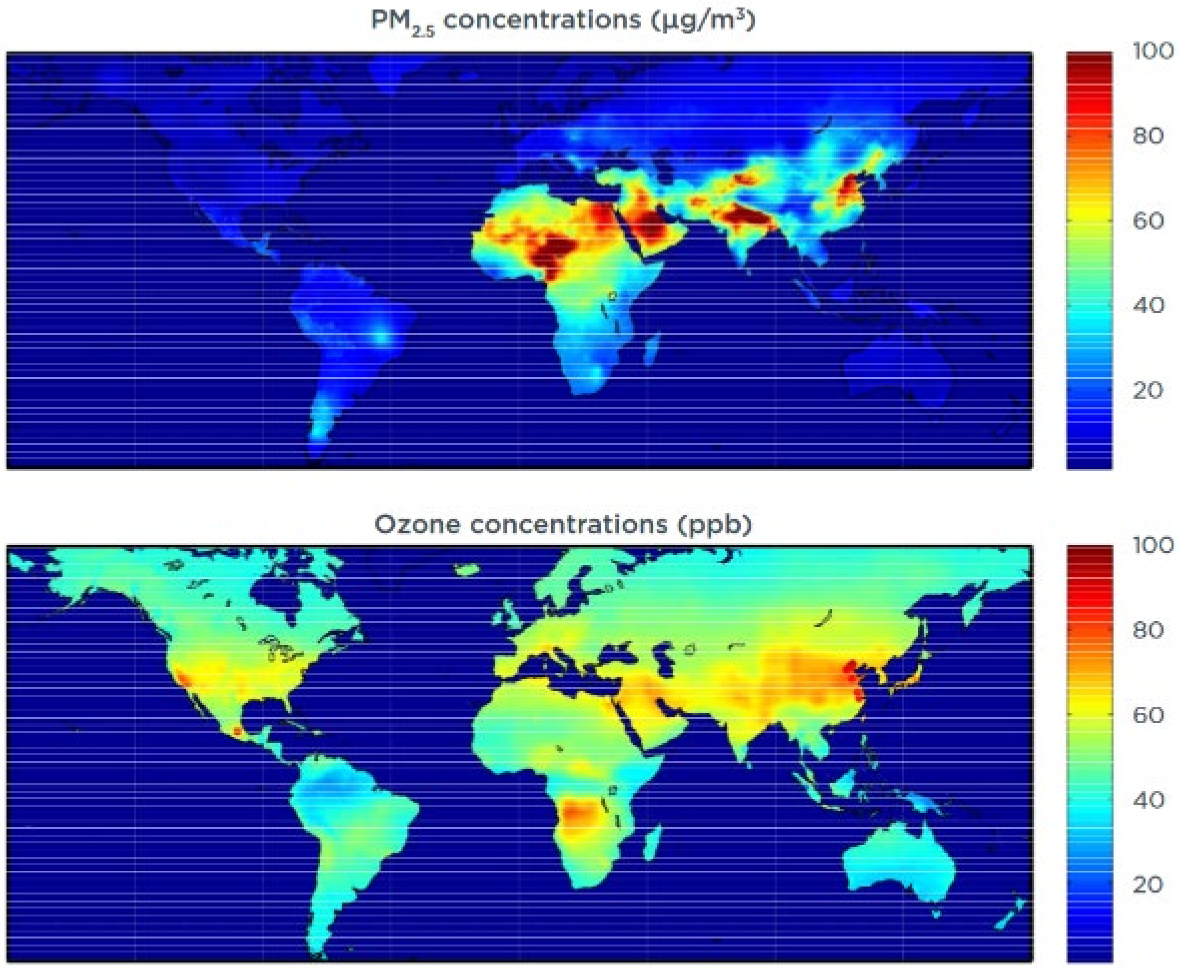


Figure 2. Total $PM_{2.5}$ (annual average) and ozone concentrations (6-month average of the 8-hour daily maximum) in 2015. $PM_{2.5}$ concentrations are from Shaddick et al. (2018). Ozone concentrations are from Chang et al. (2018). Maximum concentrations globally are 329 µg/m³ for $PM_{2.5}$ and 94 ppb for ozone.

Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

Figure 6-16 Change in transportation attributed concentration (TAC) $PM_{2.5}$ and ozone and Black Carbon (BC): 2010 to 2015

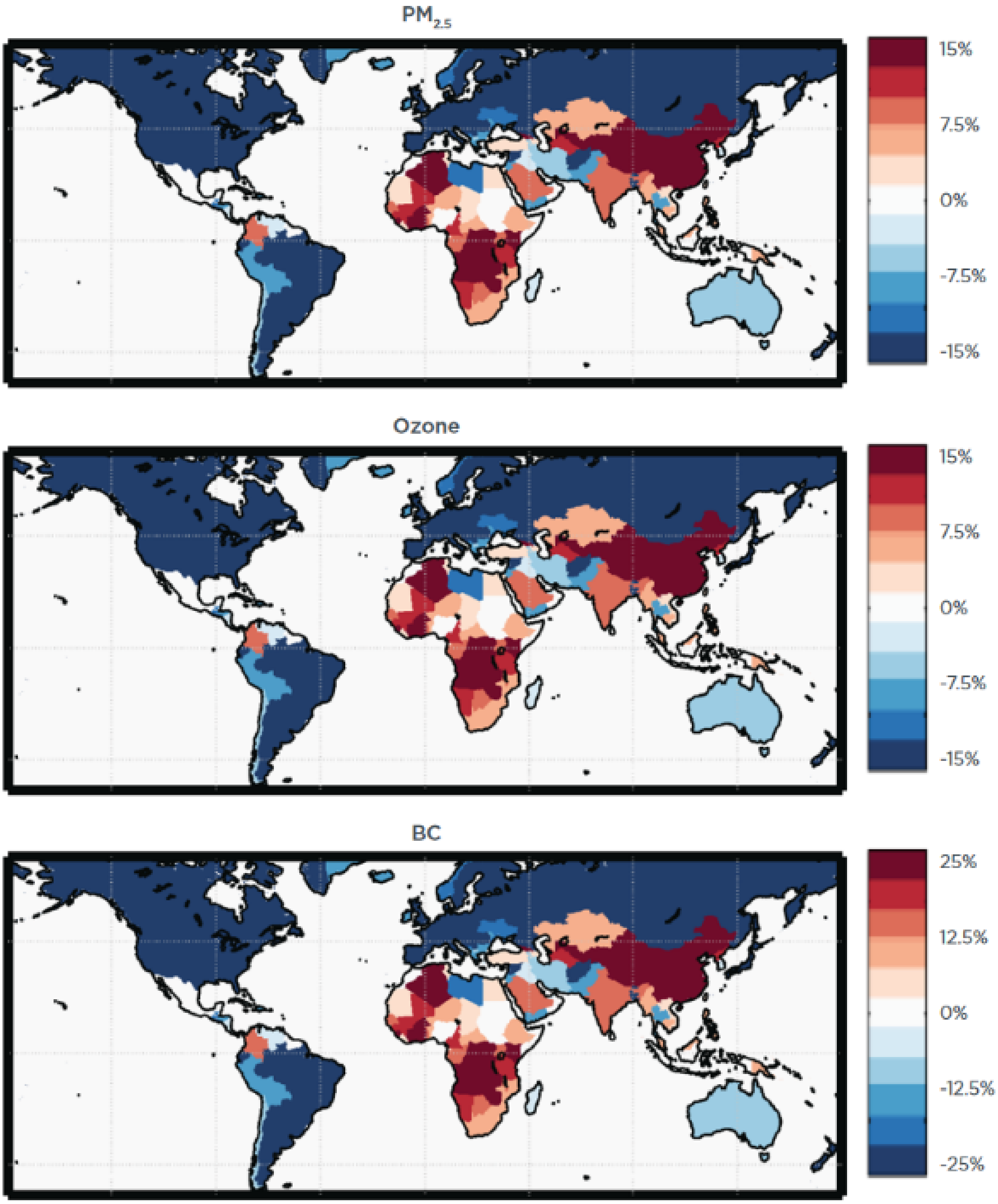


Figure 4. Maps showing the change in national population-weighted average transportation-attributable concentrations from 2010 to 2015 (annual average concentration for $PM_{2.5}$ and BC, 6-month average of the 8-hour daily maximum for ozone).

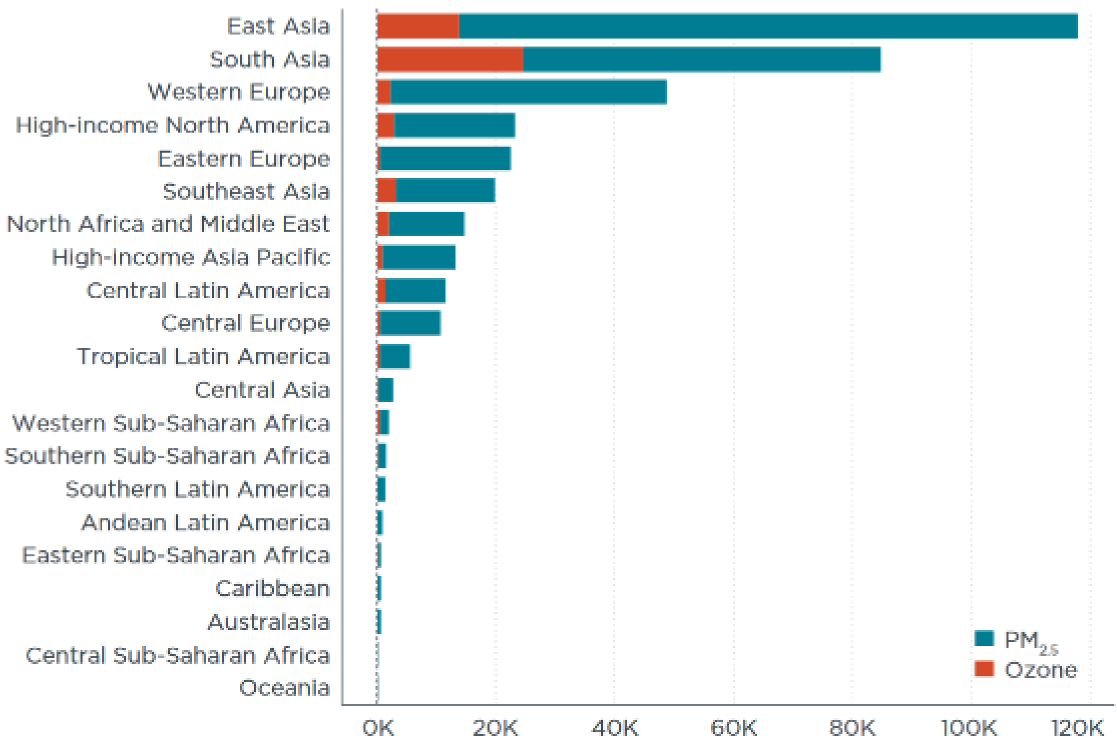
Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

Figure 6-17 Transportation attributed fractions (TAF) of $PM_{2.5}$ and ozone death in 2015

Figure 9. Globally and for each trade bloc, transportation-attributable fractions (TAF) of total (a) $PM_{2.5}$ and (b) ozone deaths in 2015, broken out by subsector. AMU = Arab Maghreb Union (North Africa); ASEAN = Association of Southeast Asian Nations; CARICOM = Caribbean Community; CEMAC = Central African Economic and Monetary Community; CIS = Commonwealth of Independent States; EAC = East African Community; ECOWAS = Economic Community of West African States; EU & EFTA = European Union and European Free Trade Association; GCC = Gulf Cooperation Council; MERCOSUR = Southern Common Market (South America); NAFTA = North American Free Trade Agreement; SAARC = South Asian Association for Regional Cooperation; SADC = Southern African Development Community; SICA = Central American Integration System.

Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

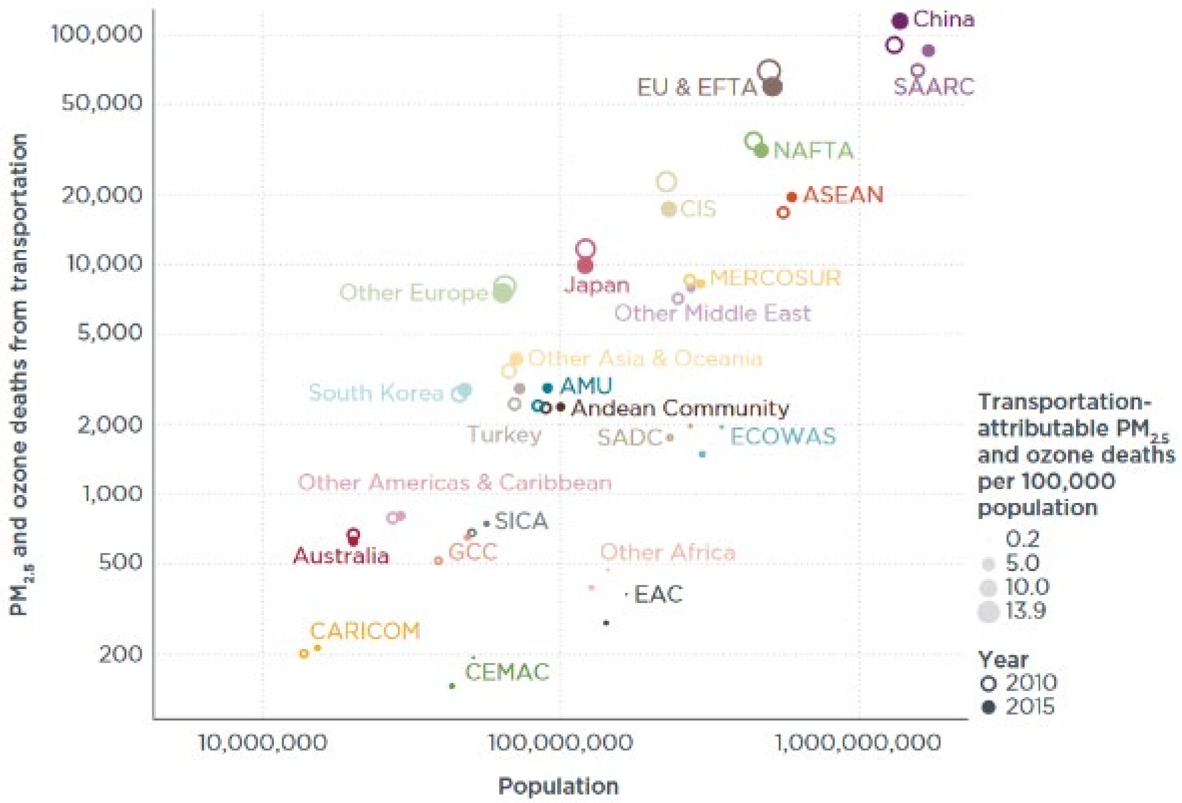
Figure 6-18 Total number of transportation-attributed $PM_{2.5}$ and ozone death in 2015 by world region



Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

Regards the total impacts and trends the ICCT study[357] concludes: “Figure 6-19 compares population size with the absolute number of transportation attributable $PM_{2.5}$ and ozone deaths by trade bloc in 2015. These estimates are shown on a logarithmic scale to account for the substantial differences in population size among trade blocs and individual countries. The size of each point in Figure 13 corresponds to the transportation-attributable mortality rate per 100,000 population. In 2015, EU and EFTA countries along with those accounted for as “Other Europe” (which includes Ukraine) had the highest transportation-attributable mortality rates, at approximately 12 deaths per 100,000 population. These elevated rates are likely attributable to a combination of factors, including high levels of transportation activity; high levels of LDV dieselization; and relatively high baseline incidence rates for diseases that are affected by air pollution. In contrast, trade blocs in sub-Saharan Africa, South America, Central America, the Caribbean, and the Middle East had comparatively low transportation attributable mortality rates. Considering the increases in motorization, freight activity, urbanization, total population, and baseline incidence rates of diseases affected by air pollution that are projected in many of these regions, coupled with the time it takes to turn over the entire existing vehicle fleet, we suggest that these regions take appropriate action to control emissions from new vehicles before health damages intensify (i.e., increased transportation-attributable mortality rates, absolute burden, and associated welfare loss)”

Figure 6-19 global $PM_{2.5}$ and ozone concentrations in 2015



Source: Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

[357] Anenberg, S.; Miller, J.; Henze, D.; Minjares, R. (2019): A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015, published by: International Council on Clean Transportation

6.6 Detailed results of the impact analysis for Specific objective 3 (missing vehicles)

6.6.1 Screening measures and separate discarded options

The table below displays the criteria for screening.

III. Screen your options and separate discarded options	
Why?	To focus the analysis on the viable options. In choosing the options, it is important to focus on those elements that are most critical for the Commission to decide on (i.e. those with significant impacts). As with the problem analysis, you must ensure that the report remains focused and that it does not drown the major issues in a 'flood' of minor issues.
How?	Excluding options at this stage should be clearly justified. Reasons should be as clear, self-evident and indisputable as possible. The report should explain when it had to discard policy options favoured by stakeholders. This should be done in a separate section on discarded options (if necessary, with further details in the annexes).
	The key **criteria for screening** the viability of your options are:
	Legal feasibility
	Options should respect the principle of conferral[358]. They should also respect any obligation arising from the EU Treaties (and relevant international agreements) and ensure respect of fundamental rights. Legal obligations incorporated in existing primary or secondary EU legislation may also rule out certain options.
	Technical feasibility
	Technological and technical constraints may not allow for the implementation, monitoring or enforcement of theoretical options.
	Previous policy choices
	Certain options may be ruled out by previous policy choices or mandates by EU institutions. Unless there is compelling evidence that these choices should be revisited, there is no point in reinventing the wheel.
	Coherence with other EU policy objectives
	Certain options may be ruled out early due to poor coherence with other general EU policy objectives.
	Effectiveness and efficiency
	It may already be possible to show that some options would with certainty achieve a worse cost-benefit balance than some alternatives.
	Proportionality

[358] Under this fundamental principle of EU law, laid down in Article 5 of the Treaty on European Union, the EU acts only within the limits of the competences that EU countries have conferred upon it in the Treaties. These competences are defined in Articles 2–6 of the Treaty on the Functioning of the EU. Competences not conferred on the EU by the Treaties thus remain with EU countries.

III. Screen your options and separate discarded options	
	Some options may clearly restrict the scope for national decision-making over and above what is needed to achieve the objectives satisfactorily.
	Political feasibility
	Options that would clearly fail to garner the necessary political support for legislative adoption or implementation could also be discarded. This, however, does not mean that such options should not be mentioned or not be subject to at least a minimal assessment. Options superior to other options but lacking political feasibility may still be discussed at the legislative stage, which may increase their chances of being politically feasible.
	Relevance
	There is no point in retaining options that do not address the needs of the policy intervention as identified in the problem definition.
	Identifiability
	When it can be shown that two options are not likely to differ materially in terms of the proposed measures, their significant impacts or their distribution, only one should be retained.

Source: Better Regulation toolbox Tool #16, Textbox page 114 – 115

In the following the potential measures are assessed against these criteria and a justification is given for the case that an option is considered as discarded. The numbers in the column "Viability screening" refer to the numbering of the key criteria for screening as displayed in the table above.

Table 6-29 Initial assessment of measures to identify discarded and short-listed measures

Measure	Viability screening	Effectiveness	Comment, Discard justification
addressing Specific Objective No 3.1			
MS to report on economic incentives for the last owner of an ELV to deliver it to amd ATF report the CoD to the administration, **Level A**	✓	Low	→ Short-list
MS to implement economic incentives for the last owner of an ELV to deliver it to amd ATF report the CoD to the administration, **Level B**	✗ 1. / 6. / 7.	Would be effective but needs a mandate beyond the current legal mandate	The implementation of a European wide obligation to introduce continuing payment to insurances schemes until permanent cancellation of a registration or the implementation of a European wide obligation to establish a premium pay out to the last owner is considered out of the scope of the European mandate (legal feasibility, subsidiarity).
Alignment of terms with Directive 1999/37/EC on registration documents.	✓	Harmonisation at EU level	A formal aspect to resolve a discrepancy → Short list
Introduction of new definition: "temporary deregistration"	✗ 1.	Precondition for reporting and collection target	Legal feasibility: Currently registration procedures are considered as not covered by EU legislation but an aspect of subsidiarity. As it is of high relevance for monitoring (of targets) it is kept in the short list. → Short-list
Establish EU wide harmonised registration procedures for vehicles	✗ 1.	Assessed in 2017 as most effective	Legal feasibility: Currently registration procedures are considered as not covered by EU legislation but an aspect of subsidiarity. As it is of high relevance it is kept in the short list. → Short-list
Obligations for dismantlers /recyclers to check and report on ELVs / CoDs	✓	As stand-alone: Limited, depends on enforcement	Short-list
Improve exchange of information between registration authorities on de-registered vehicles, ELVs and CoDs	✓	Of high relevance for complete reporting	Short-list

Measure	Viability screening	Effectiveness	Comment, Discard justification
Include Vehicle Identification Number (VIN) in customs declaration	✓	A specific detail, effective in combination	Might require implementation in another regulatory environment (TAXUD) → **Short-list**
Establish EU vehicle registration database	✗ 1. & 7.	High	Legal feasibility: Currently registration procedures are considered as not covered by EU legislation but an aspect of subsidiarity. As it is of high relevance it is kept in the short list. Political feasibility: As experienced in the past there is strong opposition by the MS regards this option **Short-list**
Improve reporting obligations on the current vehicle market and the ELVs on their territory to prove that all ELVs are directed to ATFs	✓	High, but needs combination with interoperability regards intra EU trade	**Short-list**
Establish collection target based on the reporting obligations on the national vehicle market	✗		In principle the ELV Regulation anyhow says that all ELVs (=implicit 100% target) shall be collected and directed to ATFs. As far as the reporting obligation on the current vehicle market is considered as effective and connected to the aim to prove the whereabouts of the vehicles, then such explicit target is superfluous. An explicit target must be spelt out and can (by technical reasons like stock effects over years) not achieve 100%. As such it would possibly even dilute the implicit 100% target.
addressing Specific Objective 3.2: Reduce levels of illegal dismantling and illegal export of ELVs			
Exchange on MS best practice (national implementation and enforcement incl. sector inspection campaigns)	✗ 5.	Low to zero	The criteria of effectiveness and efficiency are not achieved after a decade of attempts → **discarded**
Voluntary campaigns on export of ELVs with a focus on the current guidelines on distinction between ELVs and second-hand vehicles (waste shipment correspondents' guidelines No9)	✗ 5.	Low to zero	The criteria of effectiveness and efficiency are not achieved after a decade of attempts → **discarded**
Obligation of OEMs to manage a Deposit Refund Scheme (DRF) for vehicles	✓	Potentially high	Implementation will take time to become effective in all Member States. Possible unequal strength of negotiators (OEMs/ ATFs/ shredders) could lead to low DRF pay out and limited impact. Measure retained under the EPR package. → **short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
Alternative to the national approach above: European-wide deposit refund scheme for vehicles:	❌ 1. & 6.	Potentially high	The measure does not meet criteria of legal feasibility (subsidiarity) and proportionality. Very difficult to set up at EU level: New supervision authority at EU level might be needed, a complex set of negotiations with the stakeholders in the Member States on the correct level of DRF pay-out expected → **discarded**
Binding criteria for a distinction of used vehicles / ELVs.	✓	Low/ medium	**Short list**
Definition of minimum requirements for sector inspections	✓	Low	**Short list**
MS reporting on fines for illegal operation of dismantling / shredding facilities and for selling an ELV to illegal dismantlers and for dealers (and electronic platforms) dealing with dismantled (used) spare parts from non-authorised facilities.	✓	Low	The more effective alternative to establish harmonised and concrete fines and penalties across EU is not coherent with the Legal feasibility (subsidiarity) principle and thus this less effective option remains viable only → **short list.**
addressing Specific Objective No 3.3: Establish enforceable criteria to avoid the export of (used) cars which do not meet roadworthiness or minimal environmental standards			
Action at international level to support that roadworthiness (and others) become criteria for export of used vehicles.	✓	Low to zero	While the measure has low to zero impacts at EU level it is important for the effectiveness in the receiving countries with the aim to encourage other exporters like United States, UK, and Japan to follow the request Ms. Andersen, Executive Director of UNEP, which said "Developed countries must stop exporting vehicles that fail environment and safety inspections and are no longer considered roadworthy in their own countries, while importing countries should introduce stronger quality standards" → **short list.**
Promote enforcement actions by MS through EU funding and EU enforcement actions against environmental crime	❌ 5.	Low to zero	The criteria of effectiveness and efficiency are not achieved after a decade of attempts → **discarded**
Set new conditions applying to the export outside the EU of used vehicles, with criteria linked to roadworthiness and air emissions as conditions for authorising export	✓	Depending on the level of the conditions	**Short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
Include VIN number in customs declaration to allow for better traceability of cars exported outside the EU	✓	Low to zero	Might become relevant for monitoring / evaluation **Short list**

6.6.2 Scenarios for the shift between categories

6.6.2.1 Categories of whereabout

A) ELVs directed to ATFs and subsequently to shredders and reported by ATFs and MS (ATF, reported)

B) ELVs directed to ATFs and subsequently to shredders but not reported (ATFs, not reported)

C) ELVs directed to non-ATFs and subsequently to shredders, not reported (non-ATF)

D) Used Vehicles exported (extra EU) and reported accordingly (Export, reported)

E) Used Vehicles exported (extra EU) but not reported (Export, not reported)

F) ELVs exported (extra EU), not reported (ELVs export, not reported)

G) Missing vehicles = B) + C) + E) + F)

6.6.2.2 How to read the table with the detailed changes in percent points

The table below demonstrates how shifts between the above-mentioned categories are introduced to the model. The yellow cell indicates for instance a shift of 0.25 percent points (of the total number of ELVs) from category E (Export, not reported) to category D (Export, reported), the red cell displays the reverse (redundant information and is therefore not displayed later on). The total displays the change in percent points for the entire category. For instance, category D (Export, reported) receives in total 0.5 percent points more vehicles in the given year compared to the year 2019 where (at least for some of the categories) data is available.

	Szenario							
			shift to					
			A	B	C	D	E	F
	Schift from	A		-0.25%	-0.25%	0.00%	-0.25%	-0.25%
		B	0.25%		0.00%	0.00%	0.00%	0.00%
year		C	0.25%	0.00%		0.00%	0.00%	0.00%
		D	0.00%	0.00%	0.00%		**-0.25%**	-0.25%
		E	0.25%	0.00%	0.00%	**0.25%**		0.00%
		F	0.25%	0.00%	0.00%	0.25%	0.00%	
		total	1.00%	-0.25%	-0.25%	0.50%	-0.50%	-0.50%

6.6.2.3 Assumptions and first results for the shift between “categories of missing vehicles”

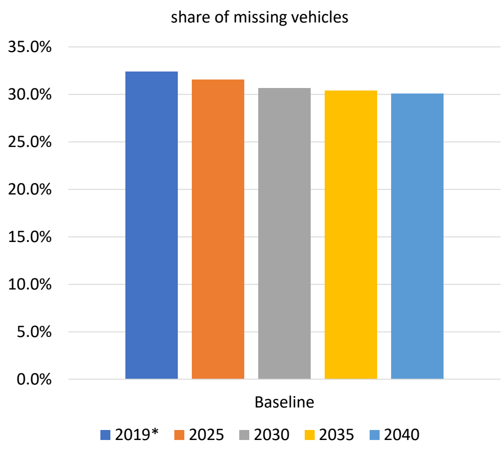
6.6.2.3.1 Baseline / Business-as-usual

As mentioned above we expect for the baseline marginal effects only as we have experienced in the past – with a lot of attention by the EC – effectively no general change on the number of missing vehicles at EU level. To be not too pessimistic we consider a limited shift from category B, C, E, F to category A, and also a slight shift from E and F to D. In result the share of missing vehicles declines by 2.4 percent points from 32.4% in 2019 to 30.1% (2040). In result the problem persists under Business-as-Usual conditions. The Figure below displays the detailed changes in percentage points

Baseline

Reihe "2019*" Punkt "3B"
Wert: 32.4%

			to A	B	C	D	E	F	
2025	From	A	[illegible]						
		B	[illegible]						0.20%
		C	[illegible]	[illegible]					0.20%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.00%	0.00%	0.00%	0.20%			0.20%
		F	0.00%	0.00%	0.00%	0.20%	0.00%		0.20%
		total	0.40%	-0.20%	-0.20%	0.40%	-0.20%	-0.20%	0.00%
2030	From	A							
		B	0.30%						0.30%
		C	0.30%	0.00%					0.30%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.25%	0.00%	0.00%	0.30%			0.55%
		F	0.25%	0.00%	0.00%	0.30%	0.00%		0.55%
		total	1.10%	-0.30%	-0.30%	0.60%	-0.55%	-0.55%	0.00%
2035	From	A							
		B	0.35%						0.35%
		C	0.35%	0.00%					0.35%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.30%	0.00%	0.00%	0.35%			0.65%
		F	0.30%	0.00%	0.00%	0.35%	0.00%		0.65%
		total	1.30%	-0.35%	-0.35%	0.70%	-0.65%	-0.65%	0.00%
2040	From	A							
		B	0.40%						0.40%
		C	0.40%	0.00%					0.40%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.35%	0.00%	0.00%	0.40%			0.75%
		F	0.35%	0.00%	0.00%	0.40%	0.00%		0.75%
		total	1.50%	-0.40%	-0.40%	0.80%	-0.75%	-0.75%	0.00%



6.6.2.3.2 Policy option 3A: Enhanced reporting & enforcement

The policy option 3A is relying on enhanced monitoring and reporting requirements to demonstrate the whereabout of used vehicles and ELVs. It includes inter alia obligation for reporting on the changes in the vehicle fleet with the aim that such reporting shall prove that all ELVs are directed to ATFs. The MS have full flexibility to choose the measures to achieve this target either with an adjusted registration system or with penalties or with incentives or other means.

The main shortcoming of this options is that a single Member State alone has not all means at hand to complete the reporting form and thus can argue that he is by external reasons not able to fulfil his obligations. And might even cover with this argument his non-action in fields where the Member State would have opportunities to act and improve.

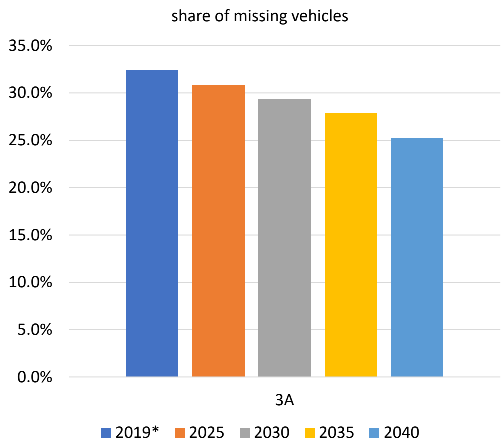
Main missing aspects with this regard is the alignment definition of terms (e.g. for temporary deregistration) and the obligatory exchange of information of vehicles dismantled in another Member State as it was last registered and last not least the missing introduction of a more detailed / applicable definition of the term ELV.

We expect a few more Member States to take action regards their registration system and also regards incentives / penalties. This will cause step by step a shift to the categories A and D (both decreasing the number of missing vehicles) and also a small shift from category E to F.

According to our assumptions the share of missing vehicles will continuously decline by 7.2 percent points from 32.4% in 2019 to 25.2% (2040). Due to the shortcomings mentioned above it is very likely that the Policy Option 3A is at risk to fail in generating **substantial** improvements regards the share/number of missing vehicles.

Policy Option 3A

			to A	B	C	D	E	F	
2025	From	A							
		B	0.25%						0.25%
		C	0.25%	0.00%					0.25%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.25%	0.00%	0.00%	0.25%			0.50%
		F	0.25%	0.00%	0.00%	0.25%	0.25%		0.75%
		total	1.00%	-0.25%	-0.25%	0.50%	-0.25%	-0.75%	0.00%
			to A	B	C	D	E	F	
2030	From	A							
		B	0.50%						0.50%
		C	0.50%	0.00%					0.50%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.50%	0.00%	0.00%	0.50%			1.00%
		F	0.50%	0.00%	0.00%	0.50%	0.50%		1.50%
		total	2.00%	-0.50%	-0.50%	1.00%	-0.50%	-1.50%	0.00%
			to A	B	C	D	E	F	
2035	From	A							
		B	0.75%						0.75%
		C	0.75%	0.00%					0.75%
		D	0.00%	0.00%	0.00%				0.00%
		E	0.75%	0.00%	0.00%	0.75%			1.50%
		F	0.75%	0.00%	0.00%	0.75%	0.75%		2.25%
		total	3.00%	-0.75%	-0.75%	1.50%	-0.75%	-2.25%	0.00%
			to A	B	C	D	E	F	
2040	From	A							
		B	1.20%						1.20%
		C	1.20%	0.00%					1.20%
		D	0.00%	0.00%	0.00%				0.00%
		E	1.20%	0.00%	0.00%	1.20%			2.40%
		F	1.20%	0.00%	0.00%	1.20%	1.20%		3.60%
		total	4.80%	-1.20%	-1.20%	2.40%	-1.20%	-3.60%	0.00%



6.6.2.3.3 Policy Option 3B Harmonisation and interoperability

This option is aiming to improve collection by:

- requiring that the national registrations systems be made interoperable.
- a harmonised approach between the MS regards national registration of vehicles
- requirements regard incentives and penalties
- binding criteria on the distinction between used vehicles and ELVs

Compared to option 3A, this option reduces the flexibility of MS.

However, it does not include the reporting obligation on the changes in the vehicle fleet (as in Policy Option 3A) which is an important tool to prove that all ELVs are directed to ATFs.

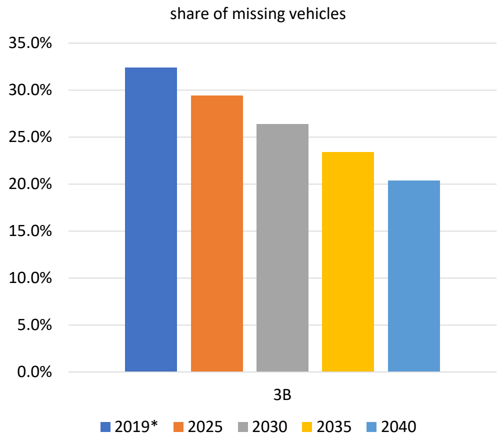
Policy Option 3B provides the tools for cooperation between the MS but a clear method for the calculation of the change in the vehicle fleet is missing. Therefore, the current problem that a comparable performance monitoring by country regards missing vehicles is not possible will persist and cause limited incentive to improve the overall situation on missing vehicles.

However, as by the interoperability the tools are available for complete balance of the whereabout of vehicles we expect some frontrunners of the Member States to make use of it and seek to improve their performance regards missing vehicles. Other measures regard permits and incentives will support this change.

Overall, the effect of Policy Option 3B is considered as more effective than Policy Option 3A, while the missing national reporting on the performance regards missing vehicles is a major gap to generate full effectiveness of this policy option.

Policy Option 3B

			to						
			A	B	C	D	E	F	
		A							
		B	0.50%						0.50%
2025	From	C	0.50%	0.00%					0.50%
		D	0.50%	0.00%	0.00%				0.50%
		E	0.50%	0.00%	0.00%	0.50%			1.00%
		F	0.50%	0.00%	0.00%	0.50%	0.00%		1.00%
		total	2.50%	-0.50%	-0.50%	0.50%	-1.00%	-1.00%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	1.00%						1.00%
2030	From	C	1.00%	0.00%					1.00%
		D	1.00%	0.00%	0.00%				1.00%
		E	1.00%	0.00%	0.00%	1.00%			2.00%
		F	1.00%	0.00%	0.00%	1.00%	0.00%		2.00%
		total	5.00%	-1.00%	-1.00%	1.00%	-2.00%	-2.00%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	1.50%						1.50%
2035	From	C	1.50%	0.00%					1.50%
		D	1.50%	0.00%	0.00%				1.50%
		E	1.50%	0.00%	0.00%	1.50%			3.00%
		F	1.50%	0.00%	0.00%	1.50%	0.00%		3.00%
		total	7.50%	-1.50%	-1.50%	1.50%	-3.00%	-3.00%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	2.00%						2.00%
2040	From	C	2.00%	0.00%					2.00%
		D	2.00%	0.00%	0.00%				2.00%
		E	2.00%	0.00%	0.00%	2.00%			4.00%
		F	2.00%	0.00%	0.00%	2.00%	0.00%		4.00%
		total	10.00%	-2.00%	-2.00%	2.00%	-4.00%	-4.00%	0.00%



6.6.2.3.4 Policy Option 3C: EU wide vehicle registration and export controls

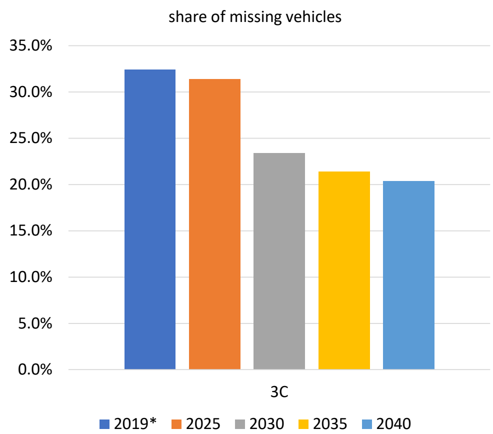
This option consists in fully harmonising the elements of the current national registrations systems relevant for the tracking of vehicles and for getting relevant information on export restrictions like the status of the roadworthiness certificate.

In addition, this option includes the establishment of new criteria regulating the export of used vehicles (also those which are not explicit ELVs), to ensure better traceability and sustainability of these exports. More strict (extra-EU) export criteria, including the mandatory use of the VIN number in export documents, based on combined roadworthiness, age, emission level criteria set at EU level.

The limitation of (extra-EU) export to vehicles with valid roadworthiness certificate will have massive effects on the extra EU export. The limitation of the export will have a sudden effect by the date of enforcement. Most likely exports of older vehicles (without valid certificate) to non-EU Member States will even increase in the period **before** the restrictions enter into force. For the assumptions regards the shifts between the categories we take into consideration that the enforcement date will be 2027 and the adverse effects will become effective in 2025 and the intended effects become visible in 2030.

The adverse impacts in 2025 on the number of missing vehicles are caused by the shift from treatment in ATFs to the export ("last chance to export")

Policy Option 3C									
			to						
			A	B	C	D	E	F	
2025	From	A							
		B	0.50%						0.50%
		C	0.50%	0.00%					0.50%
		D	-2.00%	-1.50%	-1.50%				-5.00%
		E	-1.50%	-1.00%	-1.00%	0.00%			-3.50%
		F	-1.50%	-1.00%	-1.00%	0.00%	0.00%		-3.50%
		total	-4.00%	-4.00%	-4.00%	5.00%	3.50%	3.50%	0.00%
			to						
			A	B	C	D	E	F	
2030	From	A							
		B	1.00%						1.00%
		C	1.00%	0.00%					1.00%
		D	4.00%	0.00%	0.00%				4.00%
		E	1.50%	0.00%	0.00%	2.00%			3.50%
		F	1.50%	0.00%	0.00%	2.00%	0.00%		3.50%
		total	9.00%	-1.00%	-1.00%	0.00%	-3.50%	-3.50%	0.00%
			to						
			A	B	C	D	E	F	
2035	From	A							
		B	1.50%						1.50%
		C	1.50%	0.00%					1.50%
		D	5.00%	0.00%	0.00%				5.00%
		E	2.00%	0.00%	0.00%	2.00%			4.00%
		F	2.00%	0.00%	0.00%	2.00%	0.00%		4.00%
		total	12.00%	-1.50%	-1.50%	-1.00%	-4.00%	-4.00%	0.00%
			to						
			A	B	C	D	E	F	
2040	From	A							
		B	1.50%						1.50%
		C	1.50%	0.00%					1.50%
		D	6.00%	0.00%	0.00%				6.00%
		E	2.50%	0.00%	0.00%	2.00%			4.50%
		F	2.50%	0.00%	0.00%	2.00%	0.00%		4.50%
		total	14.00%	-1.50%	-1.50%	-2.00%	-4.50%	-4.50%	0.00%



6.6.2.3.5 Preferred Policy Option

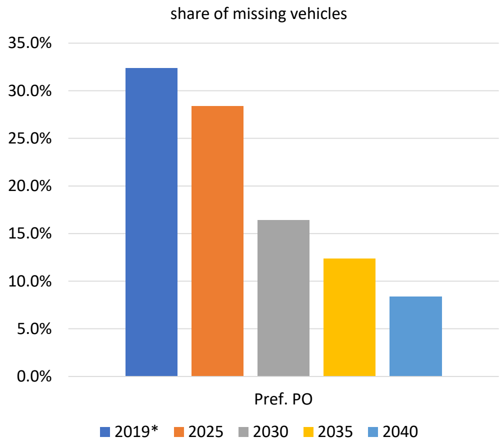
In the preferred Policy Option, all the elements for better tracking of the vehicles are in place:

- The means to exchange with other Member States on export and import and on CoD issued in another Member State than the vehicle was last registered.
- The reporting form and obligation to prove that all ELVs are directed to ATFs
- The harmonisation of the registration procedures in the different Member States including introduction of harmonised definitions, e.g. for temporary deregistration.
- Incentives and penalties encouraging last owners, but also treatment operators to behave legally
- And last not least a better definition for ELV on the one hand and clear, applicable rules for the export of vehicles to non-EU countries.

The combination of these measures generates many synergies, and the impacts are much stronger. However, the adverse effect of Policy Options 3C for the year 2025, that more used vehicles (and also ELV) might be sold shortly before the stipulations for the export to third countries enter into force, remain visible and we expect this effect visible in the statistics but also in the non-registered exports.

Preferred Policy Option

			to A	B	C	D	E	F	
2025	From	A							
		B	1.00%						1.00%
		C	1.00%	1.50%					2.50%
		D	-2.00%	-1.50%	-1.50%				-5.00%
		E	-1.50%	-1.00%	-1.00%	1.00%			-2.50%
		F	-1.50%	-1.00%	-1.00%	1.00%	0.25%		-2.25%
		total	-3.00%	-3.00%	-6.00%	7.00%	2.75%	2.25%	0.00%
			to A	B	C	D	E	F	
2030	From	A							
		B	6.00%						6.00%
		C	5.00%	0.50%					5.50%
		D	4.00%	0.50%	0.50%				5.00%
		E	2.00%	0.50%	0.50%	1.00%			4.00%
		F	2.00%	0.50%	0.50%	1.00%	0.50%		4.50%
		total	19.00%	-4.00%	-4.00%	-3.00%	-3.50%	-4.50%	0.00%
			to A	B	C	D	E	F	
2035	From	A							
		B	7.50%						7.50%
		C	6.50%	0.50%					7.00%
		D	5.00%	1.00%	1.00%				7.00%
		E	2.50%	0.50%	0.50%	1.50%			5.00%
		F	2.50%	0.50%	0.50%	1.50%	0.50%		5.50%
		total	24.00%	-5.00%	-5.00%	-4.00%	-4.50%	-5.50%	0.00%
			to A	B	C	D	E	F	
2040	From	A							
		B	8.50%						8.50%
		C	7.50%	0.50%					8.00%
		D	5.00%	1.00%	1.00%				7.00%
		E	3.00%	0.50%	0.50%	2.00%			6.00%
		F	3.00%	0.50%	0.50%	2.00%	0.50%		6.50%
		total	27.00%	-6.00%	-6.00%	-3.00%	-5.50%	-6.50%	0.00%



6.6.2.3.6 Additional effects in combination with measures in the context of EPR

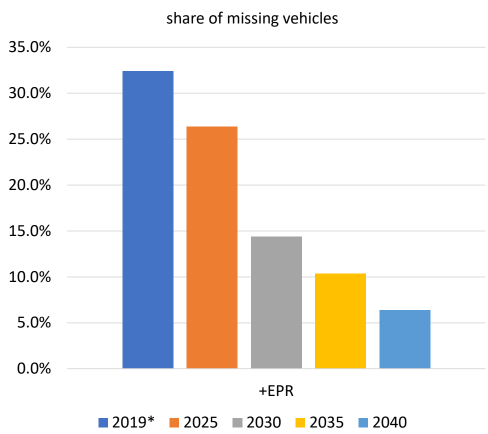
Several measures under the proposed measures support the aim to improve the collection and reduce the number of “missing vehicles as outlined in the section on the preferred Policy Option regards elements for the EPR scheme.

Depending on the detailed design of the cost compensation and the level of the compensation and enforcement it might be that this measure strengthens the competitiveness of ATFs against the illegal sector. But undercompensating and strong enforcement might even cause the opposite.

For the purpose of the impact assessment, we consider a slight positive effect on top of the preferred option

additional effects from the combination with EPR elements

			to						
			A	B	C	D	E	F	
		A							
		B	1.50%						1.50%
2025	From	C	1.50%	2.00%					3.50%
		D	-1.50%	-1.00%	-1.00%				-3.50%
		E	-1.00%	-0.50%	-0.50%	1.50%			-0.50%
		F	-1.00%	-0.50%	-0.50%	1.50%	0.25%		-0.25%
		total	-0.50%	-1.50%	-5.50%	6.50%	0.75%	0.25%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	6.50%						6.50%
2030	From	C	5.50%	1.00%					6.50%
		D	4.00%	1.00%	1.00%				6.00%
		E	2.50%	1.00%	1.00%	1.50%			6.00%
		F	2.50%	1.00%	1.00%	1.50%	0.50%		6.50%
		total	21.00%	-2.50%	-3.50%	-3.00%	-5.50%	-6.50%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	8.00%						8.00%
2035	From	C	7.00%	1.00%					8.00%
		D	5.50%	1.50%	1.50%				8.50%
		E	3.00%	0.75%	0.75%	2.00%			6.50%
		F	3.00%	0.50%	0.50%	2.00%	0.50%		6.50%
		total	26.50%	-4.25%	-5.25%	-4.50%	-6.00%	-6.50%	0.00%
			to						
			A	B	C	D	E	F	
		A							
		B	9.00%						9.00%
2040	From	C	8.00%	1.00%					9.00%
		D	6.00%	1.00%	1.00%				8.00%
		E	3.50%	0.75%	0.75%	2.00%			7.00%
		F	3.50%	0.50%	0.50%	2.00%	0.50%		7.00%
		total	30.00%	-5.75%	-6.75%	-4.00%	-6.50%	-7.00%	0.00%



6.6.2.4 Results of the scenario calculations regards the shift of number of whereabouts between categories

	Year		total ELV arising	A) ATF, reported	B) ATFs, not reported	C) non-ATF	D) Export, reported	E) Export, not reported	F) ELVs export, not reported	missing vehicles	check		A	B	C	D	E	F
Data + assumptions regards the share for different reasons for "missing vehicles"	2019	10^6 ELVs	10.50	6.1	0.9	0.9	1.0	0.9	0.9	3.4	10.5		58.1%	25.0%	25.0%	9.5%	25.0%	25.0%
			100%	58.1%	8.1%	8.1%	9.5%	8.1%	8.1%	32.4%	100.0%							
Baseline change of domestically collected &	2025	10^6 ELVs	12.39	7.2	1.0	1.0	1.2	1.0	1.0	3.9	12.4							
reported ELVs by ATFs				58.5%	7.9%	7.9%	9.9%	7.9%	7.9%	31.6%	100.0%		0.4%	-0.2%	-0.2%	0.4%	-0.2%	-0.2%
	2030	10^6 ELVs	12.41	7.3	1.0	1.0	1.3	0.9	0.9	3.8	12.4							
				59.2%	7.8%	7.8%	10.1%	7.5%	7.5%	30.7%	100.0%		1.1%	-0.3%	-0.3%	0.6%	-0.6%	-0.6%
	2035	10^6 ELVs	12.85	7.6	1.0	1.0	1.3	1.0	1.0	3.9	12.8							
				59.4%	7.7%	7.7%	10.2%	7.4%	7.4%	30.4%	100.0%		1.3%	-0.4%	-0.4%	0.7%	-0.7%	-0.7%
	2040	10^6 ELVs	13.77	8.2	1.1	1.1	1.4	1.0	1.0	4.1	13.8							
				59.6%	7.7%	7.7%	10.3%	7.3%	7.3%	30.1%	100.0%		1.5%	-0.4%	-0.4%	0.8%	-0.8%	-0.8%
Policy Option 3A	2025	10^6 ELVs	12.4	7.3	1.0	1.0	1.2	1.0	0.9	3.8	12.4							
				59.1%	7.8%	7.8%	10.0%	7.8%	7.3%	30.9%	100.0%		1.0%	-0.3%	-0.3%	0.5%	-0.3%	-0.8%
	2030	10^6 ELVs	12.4	7.5	0.9	0.9	1.3	0.9	0.8	3.6	12.4							
				60.1%	7.6%	7.6%	10.5%	7.6%	6.6%	29.4%	100.0%		2.0%	-0.5%	-0.5%	1.0%	-0.5%	-1.5%
	2035	10^6 ELVs	12.8	7.8	0.9	0.9	1.4	0.9	0.8	3.6	12.8							
				61.1%	7.3%	7.3%	11.0%	7.3%	5.8%	27.9%	100.0%		3.0%	-0.8%	-0.8%	1.5%	-0.8%	-2.3%
	2040	10^6 ELVs	13.8	8.7	0.9	0.9	1.6	0.9	0.6	3.5	13.8							
				62.9%	6.9%	6.9%	11.9%	6.9%	4.5%	25.2%	100.0%		4.8%	-1.2%	-1.2%	2.4%	-1.2%	-3.6%
Policy Option 3B	2025	10^6 ELVs	12.4	7.5	0.9	0.9	1.2	0.9	0.9	3.6	12.4							
				60.6%	7.6%	7.6%	10.0%	7.1%	7.1%	29.4%	100.0%		2.5%	-0.5%	-0.5%	0.5%	-1.0%	-1.0%
	2030	10^6 ELVs	12.4	7.8	0.9	0.9	1.3	0.8	0.8	3.3	12.4							
				63.1%	7.1%	7.1%	10.5%	6.1%	6.1%	26.4%	100.0%		5.0%	-1.0%	-1.0%	1.0%	-2.0%	-2.0%
	2035	10^6 ELVs	12.8	8.4	0.8	0.8	1.4	0.7	0.7	3.0	12.8							
				65.6%	6.6%	6.6%	11.0%	5.1%	5.1%	23.4%	100.0%		7.5%	-1.5%	-1.5%	1.5%	-3.0%	-3.0%
	2040	10^6 ELVs	13.8	9.4	0.8	0.8	1.6	0.6	0.6	2.8	13.8							
				68.1%	6.1%	6.1%	11.5%	4.1%	4.1%	20.4%	100.0%		10.0%	-2.0%	-2.0%	2.0%	-4.0%	-4.0%
Policy Option 3C	2025	10^6 ELVs	12.4	6.7	0.5	0.5	1.8	1.4	1.4	3.9	12.4							
				54.1%	4.1%	4.1%	14.5%	11.6%	11.6%	31.4%	100.0%		-4.0%	-4.0%	-4.0%	5.0%	3.5%	3.5%
	2030	10^6 ELVs	12.4	8.3	0.9	0.9	1.2	0.6	0.6	2.9	12.4							
				67.1%	7.1%	7.1%	9.5%	4.6%	4.6%	23.4%	100.0%		9.0%	-1.0%	-1.0%	0.0%	-3.5%	-3.5%
	2035	10^6 ELVs	12.8	9.0	0.8	0.8	1.1	0.5	0.5	2.7	12.8							
				70.1%	6.6%	6.6%	8.5%	4.1%	4.1%	21.4%	100.0%		12.0%	-1.5%	-1.5%	-1.0%	-4.0%	-4.0%
	2040	10^6 ELVs	13.8	9.9	0.9	0.9	1.0	0.5	0.5	2.8	13.8							
				72.1%	6.6%	6.6%	7.5%	3.6%	3.6%	20.4%	100.0%		14.0%	-1.5%	-1.5%	-2.0%	-4.5%	-4.5%

	Year		total ELV arising	A) ATF, reported	B) ATFs, not reported	C) non-ATF	D) Export, reported	E) Export, not reported	F) ELVs export, not reported	missing vehicles	check		A	B	C	D	E	F
Preferred Policy Option	2025	10^6 ELVs	12.4	6.8	0.6	0.3	2.0	1.3	1.3	3.5	12.4							
				55.1%	5.1%	2.1%	16.5%	10.8%	10.3%	28.4%	100.0%		-3.0%	-3.0%	-6.0%	7.0%	2.8%	2.3%
	2030	10^6 ELVs	12.4	9.6	0.5	0.5	0.8	0.6	0.4	2.0	12.4							
				77.1%	4.1%	4.1%	6.5%	4.6%	3.6%	16.4%	100.0%		19.0%	-4.0%	-4.0%	-3.0%	-3.5%	-4.5%
	2035	10^6 ELVs	12.8	10.5	0.4	0.4	0.7	0.5	0.3	1.6	12.8							
				82.1%	3.1%	3.1%	5.5%	3.6%	2.6%	12.4%	100.0%		24.0%	-5.0%	-5.0%	-4.0%	-4.5%	-5.5%
	2040	10^6 ELVs	13.8	11.7	0.3	0.3	0.9	0.4	0.2	1.2	13.8							
				85.1%	2.1%	2.1%	6.5%	2.6%	1.6%	8.4%	100.0%		27.0%	-6.0%	-6.0%	-3.0%	-5.5%	-6.5%
additional effects from the combination with	2025	10^6 ELVs	12.4	7.1	0.8	0.3	2.0	1.1	1.0	3.3	12.4							
EPR elements				57.6%	6.6%	2.6%	16.0%	8.8%	8.3%	26.4%	100.0%		-0.5%	-1.5%	-5.5%	6.5%	0.8%	0.3%
	2030	10^6 ELVs	12.4	9.8	0.7	0.6	0.8	0.3	0.2	1.8	12.4							
				79.1%	5.6%	4.6%	6.5%	2.6%	1.6%	14.4%	100.0%		21.0%	-2.5%	-3.5%	-3.0%	-5.5%	-6.5%
	2035	10^6 ELVs	12.8	10.9	0.5	0.4	0.6	0.3	0.2	1.3	12.8							
				84.6%	3.8%	2.8%	5.0%	2.1%	1.6%	10.4%	100.0%		26.5%	-4.3%	-5.3%	-4.5%	-6.0%	-6.5%
	2040	10^6 ELVs	13.8	12.1	0.3	0.2	0.8	0.2	0.2	0.9	13.8							
				88.1%	2.3%	1.3%	5.5%	1.6%	1.1%	6.4%	100.0%		30.0%	-5.8%	-6.8%	-4.0%	-6.5%	-7.0%

Table 6-30 Change in categories of whereabouts for the different scenarios

Policy Option	Year	A) treated in ATFs and reported	B) treated in ATFs, not reported	C) treated in non-ATF	D) exported and reported	E) Export of used, not reported	F) export of ELVs, not reported	Number of missing vehicles	Share of missing vehicles
Data *	**2019**	6 100 000	850 000	850 000	1 000 000	850 000	850 000	3 400 000	32.4%
Baseline	**2025**	7 246 831	978 122	978 122	1 229 436	978 122	978 122	3 912 486	31.6%
	2030	7 347 797	967 609	967 609	1 256 650	936 577	936 577	3 808 371	30.7%
	2035	7 630 563	995 038	995 038	1 313 463	956 497	956 497	3 903 070	30.4%
	2040	8 205 505	1 059 536	1 059 536	1 421 457	1 011 346	1 011 346	4 141 764	30.1%
3A	**2025**	7 321 164	971 927	971 927	1 241 825	971 927	909 983	3 825 765	30.9%
	2030	7 459 512	942 783	942 783	1 306 301	942 783	818 655	3 647 004	29.4%
	2035	7 848 964	943 650	943 650	1 416 239	943 650	750 943	3 581 893	27.9%
	2040	8 659 872	949 386	949 386	1 641 757	949 386	618 937	3 467 096	25.2%
3B	**2025**	7 506 995	940 955	940 955	1 241 825	879 012	879 012	3 639 934	29.4%
	2030	7 831 897	880 719	880 719	1 306 301	756 591	756 591	3 274 619	26.4%
	2035	8 427 083	847 297	847 297	1 416 239	654 590	654 590	3 003 773	23.4%
	2040	9 375 846	839 237	839 237	1 586 682	563 862	563 862	2 806 197	20.4%
3C	**2025**	6 701 726	507 349	507 349	1 799 319	1 436 506	1 436 506	3 887 709	31.4%
	2030	8 328 409	880 719	880 719	1 182 173	570 399	570 399	2 902 235	23.4%
	2035	9 005 203	847 297	847 297	1 095 062	526 119	526 119	2 746 831	21.4%
	2040	9 926 595	908 080	908 080	1 035 933	495 018	495 018	2 806 197	20.4%
Preferred Policy Option	**2025**	6 825 613	631 237	259 574	2 047 094	1 343 590	1 281 646	3 516 046	28.4%
	2030	9 569 691	508 334	508 334	809 789	570 399	446 270	2 033 338	16.4%
	2035	10 546 854	397 648	397 648	709 649	461 884	333 413	1 590 593	12.4%
	2040	11 716 529	288 488	288 488	898 245	357 331	219 644	1 153 950	8.4%
additional EPR effects	**2025**	7 135 332	817 068	321 518	1 985 150	1 095 815	1 033 871	3 268 271	26.4%
	2030	9 817 948	694 527	570 399	809 789	322 142	198 014	1 785 081	14.4%
	2035	10 868 032	494 001	365 530	645 414	269 177	204 942	1 333 651	10.4%
	2040	12 129 591	322 909	185 222	760 558	219 644	150 800	878 576	6.4%

6.6.2.5 Results of the scenario calculations regards recyclables and LCA credits

The calculation is based on the following assumptions:

- Annex I section 6.9 on Description of the model to calculate the impact assessment:
  - dynamic generation of ELVs
  - split in ICV, HEV, PHEV and BEV
  - Steady state efficiency for the recycling rate respectively loss rate (RR for glass = 0)
- Shift of vehicles from export to intra EU treatment.
- Without consideration of effects of measures to support circularity.

Table 6-31 Resources for intra EU recycling in 2025/2030/2040 for the different Policy Options

		baseline	baseline	baseline	baseline
		2025	2030	2035	2040
Steel	1000 t	5 945.7	5 993.9	6 199.1	6 626.3
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	911.9	899.3	862.4	761.1
Wrought Aluminum	1000 t	320.1	349.7	430.2	585.3
Cast Aluminum	1000 t	625.5	637.5	669.5	718.9
Copper/Brass	1000 t	114.6	123.3	147.8	195.9
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	261.2	260.5	266.5	286.9
Platinum	t	29.8	30.1	30.4	27.3
		3A	3A	3A	3A
		2025	2030	2035	2040
Steel	1000 t	5 985.7	6 034.0	6 273.6	6 776.5
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	918.0	905.3	872.7	778.4
Wrought Aluminum	1000 t	322.3	352.1	435.4	598.6
Cast Aluminum	1000 t	629.7	641.8	677.5	735.2
Copper/Brass	1000 t	115.4	124.2	149.6	200.3
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	263.0	262.3	269.7	293.4
Platinum	t	30.0	30.3	30.7	27.9

		3B	3B	3B	3B
		2025	2030	2035	2040
Steel	1000 t	6 065.8	6 194.3	6 521.9	7 094.7
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	930.3	929.3	907.3	814.9
Wrought Aluminum	1000 t	326.6	361.4	452.6	626.7
Cast Aluminum	1000 t	638.1	658.8	704.4	769.7
Copper/Brass	1000 t	116.9	127.5	155.5	209.7
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	266.5	269.2	280.3	307.2
Platinum	t	30.4	31.1	31.9	29.2

		3C	3C	3C	3C
		2025	2030	2035	2040
Steel	1000 t	4 985.3	6 514.9	6 894.5	7 536.5
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	764.6	977.4	959.1	865.7
Wrought Aluminum	1000 t	268.4	380.1	478.5	665.7
Cast Aluminum	1000 t	524.5	692.9	744.6	817.7
Copper/Brass	1000 t	96.1	134.1	164.4	222.8
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	219.0	283.2	296.4	326.3
Platinum	t	25.0	32.7	33.8	31.0

		Pref. PO	Pref. PO	Pref. PO	Pref. PO
		2025	2030	2035	2040
Steel	1000 t	4 985.3	6 835.5	7 308.4	7 890.0
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	764.6	1 025.5	1 016.7	906.3
Wrought Aluminum	1000 t	268.4	398.8	507.2	697.0
Cast Aluminum	1000 t	524.5	727.0	789.3	856.0
Copper/Brass	1000 t	96.1	140.7	174.2	233.2
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	219.0	297.1	314.1	341.6
Platinum	t	25.0	34.3	35.8	32.5

		+EPR	+EPR	+EPR	+EPR
		2025	2030	2035	2040
Steel	1000 t	5 345.4	7 156.1	7 556.7	8 110.9
Stainless Steel	1000 t	-	-	-	-
Cast Iron	1000 t	819.8	1 073.6	1 051.2	931.7
Wrought Aluminum	1000 t	287.8	417.5	524.4	716.5
Cast Aluminum	1000 t	562.4	761.1	816.1	880.0
Copper/Brass	1000 t	103.0	147.3	180.2	239.8
Glass	1000 t	-	-	-	-
Average Plastic	1000 t	234.9	311.1	324.8	351.2
Platinum	t	26.8	35.9	37.0	33.4

Source: own calculations

Table 6-32 Credits for recycling due to shift from export (used and ELVs) to EU domestic treatment; LCA unit: GWP 100a [1000 t CO2 eq]

The calculation is based on the following assumptions:

- Annex I section 6.9 on Description of the model to calculate the impact assessment:
  - dynamic generation of ELVs
  - split in ICV, HEV, PHEV and BEV
  - Steady state efficiency for the recycling rate / respectively loss rate (RR for glass = 0)
  - Credits for recycled materials
- Shift of vehicles from export to intra EU treatment.
- Without consideration of effects of measures to support circularity.

		baseline	baseline	baseline	baseline
Steel	1000 t CO2 eq	2025	2030	2035	2040
Stainless Steel	1000 t CO2 eq	7 253.8	7 312.6	7 562.9	8 084.1
Cast Iron	1000 t CO2 eq				
Wrought Aluminum	1000 t CO2 eq	1 030.4	1 016.2	974.5	860.1
Cast Aluminum	1000 t CO2 eq	4 837.4	5 284.5	6 500.5	8 844.5
Copper/Brass	1000 t CO2 eq	8 644.5	8 810.5	9 252.5	9 935.7
Glass	1000 t CO2 eq	418.3	450.2	539.4	715.0
Average Plastic	1000 t CO2 eq	-	-	-	-
Platinum	1000 t CO2 eq	496.3	495.0	506.3	545.1

		3A	3A	3A	3A
Steel	1000 t CO2 eq	2025	2030	2035	2040
Stainless Steel	1000 t CO2 eq	7 302.6	7 361.5	7 653.8	8 267.4
Cast Iron	1000 t CO2 eq				
Wrought Aluminum	1000 t CO2 eq	1 037.4	1 023.0	986.2	879.6
Cast Aluminum	1000 t CO2 eq	4 870.0	5 319.9	6 578.6	9 045.0
Copper/Brass	1000 t CO2 eq	8 702.6	8 869.4	9 363.7	10 160.9
Glass	1000 t CO2 eq	421.1	453.2	545.9	731.2
Average Plastic	1000 t CO2 eq	-	-	-	-
Platinum	1000 t CO2 eq	499.7	498.3	512.4	557.4

		3B	3B	3B	3B
Steel	1000 t CO2 eq	2025	2030	2035	2040
Stainless Steel	1000 t CO2 eq	7 400.3	7 557.0	7 956.8	8 655.5
Cast Iron	1000 t CO2 eq				
Wrought Aluminum	1000 t CO2 eq	1 051.2	1 050.1	1 025.2	920.9
Cast Aluminum	1000 t CO2 eq	4 935.1	5 461.2	6 839.0	9 469.6
Copper/Brass	1000 t CO2 eq	8 819.0	9 105.0	9 734.3	10 637.9
Glass	1000 t CO2 eq	426.7	465.3	567.5	765.5
Average Plastic	1000 t CO2 eq	-	-	-	-
Platinum	1000 t CO2 eq	506.3	511.6	532.6	583.6

		3C	3C	3C	3C
Steel	1000 t CO2 eq	2025	2030	2035	2040
Stainless Steel	1000 t CO2 eq	6 082.0	7 948.1	8 411.2	9 194.5
Cast Iron	1000 t CO2 eq				
Wrought Aluminum	1000 t CO2 eq	864.0	1 104.5	1 083.8	978.2
Cast Aluminum	1000 t CO2 eq	4 056.0	5 743.8	7 229.7	10 059.3
Copper/Brass	1000 t CO2 eq	7 248.0	9 576.3	10 290.3	11 300.4
Glass	1000 t CO2 eq	350.7	489.4	599.9	813.2
Average Plastic	1000 t CO2 eq	-	-	-	-
Platinum	1000 t CO2 eq	416.2	538.0	563.1	619.9

		Pref. PO	Pref. PO	Pref. PO	Pref. PO
Steel	1000 t CO2 eq	2025	2030	2035	2040
Stainless Steel	1000 t CO2 eq	6 082.0	8 339.3	8 916.2	9 625.8
Cast Iron	1000 t CO2 eq				
Wrought Aluminum	1000 t CO2 eq	864.0	1 158.8	1 148.8	1 024.1
Cast Aluminum	1000 t CO2 eq	4 056.0	6 026.5	7 663.7	10 531.1
Copper/Brass	1000 t CO2 eq	7 248.0	10 047.5	10 908.1	11 830.4
Glass	1000 t CO2 eq	350.7	513.4	635.9	851.3
Average Plastic	1000 t CO2 eq	-	-	-	-
Platinum	1000 t CO2 eq	416.2	564.5	596.9	649.0

Source: own calculations

6.6.3 Overview of key impacts to screen

Overview of key impacts to screen*			
Impact on	**Economic**	**Social**	**Environmental**
Climate			✓
Quality of natural resources (water, soil, air etc.)			✓
Biodiversity, including flora, fauna, ecosystems and landscapes			✓
Animal welfare			✓
Working conditions, job standards and quality		✓	
Public health & safety and health systems		✓	
Culture		✓	
Governance, participation and good administration		✓	
Education and training, education and training systems	✓	✓	
Conduct of business	✓		
Position of SMEs[199]	✓		
Administrative burdens on business	✓		
Sectoral competitiveness, trade and investment flows	✓		
Functioning of the internal market and competition	✓		
Public authorities (and budgets)	✓		
Sustainable consumption and production	✓		✓
Efficient use of resources (renewable & non-renewable)	✓		✓
Land use	✓		✓
The likelihood or scale of environmental risks	✓		✓
Employment	✓	✓	
Income distribution, social protection and social inclusion (of particular groups)	✓	✓	
Technological development / Digital economy	✓	✓	
Consumers and households	✓	✓	
Capital movements; financial markets; stability of the euro	✓	✓	

[198] The obligation to screen these impacts is the consequence of the Treaty on the Functioning of the European Union (Articles 8-14).
[199] In order to systematically screen the potential impact on SMEs, the SME-test needs to be performed in all impact assessment reports. See Tool #23 (*the SME test*).

Property rights; intellectual property rights	✓	✓	
Territorial impacts (specific (types of) regions and sectors)	✓	✓	✓
Innovation (productivity and resource efficiency); research (academic and industrial)	✓	✓	✓
Fraud, crime, terrorism and security, including hybrid threats	✓	✓	✓
Resilience, technological sovereignty, open strategic autonomy, security of supply	✓	✓	✓
Transport and the use of energy	✓	✓	✓
Food safety, food security and nutrition	✓	✓	✓
Waste production, generation and recycling	✓	✓	✓
Third countries, developing countries, and international relations	✓	✓	✓
Sustainable development	✓	✓	✓
Fundamental rights	✓	✓	✓

** - The 'tick' denotes an indicative dominant category of impact*

6.7 Detailed current situation of EPR schemes, PROs and fees / taxes applied in the MS for the management ELVs

6.7.1 Questions to the Member States in March 2022 on EPR

The following questions were sent in March 2022 to the Member States:

1. Does a fee or tax apply in your country, which is used to financially support the recycling of ELVs? If so, please specify:

- What is the level of the fee?
- For which vehicles does the fee apply?
- For what purpose can the collected fees be allocated?
- Who is managing the fund (e.g., which organisation, which stakeholders are involved)?

2. Does an EPR System exist in your country? If so, please specify:

3. Please indicate the number of Producer Responsibility Organisations (PRO) involved or if the EPR is maintained by each single producer individually (direct contracting of producers with ATFs)?

4. Is the EPR System operating in a way which is consistent with the minimum requirements of the Waste Framework Directive Art 8a?

14 Member States replied to the questionnaire: BE, MT, FR, SE, DE, IE, SK, FI, ES, NL, HR; LT; CZ, EL.

6.7.2 Details for the countries where fees / taxes are mentioned

6.7.2.1 Austria

The PRO OECAR charges its members in 2022 with € 3.10 per vehicle placed on the market; The minimum fee per brand and year is € 500, the maximum per brand and year is € 15.500 (net)[359].

The PRO Österreichische Schredder charges its members in 2022 with € 1.50 per vehicle placed on the market plus an annual lump sum of € 100. The fees are used for the management of the PRO.

6.7.2.2 Czech Republic

No recycling taxes or fees apply for new imported or produced vehicles in the Czech Republic.

A recycling fee is established for used vehicles in the Czech Republic. Vehicle owners pay the recycling fee pay when registering used vehicles as specified below:

The fee is determined by compliance with the limit values of exhaust emissions:

CZK 3 000 (app. 120 €) if the emission limits EURO 2,

CZK 5 000 (app. 200 €) if the emission limit values EURO 1,

CZK 10 000 CZK (app 400 €) in case of non-compliance with the emission limits under a) and b).

The fee does not apply to vehicles that meet minimum emission limit values EURO 3.

The fee is paid to support the collection, treatment, recovery, and disposal of ELVs and their parts, for infrastructure development and for support of alternative fuel vehicles. The fee is payable for the first registration of selected vehicles in the Czech Republic. If the vehicle is already registered in the Czech Republic, owner is obligated to pay a fee for the first re-registration of vehicles. [360]

6.7.2.3 Finland

In Finland we have only one PRO for ELV's: Suomen Autokierrätys Oy (Finnish Car recycling Ltd). Producers (producer = the manufacturer or importer of the vehicle in a professional capacity) who want to join the PRO have to pay a joining fee (only once) and an annually fee. These fees are same for producers who import new cars and producers who import used cars. Both of those fees are depending on the amounts of imported cars. The joining fee is 300 € for those producers who has imported 49 or less cars / previous year, 600 € for 50-99 imported cars; 1200 € for 100-199 imported cars; 1500 € for 200-999 imported cars and 2000 € for 1000 or more imported cars. The amount of annually subscription fees varied in 2014 from minimum 3,20 €/car for those producers who imported more than 3000 cars/year to maximum 18,92 € for those who imported ten or less cars/year. These annually subscription fees cover mainly the administration costs of PRO. There are no additional recycling fees.[361]

[359] https://www.oecar.at/, accessed: 2022-03-22

[360] Survey of the EC in 2014/2015

[361] Survey of the EC in 2014/2015

6.7.2.4 France

As reported in the ELV Expert Group meeting the 31 March 2022, France adopted two relevant legislations with this regard: the "Anti Waste" bill (2020)[362] and the "Climate and Resilience" bill (2021)[363]. The "Anti Waste" bill established the obligation to have signed a contract with vehicle manufacturers or PROs to collect, depollute or treat hazardous waste from ELVs. The "Climate and Resilience" bill established the obligation to producers to ensure free collection of vehicles at holder's premises and an ELV return bonus to the last vehicle holder paid by vehicle manufacturers or PRO if it improves ELVs collection efficiency (compensate the gap of economic competitiveness with illegal sector). The level of cost for the producers is not known jet.

6.7.2.5 Republic of Croatia

According to Croatian ELV legislation, legal or natural person who imports new or used motor vehicles or produces motor vehicles and puts them on the market in the Republic of Croatia is obliged to pay ELV management fee to Croatian Environmental Protection and Energy Efficiency Fund, in the amount of 0,60 kn/kg (€ 0,08/kg).

The Fund covers the costs of the entire ELV management system and ensures the fulfilment of the prescribed objectives of reuse / recovery / recycling:

a) Compensation for the last owner when handing over an ELV to ATFs. the pay-out (for a complete ELV) is 1000 HRK/1000 kg (ca € 130/1000 kg). For an incomplete ELV the pay-out is 500 HRK/1000 kg (ca. € 66/1000 kg);

b) Compensation for the collector - for collection, storage, and transport of ELVs to ATFs: 150-450 HRK/1000 kg (≈ € 20-60/1000 kg) depending on the distance between the pick-up point and ATF; in the case of transport distance of more than 150 km: the fee amounts to 0,80 HRK/km/t (≈ € 0,105/km/t) of vehicles transported[364].

6.7.2.6 Ireland

Ireland announced for 2023 fees will be 20 € per unit (one-time payment). If a Producer were to self-comply, registration fees would be paid to local authorities. The fees paid to the PRO ELVES are used to support the operation and objectives of their operation – improving the processing of ELVs in Ireland, primarily ensuring ELV reuse and recovery targets are met and delivering public awareness around the correct way to scrap a vehicle.

6.7.2.7 The Netherlands

The Dutch EPR system is based on a recycling fee. The recycling fee is a fixed, one-off supplement that every car buyer in the Netherlands pays when registering for the first time a car or light commercial vehicle. The price is the same for all cars, irrespective of the make or type, vehicle weight, motorisation or catalogue price. At the start of 1995 the former 'disposal fee' was 250 guilders. When the euro was introduced in 2002, it became €45. And it remained

[362] https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000041553759 Articles 18, 62 and 72

[363] https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924 Article 32

[364] Survey of the EC in 2014/2015

the same until 2016. The funds are directed to ARN the Automotive Recycling Netherlands. As outlined in the report of Ademe (2019) [365] "*This organisation set specific targets for ELV centres: xx% of rubber to be recovered from a car, yy% of plastic from bumpers, zz% of glass, etc. This led to a total recovery of 93.5% in The Netherlands. If an ELV centre achieved the dismantling targets, the centre received 75 euros per vehicle from the ARN. The difference between 45 and 75 euros is due to the volume of exports from The Netherlands, considering that half of the vehicles sold in The Netherlands are processed in that country. In 2012, the ARN decided to build a post-shredding sorting unit to separate the light fraction from shredder waste. This unit replaced "conventional" dismantling practices; nowadays, ELV centres are only required to decontaminate vehicles before sending to shredders. The ARN no longer subsidises ELV centres: the organisation still receives the money due from the first registration of cars, but this premium is used to support the post-shredding sorting unit which is not profitable at the moment*".

In 2020 ARNs PST plant in Tiel is sold to the ESA (Euro Scrap Alliance)[366].

As explained at ARNs homepage[367], ARN today organises, monitors and continually optimises environmentally friendly disposal and processing of end-of-life vehicles. All of the almost 300 partners in the recycling chain can function optimally through a fair distribution key.

- From fluid drainage installations to special boxes for transporting batteries: thanks to the recycling fee we can organise these issues together. ARN facilitates this process and provides practical solutions.
- Moreover, ARN spends a part of the recycling fee to help the development of vehicles that are easier to dismantle, on protocols for safe dismantling of electric vehicles and on new, innovative recycling techniques and procedures.

Since 2017, the recycling fee has decreased by €2.50 each year. It is currently (2022) €30.

6.7.2.8 Poland

From 2005 to 2015 all natural persons placing vehicles on the Polish market, as well as smaller importers, were required to pay a charge of PLN 500 (just under 110 €)[368] for each vehicle. The manufacturers and importers marketing large quantities of vehicles (those who were required to ensure the vehicle collection network) were exempt from the duty. The funds were deposited by the National Fund for Environmental Protection and Water Management.

Operators of vehicle dismantling facilities receive subsidies in the amount of PLN 500 per each ton of correctly processed waste (ELV). Owing to the limits on the subsidies of 200.000 € for 3 years, the operators of vehicle dismantling facilities received state aid for about 500 vehicles per year. If more ELVs were processed at the facilities, the operators did not receive any reimbursement for the processing costs or state aid for the vehicles above the limit.

[365] ADEME (Eric LECOINTRE), Deloitte Développement Durable (Alexis LEMEILLET, Radia BENHALLAM, Antoine HENRY, Marie FILLION, Rafael BASCIANO), In Extenso Innovation Croissance (Victoire ESCALON, Beatriz BERTHOUX). 2019. Final report: Global Overview of Incentive Schemes aiming to bring ELVs through Authorised Processing Channels. 119 pages.

[366] EUWID Recycling and Waste Management 18 March 2020: ARN sells post-shredder treatment plant in Tiel to Remondis subsidiary

[367] https://arn.nl/en/car-recycling/the-recyclingfee/ accessed 2022-06-22

[368] based on the exchange rate of 2.11.2021, taken form https://de.ex-rate.com/convert/pln/500-to-eur.html

Over PLN 2 billion have been collected during the entire period. However, after an amendment of the Act, most of the funds were spent on other projects, like water supply and sewage.

On 1 January 2016, the Polish ELV Act was amended and the ELV Fund was abolished. The amendment also introduced penalties for ATFs in a situation when recovery or recycling levels are not achieved. ATF are obligated to pay for each kilogram missing for recovery and recycling levels:

- 0,05 PLN for each missing kilogram needed for recovery level achievement.
- 0,1 PLN for each missing kilogram needed for recycling level achievement.

Penalties are doubled in case an ATF doesn't reach the required levels for the next two years.

The same amendment introduced an obligation for car importers with more than 1000 vehicles per year, to establish an ELV collection network consisted of three ATF or collection points (at least 1 ATF) in each province = 48 elements in the country. To what extent these ATF receive financial support from producers / importers is unclear.

6.7.2.9 Portugal

Producers/Importers of vehicles (any individual or corporation that places light-duty vehicles, new or used, on the national market for the first time) are obliged to:

Register on the Integrated System of Environmental Licensing (SILiAmb) of the Portuguese Environment Protection Agency (APA), informing as to the type and quantity of vehicles placed on the national market;

Ensure the existence of a nationwide network of authorised centres to collect and recycle ELVs produced in the country. This responsibility can be assumed individually (individual system) or collectively (integrated system).

If the Producer/Importer opts to join the integrated system (SIGVFV), the responsibilities are transferred to VALORCAR by signing a contract. This contract entails the payment of a Financial Provision to finance VALORCAR's operations.

The Financial Provision for each vehicle placed on the national market for the first time and covered by the current ELVD (M1 and N1 vehicles) is for new and used vehicles 1.2 €. For used vehicles produced (first registered) before 3/Feb/2010 the Financial Provision is 5,0 per vehicle[369].

Previously (in 2014) a fee was charged for new vehicles only. The fee was not applied to second-hand vehicles, which represent 14,7% (around 29 000 second hand vehicles) of the new vehicle market in 2014.[370]

6.7.2.10 Slovakia

In 2014 Slovakia reported to the EC having a recycling fund for ELVs. New and used vehicles placed for the first time on the national market have to contribute 66,39 €/ vehicle to this fund[371].

[369] https://www.valorcar.pt/en/vfv/fabricantes (accessed 2022-06-22)

[370] Survey of the EC in 2014/2015

[371] Survey of the EC in 2014/2015

In the meantime, the fund was abolished and the PRO Autorecycling[372] is charging its members with 24 € per vehicle[373]. Not all producers / importers entered the PRO, individual systems are existing in parallel.

6.7.2.11 Norway

Norway has introduced risk sharing in relation to scrap price.

From 1978 to 2006 ATFs were paid by the Norwegian government for depollution and treatment of the ELVs. In 2007 the system was changed from state-run system to EPR. In 2009 the different parties (manufacturers, importers, ATFs, shredders) agreed upon a long-term financial risk sharing agreement. The agreement establishes a risk sharing model in dependence of the scrap prices (in case of low scrap prices ATFs receive compensation form EPR). The agreement also addresses specific long distance transport cost from ATFs to shredders.[374]

No recycling tax, but a recycling fee of 62,50 NOK (8 EUR) must be paid to the Producer Organisation.[375]

6.7.3 Details for Member States with Deposit Refund Systems

The current systems are not under an umbrella of EPRs but managed by public authorities. However, we mentioned these here as it is a cost neutral (despite management) financial incentive to strengthen the competitiveness of the ATFs against the illegal sector and thus supports many of the objectives of the ELVD. To our knowledge only a minority of Member States have established such systems as displayed below.

6.7.3.1 Norway

The deposit refund System was implemented in Norway in 1978. The intention was an incentive for the last owner to deliver the ELV to an ATF. A fee of NOK 2400 (€ 250) is paid if a vehicle is registered for the first time. The pay-out of NOK 3000 (€ 315) is provided to the last owner upon demonstration that a CoD is issued. The system is managed by the Norwegian Tax Administration.[376]

6.7.3.2 Denmark

In order to drive legally, the car owner has to pay a mandatory insurance. On top of the insurance the car owner pays an additional fee. The current rate is 101 DKK/year, the proposed future rate 85 DKK/year, in 2013 it was 65 DKK/year[377]. The extra money collected

[372] https://www.autorecycling.sk/

[373] https://www.autorecycling.sk/dovoz-vozidla/ (accessed 2022-06-22)

[374] Siri Sveinsvoll (2019): The Norwegian ELV System, presentation held at the IV INTERNATIONAL CONFERENCE: DOMESTIC AND WORLDWIDE VEHICLES RECYCLING PRACTICE AND EXPERIENCE in Cracow, September 18th-20th, 2019

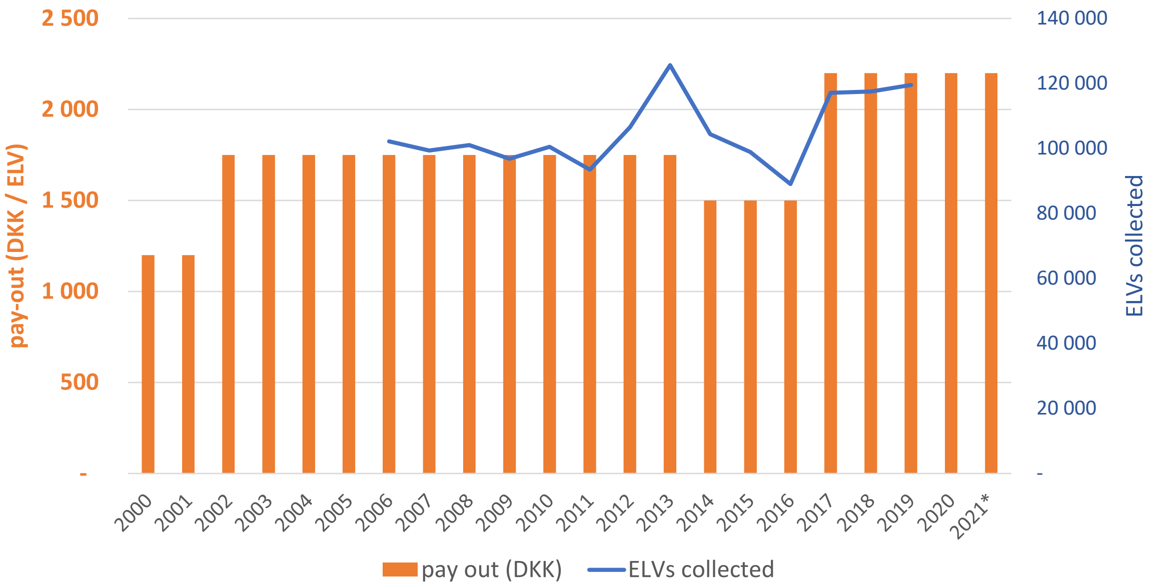
[375] Survey of the EC in 2014/2015

[376] Siri Sveinsvoll (2019): The Norwegian ELV System, presentation

[377] Jens Michael Povlsen (2016): Improving ELV collection rates in Denmark-a story about a changed market, TAC meeting 22 November 2016

is forwarded to the EPA, and finally to Danish EPR System[378]. The pay-out to the last owner was in the first year 1200 DKK per ELV, increased in 2002 to 1750 DKK, dropped in 2014 to 1500 DKK and increased to a level of 2200 DKK per ELV in 2017. As displayed in the figure below the number of collected vehicles dropped at the same time when the pay-out was reduced in 2014 and increased again when the level of pay-out increased in 2017. In 2016 a comprehensive study assessed diverse impacts of services and incentives on the ELV market[379].

Figure 6-20 Denmark: Pay-out for ELVs and number of ELVs collected



2021*: 5 000 DKK only for diesels from pre-2006

Sources:
https://www.dr.dk/nyheder/penge/1750-kroner-skrotte-bilen; https://www.retsinformation.dk/eli/accn/B20140029305; https://fdm.dk/nyheder/bilist/2016-09-minister-vil-haeve-skrotpraemie; https://bilmagasinet.dk/bil-nyheder/nye-regler-saadan-faar-du-5-000-kr-i-skrotpraemie-for-en-gammel-dieselbil

[378] Stig Thorlak, DPA (2017): Country Report: Hot topics in the Danish Dismantling Industry, presentation at the IARC 2017 the 22.- 24 March 2017 in Berlin)

[379] Deloitte Consulting (September 2016): Udredning af skrotningsgodtgørelsens incitamentsstruktur (

6.8 Detailed results of the impact analysis for EPR Scheme and economic instruments

6.8.1 Screening measures and separate discarded options

The table below displays the criteria for screening.

III. Screen your options and separate discarded options	
Why?	To focus the analysis on the viable options. In choosing the options, it is important to focus on those elements that are most critical for the Commission to decide on (i.e., those with significant impacts). As with the problem analysis, you must ensure that the report remains focused and that it does not drown the major issues in a 'flood' of minor issues.
How?	Excluding options at this stage should be clearly justified. Reasons should be as clear, self-evident and indisputable as possible. The report should explain when it had to discard policy options favoured by stakeholders. This should be done in a separate section on discarded options (if necessary, with further details in the annexes).
	The key **criteria for screening** the viability of your options are:
	Legal feasibility
	Options should respect the principle of conferral[380]. They should also respect any obligation arising from the EU Treaties (and relevant international agreements) and ensure respect of fundamental rights. Legal obligations incorporated in existing primary or secondary EU legislation may also rule out certain options.
	Technical feasibility
	Technological and technical constraints may not allow for the implementation, monitoring or enforcement of theoretical options.
	Previous policy choices
	Certain options may be ruled out by previous policy choices or mandates by EU institutions. Unless there is compelling evidence that these choices should be revisited, there is no point in reinventing the wheel.
	Coherence with other EU policy objectives

[380] Under this fundamental principle of EU law, laid down in Article 5 of the Treaty on European Union, the EU acts only within the limits of the competences that EU countries have conferred upon it in the Treaties. These competences are defined in Articles 2–6 of the Treaty on the Functioning of the EU. Competences not conferred on the EU by the Treaties thus remain with EU countries.

	Certain options may be ruled out early due to poor coherence with other general EU policy objectives.
	Effectiveness and efficiency
	It may already be possible to show that some options would with certainty achieve a worse cost-benefit balance than some alternatives.
	Proportionality
	Some options may clearly restrict the scope for national decision-making over and above what is needed to achieve the objectives satisfactorily.
	Political feasibility
	Options that would clearly fail to garner the necessary political support for legislative adoption or implementation could also be discarded. This, however, does not mean that such options should not be mentioned or not be subject to at least a minimal assessment. Options superior to other options, but lacking political feasibility may still be discussed at the legislative stage, which may increase their chances of being politically feasible.
	Relevance
	There is no point in retaining options that do not address the needs of the policy intervention as identified in the problem definition.
	Identifiability
	When it can be shown that two options are not likely to differ materially in terms of the proposed measures, their significant impacts or their distribution, only one should be retained.

Source: Better Regulation toolbox Tool #16, Textbox page 114 – 115

In the following the potential measures are assessed against these criteria and a justification is given for the case that an option is considered as discarded. The numbers in the column "Viability screening" refer to the numbering of the key criteria for screening as displayed in the table above.

Table 6-33 Initial assessment of measures to identify discarded and short-listed measures

Measure	Viability screening	Effectiveness	Comment, Discard justification
1 Specification of general minimum requirements of Art 8/8a WFD: Obligations for the Member States			
1.1 Obligation for all MS to establish national EPR schemes	✓	Pre-Condition for effectiveness	Precondition regards measures und 2.1 to 2.9 below → **Short list**
1.2 MS to report on implementation and enforcement regards EPR	✓	Pre-Condition for effectiveness	Unclear to what extent WFD Art 8 / 8a is implemented and enforced in the MS. A reporting obligation is required on the implementation and enforcement of Art 8 / 8a and the new introduced EPR specifications. → **Short list**
1.3 MS to establish an independent competent authority (clearing house)	✓	Pre-Condition for effectiveness	Minimum requirements for the governance, the supervision, monitoring and moderation of the stakeholders → **Short list**
2 Specification of general minimum requirements of Art 8/8a WFD: Obligations for Producers to cover cost for			
2.1 Collection of vehicles at holder's premises and abandoned vehicles free of charge for the last holder. → specification of WFD Art 8a(3) point (b)	✓	Possibly high effectiveness but at high cost too	Currently the last holder is obliged to deliver the vehicle to an ATF (or collection point). Producers are responsible to offer ATFs/ collection points sufficiently close (geographical coverage). The current system is a share of responsibility; If all / abandoned vehicles are collected on cost of the OEMs at holder's premise this might cause inefficient cost. The impact assessment shall assess the cost accordingly. → **Short list**
2.2 Awareness raising of last holder to deliver ELVs to ATFs	✓	Zero to medium	This might be the possibly more cost-effective measure compared to the previous → **Short list**

Measure	Viability screening	Effectiveness	Comment, Discard justification
2.3a Establishment of a notification system for ELV, CoD and final cancellation	✓	Medium to high	New burden to producers; IT Harmonisation will improve efficiency of ATFs and authorities → **Short list**
2.3b.Support / software interfaces to international notification system	✗	-/-	According to previous policy choices the exchange between national registration authorities shall be a task to the Member States. It is deemed as politically not feasible and technically challenging to shift this obligation to producers. The Producers shall not interfere in the cooperation of the national registration systems → **discarded**
2.4 Monitoring of material flows and compliance with RRR targets	✓	Low to medium	Could be done in principle by public authorities as well, but under EPR expected much more efficient. → **short list**
2.5 Monitoring and reporting on illegal activities in the sector	✓	Low to medium	New burden to producers; Will increase efficiency of inspection campaigns → **short list**
Training for staff of ATFs (and shredders)	✓	Effective in particular for **small** (and SME) ATFs	New burden to producers: will support and encourage ATFs to build up knowledge. In particular for small ATFs the provision of such free training is of high relevance as to them it is a relevant cost bloc. → **Short list**
Provision of easy access to harmonised information	✓	medium	→ **Short list**
Fee modulation	✓	Long term effects on design for CE	→ **Short list**
Compliance cost offsetting	✓	Precondition for circularity	→ **Short list**
3. Advanced European EPR			

Measure	Viability screening	Effectiveness	Comment, Discard justification
3.1 EPR schemes for intra EU trade (delegated / implementing act)	✓	Depends on the details, mid-term impacts	→ Short list
3.2 European EPR for the EU market (feasibility study)	✓	Depends on the details, mid-term impacts	→ Short list
4. Advance economic incentives			
4.1 Deposit Refund Schemes (DRF) manged by EPR scheme	✗	Potentially high	As discussed under the section “missing vehicles”, DRF schemes are considered as a voluntary option and the MS might opt to establish it under the national EPR scheme or as a public fund. Insofar this option becomes superfluous → **discarded**
4.2 Green Public Procurement	✓	**Medium, long-term**	→ Short list

Measure	Viability screening	Effectiveness	Comment, Discard justification
Advance economic incentives			
Compliance cost offsetting	✓	Precondition for more challenging (high quality) recycling	→ short list
Deposit Refund Scheme (DRF) for vehicles	✓	Potentially high if the premium is high enough	Implementation will take time to become effective in all Member States. Possible unequal strength of negotiators (OEMs/ ATFs/ shredders) could lead to low DRF pay out and limited impact. → short list
EPR schemes for intra-EU trade	✓		
European DRF for the European Market	✓		
Strengthening the relevance of the COD, **Level B**: either implement strong economic incentives as listed or demonstrate equal effectiveness	✓	High	The measures is not in conflict with proportionality as it is up to the MS how the economic incentives are established. → short list
Fee modulation based on circularity features	✓	Difficult to achieve a level of modulation that influences the purchase decision	→ short list
Green public procurement	✓	Low	GPP at EU level is for voluntary application and insofar guidance only. However, it does not harm providing such EU guidance and costs for the development of the guidance are limited to cost for the EC. Potential for later obligatory application → short list

6.9 Description of the model to calculate the impact assessment (environmental)

6.9.1 General description of the model

The development of the model represents a central element of the impact assessment support study. The main task of the tool is to assist in the determination of impacts of applying policy options intended to address shortcomings identified in the ELV Directive. Related changes in the Directive's provisions and thus also the results of the model shall reflect the protection of the environment, the promotion of the circular economy and the smooth functioning of the internal market.

The outcome of the model is not restricted to quantitative data outputs. As an analytical tool, relationships, dependencies and linkages between different stakeholders or operators and also along the entire lifecycle of vehicles are identified, analysed and clarified. The mass flows from sales until the end-of-life stages of the vehicle's life cycle play a key role in the model.

A full range of impacts and thus a relevant share of the results of the policy options are directly linked and proportional to the mass flows. This applies especially to environmental impacts. Some economic data is directly linked to mass flows, too.

The structure of the model is tailored to its purpose and the model is able to process a variety of policy options from different areas (e.g. reuse targets and specific material recycling targets). This required a flexible but simple approach. Such a pragmatic approach has also helped the study to focus on the actual task, namely the policy options and their impacts.

The following sub-sections provide an overview of the structure and the characteristics of the model.

6.9.1.1 Scope of the model

With the focus on the end-of-life vehicles, the details of vehicle production become less important. Therefore, the initial life cycle stages of resource extraction, material processing and vehicle assembly were aggregated to the common process of 'vehicle production'. Thus, the mass flows start with the 'sales' stage which includes the carbon footprint of the vehicle production (e.g. carbon footprint, x kg CO_2eq per vehicle; material footprint, x kg copper per vehicle). The vehicle life cycle ends with recycling and recovery of secondary materials.

The geopolitical scope of the model covers the EU-27 and thus excludes the United Kingdom.

6.9.1.2 Timeframe of ELV mass flows

The model covers a period up to the year 2035. Results are available for the years 2020 to 2035. Not extending the modelling period beyond 2035 seems sensible in view of the unpredictable technical possibilities and developments, especially in the development of the vehicle fleet.

As a starting point for comparison – mainly for developing, checking and adapting modelled vehicle mass flows – we use time series that go back to the year 2009 for all applications except for ICEVs which have been modelled back to 1990. The most recent data from Acea are available for the reference year 2020. The future perspective is based on data from the Euro 7 impact assessment[381].

6.9.1.3 Types of engines

For each individual life cycle stage, the mass flows are differentiated into the relevant engine types of ELVs. The following engine types are addressed in the model: Internal combustion engines (ICEs), battery electric vehicles (BEVs), Hybrid electric vehicles (HEVs) and Plug-in-Hybrid electric vehicles (PHEVs).

There is a wide variety of terms to describe the type of technology that moves a vehicle. This includes terms such as ‘powertrain’, ‘drive system’, ‘drive type’, ‘propulsion system’, etc. The terms all differ slightly in their definitions and with regard to the components contained in a vehicle. In this study, all of these terms are used synonymously to differentiate between vehicles powered by a battery (BEV), by an internal combustion engine (ICE) or by both (PHEV, HEV).

For the in-depth investigation of the fleet development in the passenger vehicle sector in the EU, the following propulsion systems are considered in the scenarios:

- ICE: vehicle with an internal combustion engine (diesel or petrol),
- BEV: battery electric vehicle,
- HEV: hybrid electric vehicle,
- PHEV: plug-in hybrid electric vehicle.

Passenger cars with other propulsion systems, such as fuel cell vehicles (FCEV), were excluded from this study, as only very few of these vehicles are expected to be in use during the period considered in the scenarios. In the context of this study, natural gas vehicles are treated as ICEs as they are based on the same principles using a different fossil fuel. FCEV are comparable to BEVs since they also contain a battery and an electric motor, resulting in a very roughly comparable resource demand (when excluding the fuel cell itself).

6.9.1.4 Environmental Impact categories

The environmental assessment is based on a life cycle approach. The entire life cycle of ELVs is taken into account: from the extraction of primary resources and energy sources, the production of the vehicles to the recycling processes of the ELVs and disposal of materials at the end of the life cycle.

A full range of impacts and thus a relevant share of the results of the policy options are directly linked and proportional to the mass flows. This applies especially to environmental impacts. Some economic data are as well directly linked to mass flows depending on the policy options that are selected for assessment.

The main environmental impact category that is given as a default by the model is the global warming potential (GWP in t CO_2eq) (CO_2-equivalents = CO_2eq).

A further 10 environmental impact categories can be called up via the model, including e.g. acidification potential, ozone layer depletion, photochemical oxidation or eutrophication. These impacts are linked to individual life cycle stages of the mass flows, as described above for the example of the production footprint linked to ‘sales’. Other life cycle stages with

[381] Aeris Europe: Euro 7 Impact Assessment: The outlook for air quality compliance in the EU and the role of the road transport sector. 2021. Online available under https://aeriseurope.com/papers-and-articles/euro-7-impact-assessment-the-outlook-for-air-quality-compliance-in-the-eu-and-the-role-of-the-road-transport-sector/

relevant environmental impacts are 'recycling' and a comparison of the production of primary and secondary materials (e.g. steel, aluminium, copper, plastics and glass).

LCA studies and LCA databases are the source for the calculation of the environmental impacts. If available, datasets from the database ecoivent 3.8 were preferred. The used datasets from LCA databases and the used literature are listed in Table 6-37 to Table 6-39.

6.9.2 Fleet model

6.9.2.1 Material composition of the vehicles

To model the material composition of passenger cars, data from JRC-RMIS[382] on the composition of passenger cars was used, supplemented by data from the Greet model (Argonne 2021) (see Table 6-34). The percentage composition was calculated down to the average weight of ELVs in the EU according to Eurostat.

Table 6-34 Material composition of End-of-life vehicles (passenger cars) in kg after depollution

Material	ICEV	HEV	PHEV	EV
Steel	653	660	621	642
Cast Iron	101	101	96	16
Wrought Aluminium	40	58	76	108
Cast Aluminium	79	91	93	77
Copper	14	20	23	35
Magnesium	5	5	5	1
Manganese	8	8	8	7
Glass	24	21	22	26
Average Plastic	159	129	143	166
Rubber	41	34	38	39
Glass Fiber-Reinforced Plastic	9	4	5	5
Others	5	6	7	14
Total	1 137	1 137	1 137	1 137

Source: Calculated with data from JRC-RMIS and Argonne 2021 and average weight according to Eurostat

6.9.2.2 For the calculation of the material composition of other vehicles (see Table 6-4 through Table 6-7) other sources are used:

Please see section 6.1.3 under this annex.

6.9.2.3 Sales and Stock

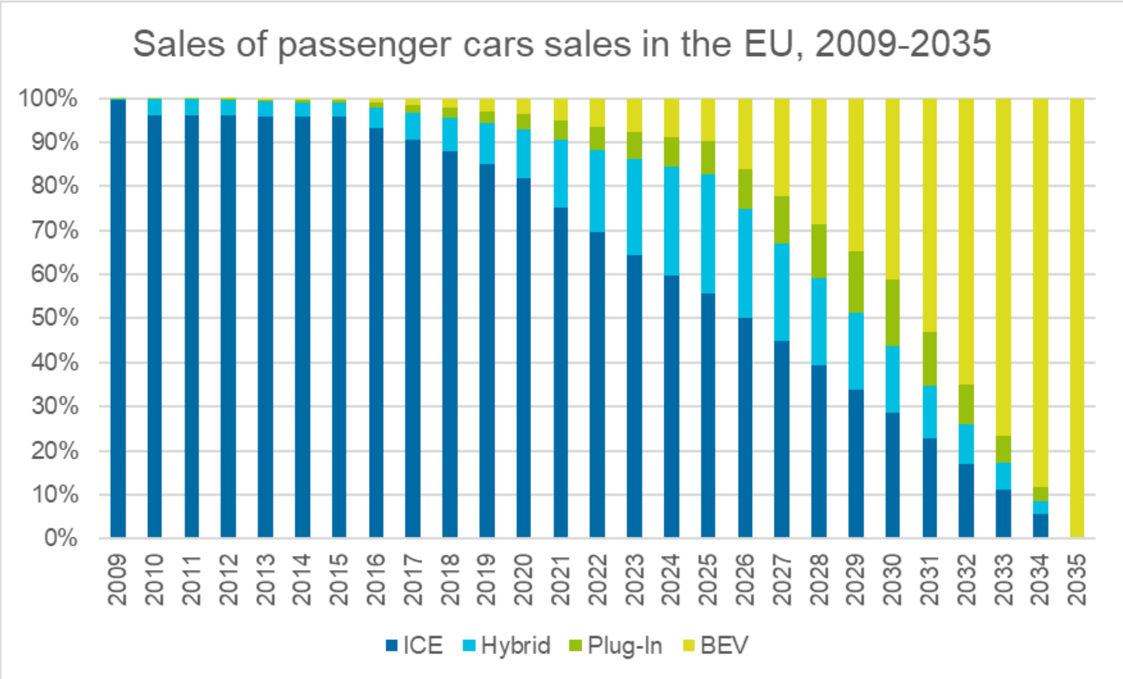
The model delivers mass flows based on the development of different types of vehicles. It includes passenger cars with a variety of different propulsion types (internal combustion

[382] https://rmis.jrc.ec.europa.eu/apps/veh/#/p/viewer

engine (ICE), hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV) and battery electric vehicles (BEV). Furthermore, the model also includes light commercial vehicles, heavy commercial vehicles and buses. The fleet model for all vehicles is based on the model used for the Euro 7 impact assessment[383]. The data were supplemented by additional information from other sources. The overall development has been cross-checked with scenarios used by the JRC.

The next below shows the sales of passenger cars in the EU split by propulsion types according to statistical data from ACEA and the predicted forecast according to Euro 7 impact assessment.

Figure 6-21 Sales of passenger cars in the EU (2009-2035)



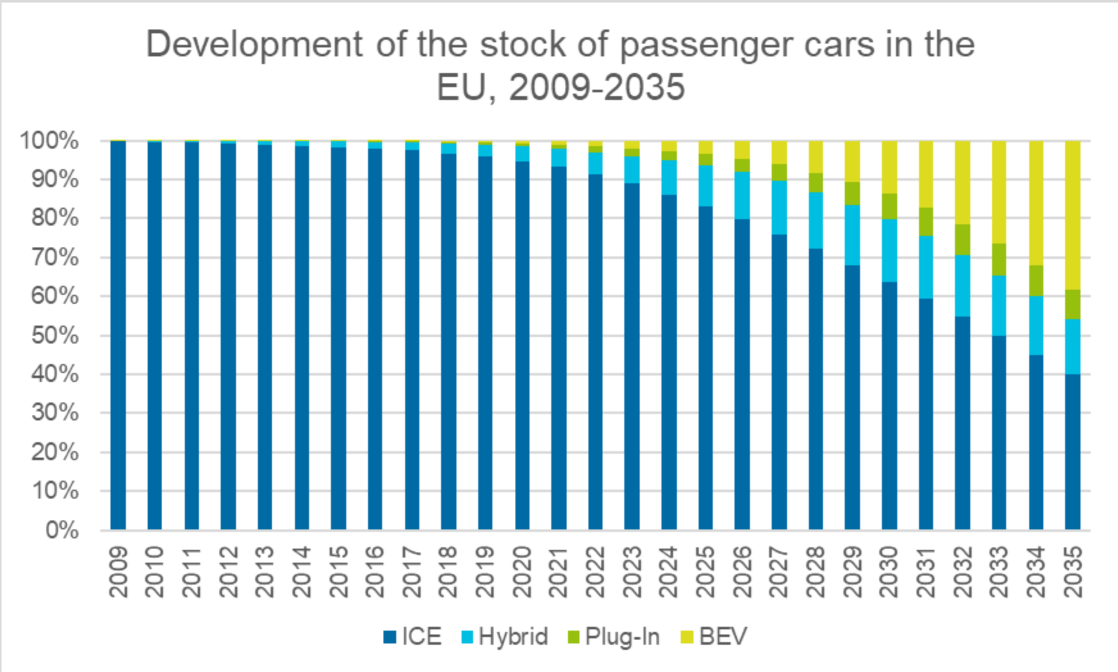
Source: Own calculation on the basis of data from Aeris Europe 2021 and ACEA 2021

Since this only covers the fraction of newly registered vehicles, the vehicle stock had to be modelled. To cover the accurate number of vehicles in the stock, the model takes into account all registrations dating back to 1990 based on ACEA data (ACEA 2009-2019, OICA 2020).

The figure below shows the development of the stock of passenger cars in the EU split by propulsion types.

[383] Aeris Europe: Euro 7 Impact Assessment: The outlook for air quality compliance in the EU and the role of the road transport sector. 2021. Online available under https://aeriseurope.com/papers-and-articles/euro-7-impact-assessment-the-outlook-for-air-quality-compliance-in-the-eu-and-the-role-of-the-road-transport-sector/

Figure 6-22 Development of the stock of passenger cars int the EU



Source: Own calculation on the basis of data from Aeris Europe 2021 and ACEA 2021

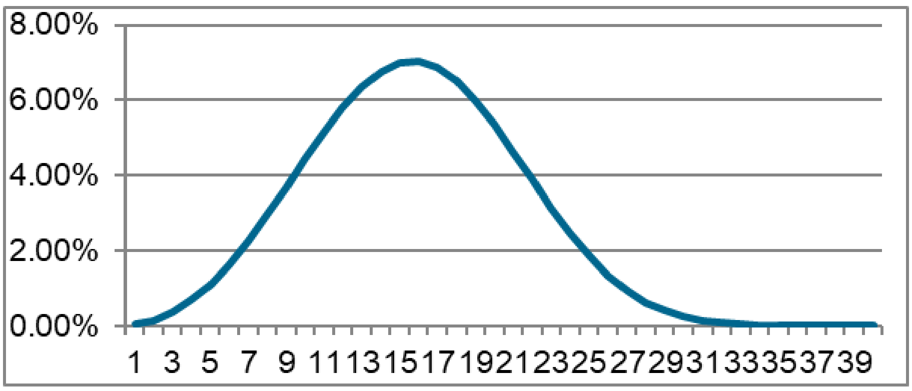
6.9.2.4 EoL

In order to determine volumes of ELVs, it is necessary to estimate the duration of the use phase of the vehicles.

To describe the probability of a vehicle reaching its end-of-life, a Weibull distribution has been used. Since no long-term data on the lifetimes of EVs are currently available, estimates based on literature, interviews with the automotive industry and own expert judgement have been used to determine reasonable assumptions for the lifetime of EVs (Ricardo 2015, Møller Andersen 2008, Buchert et al. 2017, Buchert et al 2019, Mehlhart et al. 2017).

The figure below depicts the curve used for ICEs, EVs, PHEVs and HEVs. The distribution shows the probability of the number of years after which a newly registered vehicle reaches its end of life. Accordingly, e.g. 14% of all vehicles that have been registered 15 years ago will reach the EoL.

Figure 6-23 EoL Weibull distribution for vehicles



Source: Own representation

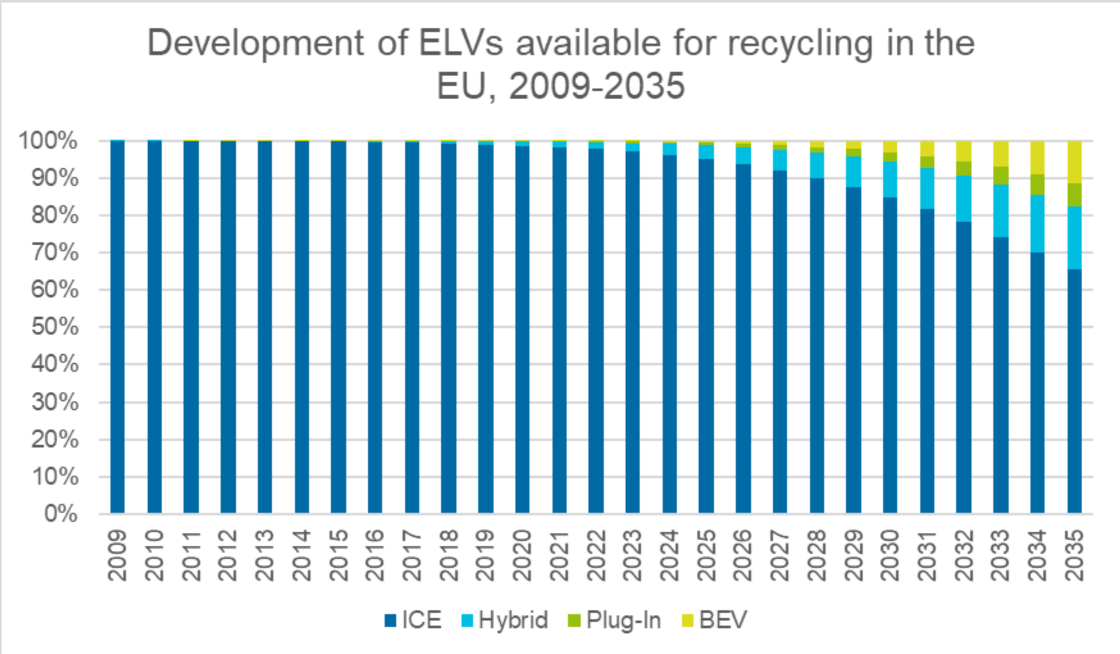
The model calculates the volumes of ELVs for each year based on the lifetime distribution shown above. This represents the total volume of ELVs available for collection.

6.9.2.5 ELVs available for recycling in the EU

The total volume available for recycling in the case of ELVs is reduced due to some losses. There are two main types of losses. Firstly, export losses and secondly, unknown whereabouts.

In the assessment report of the ELV directive, Mehlhart et al. (2017) pointed out that in 2014 app. 12 million vehicles were estimated to become ELVs in the EU, 51% of which were reported. App. 10 % of the used vehicles were exported (outside the EU) and 39 % had unknown whereabouts. It is assumed that half of the unknown were exported to non-Community countries and half were dismantled within the EU without reporting. This assumption leads to an estimated export rate of 35 % which has been used for the baseline for HEVs and PHEVs since these vehicles are similar to ICEVs. BEVs, on the other hand, are expected to be exported to a lesser extent, since they require a charging infrastructure which is not available in all countries outside the EU. Hence, the export rate applied for used BEVs is 10 %. The figure below shows the development of ELVs available for recycling in the EU split by split by propulsion types.

Figure 6-24 Development of ELVs available for recycling in the EU



Source: Own calculation on the basis of data from Aeris Europe 2021 and ACEA 2021

Table 6-35 ELVs available for treatment (PTW, lorries, buses, trailers)

EoL	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
motorcycles	1336572	1362667	1388348	1413449	1437763	1461075	1483176	1503903	1523145	1540863	1557104
lorries	212025	216992	222048	227193	232418	237708	243023	248291	253441	258410	263158
buses	28061	28449	28822	29182	29527	29859	30177	30483	30780	31070	31359
Trailers	1007722	1039377	1072220	1106517	1142498	1180362	1220275	1262369	1306737	1353423	1402422

Source: Calculated as M1 and N1 ELVs based on stock data from the PRIMES model for lorries and buses, calculated based on Eurostat and linear forecast according to development from 2015-2019 for trailers; calculated based on Eurostat using the trend in the EU Reference Scenario for PTW.

6.9.3 Reuse

In case of reused parts or materials in the model Since the model includes detailed information related to material compositions of the different vehicles, it allows for the estimation of recycling potentials. In the case of reused parts, an environmental credit is calculated based on the environmental burdens of primary production of the corresponding material.

6.9.4 Recycling

Since the model includes detailed information related to material compositions of the different vehicles, it allows for the estimation of recycling potentials.

The recycling of the end-of-life vehicles is modelled in different steps: depollution, dismantling, shredding, post-shredder technologies (PST) and material specific recycling processes. The steps of depollution, dismantling and shredding were modelled using data from Sander et al. (2020). The PST was calculated using data from JRC.

The following table shows the efficiency rates for different materials that have been used in the model. In the second column (‘Recycling rate (ASR + PST)’) recovery rates from shredder (ASR) and post shredder treatment (PST) from literature and interviews are given for different materials. In the third column (‘Recycling rate (specific process)’) recovery rates for the materials specific recycling processes are given, e. g. the recovery rate for steel recycling in an electric arc furnace. The percentages refer to the input that goes into the shredding process and the specific recycling process, respectively, not to the original composition of the ELVs.

The efficiency rates here only include those quantities that were recovered as material, not of those quantities where, for example, glass was used for backfilling or aluminium was used as a reducing agent in steel recycling.

Table 6-36 Efficiency rates for different materials in ASP + PST and in the material specific recycling processes

Material	Efficiency rates (ASR + PST)	Efficiency rates (specific process)
Steel	99%	88.0%
Cast Iron	99%	88.0%
Wrought Aluminium	85%	94.5%

Cast Aluminium	85%	94.5%
Copper	85%	76.3%
Glass	0%	99.5%
Average Plastics	24%	95.0%
PP	40%	95.0%
PUR	0%	95.0%
Nylon	0%	95.0%
PE	40%	95.0%
ABS	37%	95.0%
PET	0%	95.0%

Source: Recycling rates ASR: own estimations according to data from Sander et al. 2020; PST: JRC 2021; Materials specific recycling rates: ecoinvent 3.8

6.9.5 LCA data

The calculation of the environmental impacts of ELVs takes into account different life cycle stages, including upstream processes. Results are generated according to different environmental impact categories. The calculation presented in this study is based on the ecoinvent database (ecoinvent 3.8), the "openLCA" (openLCA 2022) LCA tool and further literature data. The quantification of environmental impacts of ELVs focuses on material production (incl. upstream processes such as mining and further processing, regardless of whether inside or outside the EU) and the recycling of the end-of-life vehicles. Detailed results of the calculations are presented for selected impact categories in Table 6-40 to Table 6-43.

The following sections describe the applied methodology and main assumptions used for quantifying the environmental impacts of batteries.

Generally, quantifications for this simplified approach could not be newly developed within the scope of this study. This means that no primary data, e.g. from producers or recyclers, were collected and no new and detailed LCA was developed for individual production and recycling processes, but rather LCA data were extracted from literature sources. The calculation presented is based on these literature data and the ecoinvent database (ecoinvent 3.8).

Although much literature is available addressing the environmental impacts of ELVs, its usability for the present calculation is limited for various reasons, including:

- the level of detail is not sufficient to extract relevant data;
- different functional units are applied;
- relevant input factors are not compatible to the scope of the present calculation; and/or
- results are given in aggregated parameters instead of individual impact categories.

A full range of environmental impacts is directly linked to the mass flows in the model. The total environmental impacts are proportional to the mass flows and are calculated via the model for the different policy options. The main environmental impact category that was evaluated via the model and addressed in the report is climate change (global warming potential GWP in kg CO_2-eq.).

A further 10 environmental impact categories can be called up via the model:

Abiotic depletion potential of mineralic resources ($ADP_{elem.}$ in kg Sb eq.)
Abiotic depletion of fossil fuels (ADP in MJ)
Acidification (AP in kg SO_2 eq.)

Eutrophication potential (EP in kg PO_4---eq.)
Fresh water aquatic ecotoxicity (FAET in kg 1,4-DB eq.)
Human toxicity (in kg 1,4-DB eq.)
Marine aquatic ecotoxicity (MAET in kg 1,4-DB eq.)
Ozone layer depletion potential (ODP in kg CFC-11 eq.)
Photochemical oxidation (POCP in kg C2H4 eq.)
Terrestrial ecotoxicity (TET in kg 1,4-DB eq.)

The impacts are linked to individual life cycle stages of the mass flows as described above for the example of the production footprint linked to 'placed on the market'. Other life cycle stages with relevant environmental impacts are 'recycling' and a comparison of the production of primary and secondary materials (e.g. steel, aluminium, copper, plastics).

The primary production of vehicles was calculated from the material composition of the vehicles with data for the primary production of these materials and the energy and material demand for the manufacturing of the vehicles.

The recycling was calculated from the energy and material demand for the recycling process and the refining of the recovered materials. Credits for the recovered materials were given for the avoided primary production.

The data for the primary production and the recycling was taken from the LCA database ecoinvent 3.8 and specific LCA studies and supplemented by information from the stakeholder surveys. Data and the data sources, which have been used for the modelling of the primary production of materials and the recycling of the vehicles used, are listed in the following tables.

Table 6-37 LCA data: Used datasets from ecoinvent 3.8 for primary production of materials

Material	Used dataset from ecoinvent 3.8 for primary production
Steel	steel production, converter, low-alloyed | APOS, U
Stainless Steel	market for steel, chromium steel 18/8, hot rolled | APOS, U - GLO
Cast Iron	market for cast iron | APOS, U | GLO
Wrought aluminium	aluminium ingot, primary, to aluminium, wrought alloy market | APOS, U
Cast aluminium	aluminium ingot, primary, to aluminium, cast alloy market | APOS, U | GLO
Copper	market for copper, cathode | APOS, U | GLO
Glass	market for flat glass, uncoated | APOS, U - RER
Zinc	market for zinc | APOS, U | GLO
Magnesium	market for magnesium | APOS, U - GLO
ABS	market for acrylonitrile-butadiene-styrene copolymer | APOS, U - GLO
Liquid Epoxy	market for epoxy resin, liquid | APOS, U | RER
GPPS	polystyrene production, general purpose | APOS, U | RER
HIPS	polystyrene production, high impact | APOS, U | RER
HDPE	market for polyethylene, high density, granulate | APOS, U - GLO
LDPE	market for polyethylene, low density, granulate | APOS, U - GLO
LLDPE	market for polyethylene, linear low density, granulate | APOS, U > GLO

Nylon 6	market for nylon 6 | APOS, U - RER
Nylon 66	market for nylon 6-6 | APOS, U | RER
PC	market for polycarbonate | GLO
PET	market for polyethylene terephthalate, granulate, amorphous | APOS, U - GLO
PP	market for polypropylene, granulate | APOS, U - GLO
PUR Flexible Foam	market for polyurethane, flexible foam | APOS, U - RER
PUR Rigid Foam	market for polyurethane, rigid foam | APOS, U - RER
PVC	market for polyvinylchloride, suspension polymerised | APOS, U - GLO
Rubber	market for synthetic rubber | APOS, U - GLO
Carbon Fiber-Reinforced Plastic	market for carbon fibre reinforced plastic, injection moulded | APOS, U | GLO
Glass Fiber-Reinforced Plastic	market for glass fibre reinforced plastic, polyester resin, hand lay-up | APOS, U - GLO
Nickel	market for nickel, class 1 | APOS, U | GLO
PTFE	market for tetrafluoroethylene film, on glass | APOS, U | GLO
Platinum	market for platinum | APOS, U - GLO
Silicon	market for silicone product | APOS, U | RER
Gold primary	market for gold | APOS, U
Silver primary	market for silver | APOS, U
Tin primary	market for tin | APOS, U
Brass primary	brass production | APOS, U
Palladium primary	market for palladium | APOS, U

Table 6-38 LCA data: Used datasets from ecoinvent 3.8 for secondary production of materials

Material	Used dataset from ecoinvent 3.8 for secondary production
Steel	steel production, electric, low-alloyed | APOS, U
Wrought aluminium	treatment of aluminium scrap, wrought alloy, post-consumer, prepared for recycling, at remelter | aluminium, | APOS, U
Cast aluminium	treatment of aluminium scrap, cast alloy, post-consumer, prepared for recycling, at refiner | APOS, U
Copper	treatment of copper scrap by electrolytic refining | APOS, U
Glass	(Own LCA for glass recycling with confidential data from industry)
HDPE	polyethylene production, high density, granulate, recycled | polyethylene, high density, granulate, recycled | APOS, U
PET	polyethylene terephthalate production, granulate, amorphous, recycled | polyethylene terephthalate, granulate, amorphous, recycled | APOS, U
Platinum	treatment of automobile catalyst | platinum | APOS, U

Table 6-39 LCA data: Used datasets from ecoinvent 3.8 for different process steps

Used dataset from ecoinvent 3.8 for different process steps
passenger car production, petrol / natural gas | APOS, U
passenger car production, electric, without battery | APOS, U
market for sheet rolling, steel | APOS, U - GLO
market for sheet rolling, aluminium | APOS, U - GLO
market for wire drawing, copper | APOS, U - GLO
market for tempering, flat glass | APOS, U - GLO
market for coating powder | APOS, U - RER
market for light emitting diode | APOS, U - GLO
market for lubricating oil | APOS, U - RER
market for printed wiring board, mounted mainboard, desktop computer, Pb free | APOS, U - GLO
treatment of waste plastic, mixture, municipal incineration | waste plastic, mixture | APOS, U
market group for electricity, medium voltage | electricity, medium voltage | APOS, U - GLO
market group for heat, district, or industrial, natural gas | heat, district or industrial, natural gas | APOS, U - GLO
market group for heat, district or industrial, other than natural gas | heat, district or industrial, other than natural gas | APOS, U - GLO

Table 6-40 LCA data: Primary production of materials I

Impact category	Unit	Steel	Stainless Steel	Cast Iron	Wrought aluminium	Cast aluminium	Copper	Glass	Rubber	Carbon Fiber-Reinforced Plastic	Glass Fiber-Reinforced Plastic	PTFE	Silicon
Abiotic depletion	kg Sb eq	3.4E-05	1.6E-04	5.9E-06	1.9E-05	1.9E-05	2.4E-03	8.3E-06	4.9E-05	2.2E-04	3.5E-05	2.3E-04	2.5E-05
Abiotic depletion (fossil fuels)	MJ	1.9E+01	4.6E+01	1.8E+01	1.8E+02	1.8E+02	6.8E+01	1.0E+01	7.4E+01	8.9E+02	5.8E+01	1.3E+02	4.5E+01
Acidification	kg SO_2 eq	7.3E-03	2.4E-02	6.3E-03	1.1E-01	1.1E-01	1.0E-01	8.4E-03	1.3E-02	4.0E-01	1.8E-02	5.5E-02	1.2E-02
Eutrophication	kg PO_4--- eq	3.8E-03	7.6E-03	2.7E-03	2.7E-02	2.7E-02	3.8E-01	1.1E-03	3.8E-03	1.2E-01	5.7E-03	1.4E-02	4.0E-03
Fresh water aquatic ecotox.	kg 1,4-DB eq	6.0E+00	1.5E+01	1.4E+00	1.4E+01	1.4E+01	7.7E+02	2.5E-01	1.3E+00	3.6E+01	1.5E+00	7.8E+00	1.7E+00
Global warming (GWP100a)	kg CO_2 eq	2.1E+00	4.4E+00	1.8E+00	1.9E+01	1.9E+01	6.5E+00	9.7E-01	2.7E+00	8.3E+01	3.9E+00	1.3E+02	2.9E+00
Human toxicity	kg 1,4-DB eq	3.2E+00	7.7E+01	1.6E+00	1.2E+01	1.2E+01	1.2E+03	3.7E-01	1.8E+00	3.2E+01	4.7E+00	3.0E+01	1.6E+00
Marine aquatic ecotoxicity	kg 1,4-DB eq	7.0E+03	1.7E+04	2.7E+03	5.6E+04	5.6E+04	8.7E+05	1.4E+03	2.9E+03	1.1E+05	4.4E+03	2.6E+05	7.4E+03
Ozone layer depletion (ODP)	kg CFC-11 eq	9.2E-08	1.9E-07	8.7E-08	5.8E-07	5.8E-07	4.0E-07	9.3E-08	5.3E-07	2.0E-06	3.5E-07	4.3E-03	1.9E-06
Photochemical oxidation	kg C_2H_4 eq	9.5E-04	1.1E-03	8.1E-04	6.7E-03	6.7E-03	2.0E-03	2.7E-04	7.0E-04	1.8E-02	1.1E-03	4.4E-03	7.1E-04
Terrestrial ecotoxicity	kg 1,4-DB eq	2.3E-03	7.5E-02	6.6E-02	3.5E-02	3.5E-02	1.5E-01	6.6E-04	3.8E-03	2.5E-01	5.6E-03	2.0E-02	5.1E-03

Table 6-41 LCA data: Primary production of materials II

Impact category	Unit	ABS	Liquid Epoxy	GPPS	HIPS	HDPE	LDPE	LLDPE	Nylon 6	Nylon 66	PC	PET	PP
Abiotic depletion	kg Sb eq	2.8E-06	5.5E-05	4.4E-07	4.4E-07	1.4E-05	1.4E-05	1.5E-05	6.5E-05	3.0E-06	1.7E-06	3.7E-05	1.4E-05
Abiotic depletion (fossil fuels)	MJ	8.7E+01	8.0E+01	7.8E+01	7.8E+01	7.1E+01	7.3E+01	7.0E+01	1.0E+02	1.1E+02	9.2E+01	6.8E+01	7.3E+01
Acidification	kg SO_2 eq	1.3E-02	1.7E-02	1.1E-02	1.2E-02	7.8E-03	8.7E-03	7.5E-03	3.0E-02	2.9E-02	2.5E-02	1.1E-02	7.6E-03
Eutrophication	kg PO4--- eq	2.2E-03	6.9E-03	9.4E-04	9.9E-04	2.0E-03	2.6E-03	2.0E-03	6.8E-03	7.7E-03	2.5E-03	3.1E-03	1.9E-03
Fresh water aquatic ecotox.	kg 1,4-DB eq	4.7E-01	3.6E+00	6.8E-01	6.7E-01	6.3E-01	7.5E-01	6.4E-01	3.0E-01	2.5E-01	2.2E-01	1.2E+00	6.1E-01
Global warming (GWP100a)	kg CO_2 eq	4.5E+00	4.6E+00	3.6E+00	3.6E+00	2.3E+00	2.5E+00	2.2E+00	9.1E+00	8.1E+00	8.1E+00	3.1E+00	2.3E+00
Human toxicity	kg 1,4-DB eq	4.1E-01	8.0E+00	3.5E-01	3.8E-01	8.4E-01	9.4E-01	9.8E-01	4.6E-01	4.2E-01	4.2E-01	2.1E+00	7.9E-01
Marine aquatic ecotoxicity	kg 1,4-DB eq	1.6E+03	4.7E+03	3.7E+03	3.6E+03	1.5E+03	1.9E+03	1.4E+03	1.4E+03	1.1E+03	9.0E+02	2.7E+03	1.4E+03
Ozone layer depletion (ODP)	kg CFC-11 eq	7.5E-08	6.5E-07	2.9E-09	3.4E-09	5.2E-08	4.7E-08	6.0E-08	1.2E-08	7.4E-09	1.7E-08	1.0E-05	3.9E-08
Photochemical oxidation	kg C_2H_4 eq	7.5E-04	2.3E-03	7.5E-04	7.3E-04	6.8E-04	1.4E-03	5.6E-04	1.4E-03	1.4E-03	1.4E-03	6.8E-04	4.4E-04
Terrestrial ecotoxicity	kg 1,4-DB eq	1.3E-03	6.4E-03	5.4E-04	6.7E-04	1.5E-03	2.1E-03	1.5E-03	9.6E-04	7.0E-04	2.7E-02	4.0E-03	1.3E-03

Table 6-42 LCA data: Primary production of materials III

Impact category	Unit	PUR Flexible Foam	PUR Rigid Foam	PVC	Zinc	Magnesium	Nickel	Platinum	Gold	Silver	Tin	Brass	Palladium
Abiotic depletion	kg Sb eq	1.4E-05	6.8E-05	3.7E-05	1.5E-03	5.2E-05	2.2E-03	3.6E+00	6.1E+01	8.5E-01	2.7E-02	9.4E-03	8.9E-01
Abiotic depletion (fossil fuels)	MJ	8.2E+01	9.8E+01	5.0E+01	3.1E+01	1.1E+03	2.3E+02	1.0E+06	5.7E+05	5.8E+03	1.2E+02	8.0E+01	1.9E+05
Acidification	kg SO_2 eq	2.2E-02	2.6E-02	8.9E-03	2.2E-02	2.3E-01	1.8E+00	4.1E+03	3.8E+02	4.9E+00	9.8E-02	3.4E-01	2.0E+03
Eutrophication	kg PO_4--- eq	5.5E-03	1.1E-02	3.2E-03	1.3E-02	1.6E-01	6.4E-02	4.5E+02	5.8E+02	4.8E+00	9.1E-02	1.1E-01	6.9E+01
Fresh water aquatic ecotox.	kg 1,4-DB eq	1.5E+00	3.0E+00	1.3E+00	1.2E+01	2.9E+01	1.6E+02	2.8E+05	7.5E+05	5.6E+03	8.1E+01	1.9E+02	5.0E+04
Global warming (GWP100a)	kg CO2 eq	5.2E+00	5.0E+00	2.4E+00	2.7E+00	4.5E+01	1.8E+01	6.9E+04	4.9E+04	5.0E+02	1.0E+01	6.6E+00	1.3E+04
Human toxicity	kg 1,4-DB eq	9.7E-01	4.2E+00	1.8E+00	1.1E+01	8.3E+01	1.2E+02	2.3E+05	6.7E+05	4.9E+03	6.8E+01	3.4E+02	3.9E+04
Marine aquatic ecotoxicity	kg 1,4-DB eq	6.6E+03	7.1E+03	2.8E+03	3.6E+04	6.6E+04	1.5E+05	3.9E+08	1.2E+09	7.3E+06	9.2E+04	2.3E+05	6.6E+07
Ozone layer depletion (ODP)	kg CFC-11 eq	2.6E-08	8.2E-07	1.1E-06	1.7E-07	5.9E-06	1.7E-06	3.3E-03	2.9E-03	5.2E-05	5.8E-07	9.8E-07	3.0E-03
Photochemical oxidation	kg C_2H_4 eq	1.0E-03	4.9E-03	5.0E-04	7.1E-04	3.4E-02	8.5E-02	1.4E+02	1.2E+01	1.6E-01	2.9E-03	1.3E-02	7.9E+01
Terrestrial ecotoxicity	kg 1,4-DB eq	5.5E-03	1.4E-02	3.8E-03	1.8E-02	4.1E-02	3.1E-01	2.5E+02	9.7E+02	3.8E+00	7.4E-02	2.2E-01	4.6E+01

Table 6-43 LCA data: Secondary production of materials

Impact category	Unit	Steel	Aluminium wrought alloy	Aluminium cast alloy	Glass	HDPE	PET	Platinum
Abiotic depletion	kg Sb eq	1.1E-05	1.9E-04	7.5E-05	4.2E-08	7.0E-06	6.1E-06	7.2E-01
Abiotic depletion (fossil fuels)	MJ	6.6E+00	3.6E+01	6.4E+01	1.6E-01	4.7E+00	8.0E+00	2.0E+05
Acidification	kg SO_2 eq	2.6E-03	1.6E-02	3.0E-02	3.5E-05	1.9E-03	2.5E-03	1.5E+02
Eutrophication	kg PO_4--- eq	1.6E-03	7.2E-03	8.4E-03	5.8E-05	4.1E-03	2.3E-03	4.1E+01
Fresh water aquatic ecotox.	kg 1,4-DB eq	1.9E+00	5.0E+00	3.3E+00	1.1E-02	2.1E+00	8.1E+00	9.4E+04
Global warming (GWP100a)	kg CO2 eq	6.4E-01	3.5E+00	4.2E+00	1.4E-02	4.9E-01	8.2E-01	1.8E+04
Human toxicity	kg 1,4-DB eq	1.5E+00	4.3E+00	3.7E+00	7.5E-03	1.4E+00	1.6E+00	8.4E+04
Marine aquatic ecotoxicity	kg 1,4-DB eq	2.3E+03	1.1E+04	6.0E+03	2.4E+01	9.5E+03	4.2E+04	6.4E+07
Ozone layer depletion (ODP)	kg CFC-11 eq	4.8E-08	1.7E-07	2.1E-06	1.2E-09	3.7E-08	6.6E-08	1.6E-03
Photochemical oxidation	kg C_2H_4 eq	1.4E-04	2.8E-03	1.4E-03	1.4E-06	1.2E-04	1.5E-04	8.8E+00
Terrestrial ecotoxicity	kg 1,4-DB eq	2.3E-03	2.1E-02	5.6E-02	3.4E-05	1.2E-02	4.9E-03	6.6E+01

6.10 Ad-hoc contributions to the impact assessment of the EC: Further details on economic impacts of measures related to the proposed scope extension

6.10.1 Background

The purpose of this ad-hoc contribution to the impact assessment of the EC is to provide further details on economic impacts of potential measures related to a proposed scope extension:

- Mandatory treatment of additional vehicle categories at ATFs
- Roadworthiness certificate with implication on exports
- Minimum requirements for the extended producer responsibility for L-category vehicles, lorries, buses, and trailers
- Advanced waste treatment requirements of the mandatory removal prior to shredding/PST (example of glass)

6.10.2 Measure "Roadworthiness certificate with implication on exports"

6.10.2.1 Overview of the total exports for categories considered for the scope extension

Available data provided by Eurostat for the relevant categories are displayed in Table 6-44.

Table 6-44 Total Export (used and new) of HDV from EU27 to extra EU27 in 2022

	CN code	Million Euro	Distinction of new and used possible
Total export: „vehicles for the transport of goods"	8704	14 677	No
Thereof			
"diesel or semi-diesel engine" of a gross vehicle weight <= 5 t	870421	6 431	Yes
park-ignition internal combustion piston engine, of a gross vehicle weight <= 5 t	870431	496	Yes
"diesel or semi-diesel engine" of a gross vehicle weight > 5 t but <= 20 t	870422	1 832	Yes
"diesel or semi-diesel engine" of a gross vehicle weight > 20 t	870423	4 330	Yes
with spark-ignition internal combustion piston engine, of a gross vehicle weight > 5 t	870432	21	Yes
Dumpers for off-highway use	870410	763	no
Others	difference	801	no

Source: Eurostat

Note (1) for the green cells: The vehicles with a weight of up to 5 t are considered as N1[384], accordingly exports of 6 928 million € are considered under the IA for the existing scope and not under the scope extension.

[384] Unfortunately the Eurostat definitions do not exactly match with the vehicle categories: N1 vehicles have a maximum gross weight of 3.5 tons.

Note (2) For off-road-dumpers and „others“ Eurostat does not provide detailed information on the share / value of used vehicles therefore no detailed economic impact assessment regards economic impacts of the exports of used vehicles can be derived.

Table 6-45 Total Export (used and new) of trailers from EU27 to extra EU27 in 2022

	CN code	Million Euro	Distinction of new and used possible
Total export: „Trailers and semi-trailers“	87163930, 87163950, 87163980	1 577	Yes

Source: Eurostat

Table 6-46 Total Export (used and new) of buses from EU27 to extra EU27 in 2022

	CN code	Million Euro	Distinction of new and used possible
Total export: „Motor vehicles for the transport of >= 10 persons, incl. driver “	8702	800	Yes

Source: Eurostat

For the L-type approved vehicles according to Regulation (EU) No 168/2013, Eurostat does not provide information on export of used L-type vehicles.

6.10.2.2 Methodology to assess the share of vehicles which might not pass the future requirement of a valid roadworthiness certificate

The vehicle categories 870422, 870423, 870432, 871639xx and 8702 (highlighted in the above tables in blue) are assessed at the level of the 8-digit CN-codes with the following approach:

1. Identification of the average value of the intra EU trade with new vehicles per CN code as displayed in Table 6-47.
2. Definition of a function on the share of non-eligible vehicles, depending on the distance to the average value of a new vehicle as displayed in the Figure 6-25.
3. Calculation of the number of non-exportable vehicles with the above function.
4. Estimation for the economic impact.

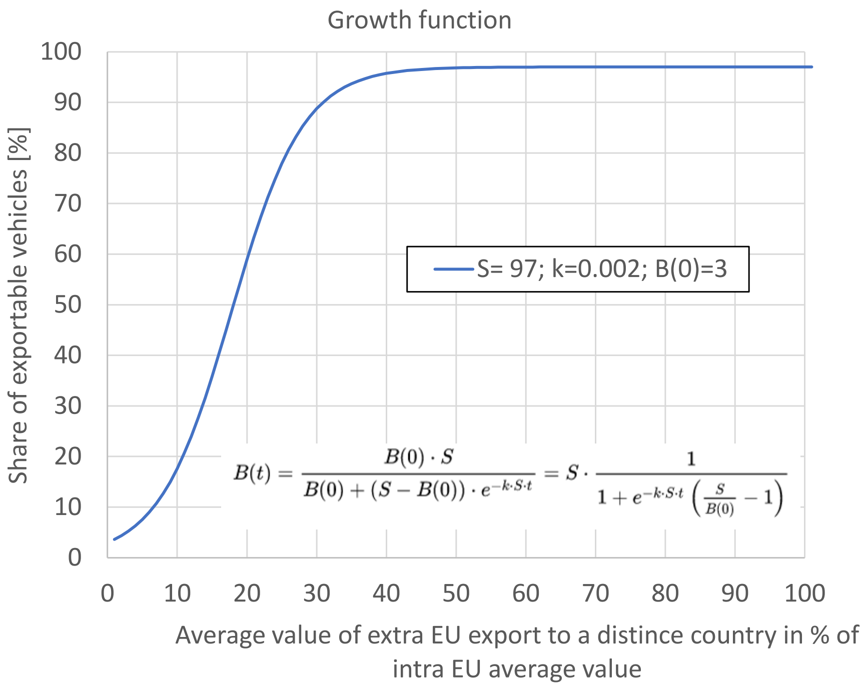
Table 6-47 Average value per vehicle of the intra-EU trade with new vehicles per CN code

		Intra EU trade	
	CN code	Euro per new vehicle	Numbers per year
Motor Vehicle for the transport of goods			
"diesel or semi-diesel engine" of a gross vehicle weight > 5 t but <= 20 t, new	87042291	51 285	62 340
"diesel or semi-diesel engine" of a gross vehicle weight > 20 t, new	87042391	94 706	39 687
with spark-ignition internal combustion piston engine, of a gross vehicle weight > 5 t, new	87043291	72 604	276
„Trailers and semi-trailers“, new	87163930 87163950	9 229	369 771
„Motor vehicles for the transport of >= 10 persons, incl. driver“,			
diesel engine, >2500cm³, new	87021011	156 873	16 075
diesel engine, <u><</u>2500cm³, new	87021091	50 290	4 906
with spark-ignition internal combustion piston engine, > 2.800 cm³, new	87029011	87 088	1 028
with spark-ignition internal combustion piston engine, <u><</u> 2.800 cm³, new	87029031	22 026	109

Source: Eurostat

Note: Average per year for the period 2013-2022 (10 years)

Figure 6-25 Function on the share of non-eligible vehicles per country, depending on the distance to the average value of a new vehicle



Source: own calculations

The function displayed above includes the following logic:

The share of exportable vehicles is assessed for each receiving extra EU country. If the average value of the exported vehicle is close to the average value of the intra EU trade, then it is assumed that the majority is in good condition and can have or get a roadworthiness certificate. However, we consider a certain maximum share as exportable as the field experience demonstrates that we will find in any cross border here and there also an ELV (this applies for intra EU trade too). E.g. if the average value per vehicle of the exports to a receiving country is more than 50% of the average value per vehicle of the intra EU trade than we assume a maximum number of exportable vehicles of 97% (S=97).

When the average value of the exported vehicle falls below 25% of the value of the intra EU trade value per vehicles we see a sharp decline in the share of exportable vehicles. But even if the average per vehicle might be very low, there might be a number of new vehicles included in the trade. E.g. if the average value per vehicle of the exports to a receiving country is about 10% of the average value per vehicle of the intra EU trade than we assume that still a share of 18% could have or get a roadworthiness certificate and can be exported.

When applying this logic for each receiving non-EU country the overall results for the total export are displayed in the table below.

Table 6-48 Average number of exportable and non-exportable vehicles depending on the average value of the exported HDVs, trailers and buses

		Extra EU-trade	
	CN code	Exportable	Non-Exportable
Motor Vehicle for the transport of goods		**41 975**	**52 243**
"diesel or semi-diesel engine" of a gross vehicle weight > 5 t but <= 20 t, used	87042299	21 585	42 312
"diesel or semi-diesel engine" of a gross vehicle weight > 20 t, used	87042399	8 477	6 684
with spark-ignition internal combustion piston engine, of a gross vehicle weight > 5 t, used	87043299	11 913	3 248
„Trailers and semi-trailers“, used	87163980	58 064	3 440
„Motor vehicles for the transport of >= 10 persons, incl. driver“,		**2 516**	**4 253**
diesel engine, >2500cm^3, new	87021019	1 859	3 131
diesel engine, ≤2500cm^3, new	87021099	562	1 055
with spark-ignition internal combustion piston engine, > 2.800 cm^3, new	87029019	95	67
with spark-ignition internal combustion piston engine, ≤ 2.800 cm^3, new	87029039	*	*

Source: own calculations

** = not sufficient data available*

Note: Average per year for the period 2013-2022 (10 years)

6.10.2.3 Economic impacts for exporters

Considering an assumed profit (not turnover) of 500 to 1000 € per vehicle for the exporter in Europe. This might cause a reduction of profits for these exporters of about:

- 26 to 52 million € per year for exporters of HDV.
- 1.7 to 3.4 million € per year for exporters of trailers
- 2.1 to 4.3 million per year for exporters of buses

Validity of the estimation

Underestimation

An underestimation might be caused, as the results are based on export data as available from Eurostat (COMEXT) and not all exports might be reported to customs services.

Overestimation

The economic impact might be an overestimation as the reduction in exports of very old and cheap HDV, trailers and buses might be compensated by the following to effects:

- As there is a demand for spare parts for such (very) old vehicles in the receiving countries, the functional / usable spare parts might be dismantled in Europe and shipped to the receiving counties.
- As the demand for used (and cheaper) HDVs trailers and buses in the receiving countries will continue, the exporters might shift to (younger, better) HDVs, trailers and buses, which will have a roadworthiness certificate when being exported.

Conclusion

We assess that the market flexibility, expressed in the section on overestimation, is dominating the statistical effects described in the section on underestimation above. Therefore, it is likely that the negative impacts described in Section 6.10.2.3 represent an overestimation (worst case scenario) and the impacts are less harmful to the exporters.

6.10.2.4 Economic impacts for recyclers

Considering a functioning market for very old used trucks and buses we assume that the profits for the recyclers are lower than the profits for the exporters and thus exporters are capable to pay higher prices to the last owner in the EU. Thus we consider additional profits for the recycling sector of 400 to 800 € per vehicle which might be in addition recycled in the EU.

This might cause an increase in profits for recyclers of about:

- 21 to 42 million € per year for exporters of HDV.
- 1.4 to 2.7 million € per year for exporters of trailers
- 1.7 to 3.4 million per year for exporters of buses

Validity of the estimation

Underestimation

The profit might be underestimated and closer to the profits of the exporters.

Overestimation

The economic impact might be less, as the reduction in exports of very old and cheap HDV, trailers and buses might be compensated by the following to effects:

- As the demand for used (and cheaper) HDVs trailers and buses in the receiving countries will continue, the exporters might shift to (younger, better) HDVs, trailers and buses, which will have a roadworthiness certificate when being exported. In result the recyclers do not receive the estimated additional number of vehicles

Conclusion

The positive impacts might be less relevant. As the impacts on exporters and recyclers have a strong relation the difference in the impacts on exporters and recyclers will remain stable. This difference reflects the profit achieved with substandard exports.

6.10.3 Measure "Mandatory treatment of additional vehicle categories at ATFs"

6.10.3.1 Methodology & assumptions

Table 6-49 Methodology and key assumptions for calculating costs and revenues of mandatory treatment of additional vehicle categories at ATFs

Revenue of ATFs	- Tonnage of different materials which in addition compared to the baseline is sent to reuse * Revenues for reuse for these materials - Tonnage of hulk which in addition compared to the baseline is sent to shredders * number of EoL vehicle type
Costs of ATFs	- Dismantling time for reuse for the specific vehicle type * labour costs
Job creation at ATFs	- Total dismantling time * number of EoL vehicles / number of working days per year (assuming that 200 days/year = 1 job) - For the number of EoL vehicles: o For L-types it is assumed that a) the major share is currently taken back by dealers and then either sent to shredders or to dismantlers for further treatment, and b) the major share is not subject to exports at their EoL, i.e. there are no additional vehicles being treated at ATFs o For lorries and buses it is assumed that a) the majority is already treated in ATFs and b) they are subject to exports, i.e. only the share of EoL lorries and buses which will not get a roadworthiness certificate for export anymore will be new / in addition be treated at ATFs under this policy option.
Revenues of recyclers	- Tonnage of different materials which in addition compared to the baseline is sent to recycling * Revenues for these materials
Costs of recyclers	- No additional costs are expected. If there will be more recycling material in future for the recycling facilities due to the scope extension, then there will also be an increase in benefits/jobs; recycling facilities are already in place, i.e. they are currently cost-effective; if they would have to invest in new facilities, there would be enough recycling material so that this would be profitable again.

6.10.3.2 Calculation of costs and revenues for the scope extension to L-category vehicles

6.10.3.2.1 Input data for the calculations

The following data is used to calculate the costs for the scope extension to L-category vehicles.

Table 6-50 shows the calculated number of L-category vehicles reaching the End of Life for the different years. According to the IA supporting study (Baron et al. 2022), for PTWs there are no codes for the trade in used products, i.e., the aspect of export of 2nd-hand ("used") vehicles as part of the problem of vehicles of unknown whereabouts cannot be studied for this vehicle category. However, information from an expert interview suggests that the export of PTWs is not a business case (age of vehicles usually higher and material value being lower compared to cars). Thus, for the further calculations it is assumed that these L-categories are not a relevant subject to exports and below number of vehicles reaching EoL will be treated in the EU.

Table 6-50 Number of L-category vehicles reaching End of Life

Number of vehicles reaching EoL	2022	2025	2030	2035	2040
"Motorcycles"	1.388.348	1.461.075	1.557.104	1.624.242	1.701.058

Source: OEKO model

According to the IA supporting study (Baron et al. 2022), figures as to the numbers of PTW already treated in ATFs cannot be provided due to the lack of statistical or other quantitative data; as far as it is known, there are no specific PTW recyclers. Compared to other types of vehicles, such as cars, PTW have no chassis. Thus, a component which represents a considerable amount of vehicle's material is not available. This means that the material from PTWs that could potentially be sent to shredder after removal of components is very little. In general, car dismantlers say that they would gladly take the PTWs [if they would get them]. Standard tools can be used, dismantling is easy, no investments nor additional training of recyclers is needed. Car recyclers receive accidental PTW but not the end-of-life PTW.

According to an expert interview, for example for scooters, treatment at ATFs does not seem to take place at large scale so far as there is no system for collection and the treatment seems to be not yet profitable for ATFs; i.e., smaller EoL mopeds might be largely going into the scrap without proper treatment of fluids. On the other hand, another expert interview assumes that for the larger motorcycles, the EoL vehicles are not understood as waste by the vehicle owners but are rather brought back to the dealers in connection with replacement purchases; dealers are either dismantling components as spare parts by their own, or sending the EoL PTWs to shredders or directly to dismantlers (usually, in Member States the number of dismantling sites is much higher than the number of shredder sites, i.e. it might be less logistical effort for the dealers to send the EoL motorcycles to dismantlers).

Based on this information, it is assumed that the above number of L-category vehicles reaching EoL is already today to a relevant extent treated by ATFs, shredders and/or recyclers, i.e. there is no effect of the policy option PO6B requiring mandatory treatment of L-category vehicles in ATFs is not expected to have a considerable impact on the total number of ELVs treated.

Table 6-51 shows the calculated tonnage of materials of L-category vehicles sent to reuse building the baseline for calculations.

Table 6-51 Tonnage of materials of L-category vehicles sent to reuse (baseline)

L-types	year	year	year	year	year
tonnage of materials sent to reuse (=> ATFs) [tons]	**2022**	**2025**	**2030**	**2035**	**2040**
Steel	132136	134177	136871	142773	149525
Aluminium	86978	88313	90075	93959	98403
Iron	0	0	0	0	0
Copper	5887	5962	6060	6321	6620
Glass	537	538	539	563	589
Plastic	27709	28419	29357	30622	32071
Rubber	14008	14200	14454	15077	15790
Other	10503	10734	11040	11516	12061

Source: OEKO model

Although it is assumed that dismantling at ATFs builds a business case for reuse, there are no legal obligations in place which formally require proper treatment of L-category vehicles from ATFs. For this step, therefore, the costs for ATFs are calculated. For the dismantling time at ATFs, the same time is taken as for M1/N1 vehicles which is estimated at 60 minutes. According to an expert interview, the dismantling time of L-categories is rather similar to that of cars as also similar components have to be treated for depollution (fuel, motor oil, hydraulic oil, brake fluids etc.).

The labour cost – regardless of the vehicle type – is calculated with EUR 35 per hour.

Table 6-52 shows the calculated tonnage of materials of L-category vehicles sent to recycling, building the baseline for calculations.

Table 6-52 Tonnage of materials of L-category vehicles sent to recycling (baseline)

tonnage of materials sent to recycling [tons]	2022	2025	2030	2035	2040
Steel	92495	93924	82123	85664	89715
Aluminium	60885	61819	54045	56375	59042
Iron	0	0	0	0	0
Copper	4121	4173	3636	3793	3972
Glass	376	377	324	338	354
Plastic	19397	19893	17614	18373	19242
Rubber	14008	14200	14454	15077	15790
Other	10503	10734	11040	11516	12061

Source: OEKO model

6.10.3.2.2 Calculated costs, revenues and socio-economic impacts at ATFs for the proposed mandatory treatment of L-category vehicles

Table 6-53 summarises the calculated costs of ATFs due to the proposed measure of mandatory treatment of L-category vehicles in authorised treatment facilities, considering effectiveness rates for the effect of the policy options and expected implementation period of 5 years after entry into force (EIF).

Table 6-53 Calculated costs at ATFs due to the proposed mandatory treatment of L-category vehicles at ATFs

Costs of ATFs (EUR)	2022	2025	2030	2035	2040
L-types	- 48.592.172 €	- 51.137.612 €	- 54.498.639 €	- 56.848.473 €	- 59.537.020 €
Effectiveness rates Policy Options & Implementation		**2025**	**2030**	**2035**	**2040**
PO6B: ATF requirement effectiveness (M30a)	20%	20%	30%	40%	50%
PO6C: +EPR (M31)	12%	12%	12%	12%	12%
PO6B/PO6C: Implementation share towards +5 yrs EIF	25%	25%	50%	75%	75%
Costs of ATFs (M EUR)	**2022**	**2025**	**2030**	**2035**	**2040**
PO6B: ATF requirement effectiveness (M30a)	-2,4	-2,6	-8,2	-17,1	-22,3
PO6C: +EPR (M31)	-2,6	-4,1	-11,4	-22,2	-27,7

Source: OEKO model

It is further assumed that the recycling treatment of L-categories will not be changing under the proposed policy options compared to the current situation, assuming that all EoL L-category vehicles are already today going to recyclers.

6.10.3.3 Calculation of costs and revenues for the scope extension to HDVs (trucks)

6.10.3.3.1 Input data for the calculations

The following data is used to calculate the costs and revenues for the scope extension to HDVs. Table 6-54 shows the calculated tonnage of materials of HDVs sent to reuse. It might be underestimated as the market for used spare parts is important in the HDV segment and the assumption might even be that reuse represents a higher share than recycling (cf. Table 6-56).

Table 6-54 Tonnage of materials of HDVs sent to reuse

HDVs (trucks)	year	year	year	year	year
tonnage of materials sent to reuse (=> ATFs) [ton	**2022**	**2025**	**2030**	**2035**	**2040**
Steel	213485	228542	338917	371746	397769
Aluminium	10145	10861	16106	17666	18903
Iron	26646	28525	42301	46399	49647
Copper	7947	8508	12616	13838	14807
Glass	10598	11346	16825	18455	19747
Thermoplast	48529	51951	77041	84504	90419
Rubber	0	0	0	0	0
Other	0	0	0	0	0

Source: OEKO model

The ATF revenues per material that is sent to reuse are listed in Table 6-55 below. However, initially, there was only a revenue value for the remaining vehicle hulk of a M1/N1-type. As a proxy, therefore, the relation of the weight of an average HDV compared to the average weight of M1/N1 vehicles was taken to get an approximate value for the revenue of the average remaining HDV hulk.

Table 6-55 Assumed ATF revenues per material sent to reuse

ATF revenues per component/material [€/ton]	
iron/steel	130 €
aluminium	850 €
iron/steel	130 €
copper	4.200 €
glass	- €
plastic	400 €
rubber	- €
Other	- €
vehicle hulk	110 €
Average or typical weight M1/N1 [tons]	1,8
Average or typical weight trucks	8,25
revenue of vehicle hulk HDV (sent to shredder)	**504 €**

Source: OEKO model

The dismantling time of HDVs at ATFs is expected to be higher as the 60 minutes estimated for M1/N1 vehicles. Although one literature source gives the example of needing six to seven days to dismantle a truck[385], this seems to be extraordinary long. For the further calculations, the dismantling time of HDVs is according to expert interviews rather estimated at being two

[385] https://www.recyclingproductnews.com/article/1481/end-of-life-truck-recycling

working days. The labour cost – regardless of the vehicle type – is calculated with EUR 35 per hour.

Table 6-56 shows the calculated tonnage of materials of HDVs sent to recycling.

Table 6-56 Tonnage of materials of HDVs sent to recycling

tonnage of materials sent to recycling [tons]	2022	2025	2030	2035	2040
Steel	493151	527932	503292	552043	590687
Aluminium	20122	21541	21743	23850	25519
Iron	61552	65893	62817	68902	73725
Copper	15762	16873	17032	18682	19990
Glass	0	0	11357	12457	13329
Thermoplast	33970	36366	40447	44364	47470
Rubber	0	0	0	0	0
Other	0	0	0	0	0

Source: OEKO model

The assumed recyclers' revenues per material that is sent to recycling are given in Table 6-57.

Table 6-57 Assumed recyclers' revenues per material sent to recycling

Recycler revenues per material (market value of scrap) [€/ton]	
iron/steel	187 €
aluminium (medium value of aluminium cast & aluminiu	1.064 €
iron/steel	187 €
copper	6.286 €
glass	- €
plastic	400 €
rubber	- €
Other	- €

Source: OEKO model

Table 6-58 shows the calculated number of HDVs reaching the End of Life for the different years. However, according to the IA supporting study (see section 2.4.3.1), on average, 80 120 used road tractors and 76 839 used vehicles for transport were exported per year, with both vehicle groups together relating to about 74% of expected waste lorries (data from 2020). This percentage was applied to calculate the number of exported vehicles for the following years. According to calculations based on Eurostat statistics, see Table 6-48 "Average number of exportable and non-exportable vehicles depending on the average value of the exported HDVs, trailers and buses", from a total of 94 218 trucks (which is a little bit lower than the below assumptions of 164 315 exported trucks), about 52 243 trucks are non-exportable (= 55%); thus, we applied this share of 55% to the exported trucks which will not get a roadworthiness certificate anymore, i.e. will remain new/in addition in the EU for proper treatment at ATFs.

Table 6-58 Number of HDVs reaching End of Life, being exported and being treated new/in addition in EU ATF due to proposed policy option of export restrictions

Number of vehicles reaching EoL	2022	2025	2030	2035	2040
"lorries"	222048	237708	264382	289992	310292
Number or share of vehicles exported					
	164315	175904	195643	214594	229616
Number or share of vehicles to be treated new, i.e. in addition in EU ATF due to proposed policy option of export restrictions	**2022**	**2025**	**2030**	**2035**	**2040**
HDVs (trucks)	90373	96747	107604	118027	126289

Source: OEKO model

It is assumed that there is an existing market for the treatment of HDVs in ATFs for those vehicles not being exported. Thus, the costs and revenues for the treatment of HDVs due to the proposed scope extension will only apply to those HDVs which are currently exported but would in future not get a roadworthiness certificate anymore, i.e., would have to stay in the EU for proper treatment at ATFs and be sent to recycling afterwards.

6.10.3.3.2 Calculated costs, revenues and socio-economic impacts at ATFs and recyclers for the proposed mandatory treatment of HDVs

Table 6-59 summarises the calculated revenues, costs and expected number of jobs that can be created at ATFs due to the proposed measure of limiting exports of HDVs without roadworthiness which would lead to additional HDVs that have to be treated at European ATFs. It is expected that the revenues of materials sales to reuse will exceed the additional labour costs of the treatment.

Table 6-59 Calculated revenues, costs and job creation at ATFs due to the proposed mandatory treatment of HDVs at ATFs

Revenues of ATFs	2022	2025	2030	2035	2040
Steel	11.295.516 €	12.092.154 €	17.932.093 €	19.669.102 €	21.045.967 €
Aluminium	3.509.786 €	3.757.320 €	5.571.928 €	6.111.659 €	6.539.483 €
Iron	1.409.825 €	1.509.255 €	2.238.154 €	2.454.955 €	2.626.806 €
Copper	13.584.746 €	14.542.836 €	21.566.339 €	23.655.383 €	25.311.294 €
Glass	- €	- €	- €	- €	- €
Thermoplast	7.900.441 €	8.457.635 €	12.542.273 €	13.757.192 €	14.720.215 €
Rubber	- €	- €	- €	- €	- €
Other	- €	- €	- €	- €	- €
vehicle hulk	45.563.248 €	48.776.683 €	54.250.136 €	59.505.128 €	63.670.572 €
Total revenues ATFs for HDVs	**83.263.562 €**	**89.135.884 €**	**114.100.922 €**	**125.153.420 €**	**133.914.337 €**
Costs of ATFs	**2022**	**2025**	**2030**	**2035**	**2040**
HDVs	50.609.095 €	54.178.398 €	60.258.002 €	66.094.952 €	70.721.693 €
Job creation ATFs	**2022**	**2025**	**2030**	**2035**	**2040**
HDVs	904	967	1076	1180	1263

Source: OEKO model

It is further assumed that due to the additional EoL HDVs staying in the EU due to the export limitations of vehicles without roadworthiness, also the recycling treatment of HDVs will increase under the proposed policy options compared to the current situation; the respective revenues are displayed in Table 6-60.

Table 6-60 Calculated revenues of recyclers due to limiting the exports of HDVs

Revenues of recyclers	2022	2025	2030	2035	2040
Steel	37.533.263 €	40.180.368 €	38.305.019 €	42.015.472 €	44.956.615 €
Aluminium	8.713.629 €	9.328.174 €	9.415.903 €	10.327.984 €	11.050.958 €
Iron	4.684.631 €	5.015.023 €	4.780.956 €	5.244.068 €	5.611.160 €
Copper	40.324.810 €	43.168.794 €	43.574.788 €	47.795.702 €	51.141.469 €
Glass	- €	- €	- €	- €	- €
Thermoplast	5.530.309 €	5.920.344 €	6.584.693 €	7.222.526 €	7.728.113 €
Rubber	- €	- €	- €	- €	- €
Other	- €	- €	- €	- €	- €
Total revenues recyclers for HDVs	**96.786.641 €**	**103.612.703 €**	**102.661.359 €**	**112.605.752 €**	**120.488.315 €**

Source: OEKO model

To these costs and revenues, the following effectiveness rates for the measures under the policy options and the implementation period are applied, see Table 6-61.

Table 6-61 Effectiveness rates for policy options and implementation period

Effectiveness rates Policy Options & Implementation		2025	2030	2035	2040
PO6B: ATF requirement effectiveness (M30a) and export requirements linked to roadworthiness certificate (M30b)	20%	20%	30%	40%	50%
PO6C: +EPR (M31)	12%	12%	12%	12%	12%
PO6B/PO6C: Implementation share towards +5 yrs EIF	25%	25%	50%	75%	75%

6.10.3.4 Calculation of costs and revenues for the scope extension to buses

6.10.3.4.1 Input data for the calculations

The following data is used to calculate the costs and revenues for the scope extension to buses. Table 6-62 shows the calculated tonnage of materials of buses sent to reuse. For 2035 and 2040, no data was available in OEKO's model, therefore, the increase of material between 2030 and 2025 (=33% increase) was calculated, assuming a further half of this increase by the year 2035.

Table 6-62 Tonnage of materials of buses sent to reuse

buses (12GVW)	year	year	year	year	year
tonnage of materials sent to reuse (=> ATFs) [tons]	**2022**	**2025**	**2030**	**2035**	**2040**
Steel	19907	19907	26542	30922	n.a.
Aluminium	27659	27659	36879	42963	n.a.
Iron	4224	4224	5632	6561	n.a.
Copper	188	188	251	292	n.a.
Glass	3453	3453	4604	5363	n.a.
Plastic	11289	11289	15052	17536	n.a.
rubber	0	0	0	0	0
Misc.	0	0	0	0	0

Source: OEKO model

The ATF revenues per material that is sent to reuse are expected to be the same as in Table 6-51 above. However, there was only a revenue value for the remaining vehicle hulk of a M1/N1-type. As a proxy, therefore, the relation of the weight of an average bus compared to the average weight of M1/N1 vehicles was taken to get an approximate value for the revenue of the average bus hulk, see Table 6-63.

Table 6-63 Assumed ATF revenues per material sent to reuse

ATF revenues per component/material [€/ton]	
iron/steel	130 €
aluminium	850 €
iron/steel	130 €
copper	4.200 €
glass	- €
plastic	400 €
rubber	- €
Other	- €
vehicle hulk	110 €
Average or typical weight M1/N1 [tons]	1,8
Average or typical weight buses	10,75
revenue of vehicle hulk HDV (sent to shredder)	**657 €**

Source: OEKO model

The dismantling time of buses at ATFs is expected to be higher as the 60 minutes estimated for M1/N1 vehicles and the 2 working days estimated for HDVs. As there is no information available, it is assumed that the dismantling takes double the time of dismantling a truck, i.e., four working days. The labour cost – regardless of the vehicle type – is calculated with EUR 35 per hour.

Table 6-64 shows the calculated tonnage of materials of buses sent to recycling (same expected increase for 2035 as explained above). The assumed recyclers' revenues per material that is sent to recycling are the same as in Table 6-57 above.

Table 6-64 Tonnage of materials of buses sent to recycling

tonnage of materials sent to recycling [tons]	2022	2025	2030	2035	2040
Steel	45985	45985	39416	45919	n.a.
Aluminium	54857	54857	49786	58001	n.a.
Iron	9758	9758	8364	9744	n.a.
Copper	373	373	339	395	n.a.
Glass	0	0	3107	3620	n.a.
Plastic	7903	7903	7903	9206	n.a.
rubber	0	0	0	0	0
Misc.	0	0	0	0	0

Source: OEKO model

Table 6-65 shows the calculated number of buses reaching the End of Life for the different years. However, according to section 2.4.3.1, on average, 9 327 used buses were exported per year, this relates to about 34% of expected waste buses (data from 2020). This percentage was applied to calculate the number of exported vehicles for the following years. According to calculations based on Eurostat statistics, see Table 6-48 "Average number of exportable and non-exportable vehicles depending on the average value of the exported HDVs, trailers and buses", from a total of

6 769 buses (which is a little bit lower than the below assumptions of 9 800 exported buses), about 4 235 buses are non-exportable (= 34%); thus, we applied this share of 34% to the exported buses which will not get a roadworthiness certificate anymore, i.e. will remain new/in addition in the EU for proper treatment at ATFs.

Table 6-65 Number of buses reaching End of Life, being exported and being treated new/in addition in EU ATF due to proposed policy option of export restrictions

Number of vehicles reaching EoL	2022	2025	2030	2035	2040
"buses"	28822	29859	31359	32972	35057
Number or share of vehicles exported					
	9800	10152	10662	11211	11919
Number or share of vehicles to be treated new, i.e. in addition in EU ATF due to proposed policy option of export restrictions	**2022**	**2025**	**2030**	**2035**	**2040**
buses	6174	6396	6717	7063	7509

Source: OEKO model

It is assumed that there is an existing market for the treatment of buses in ATFs for those vehicles not being exported. Thus, the costs and revenues for the treatment of buses due to the proposed scope extension will only apply to those buses which are currently exported but would in future not get a roadworthiness certificate anymore, i.e., would have to stay in the EU for proper treatment at ATFs and be sent to recycling afterwards.

6.10.3.4.2 Calculated costs, revenues and socio-economic impacts at ATFs and recyclers for the proposed mandatory treatment of buses

Table 6-66 summarises the calculated revenues, costs and expected number of jobs that can be created at ATFs due to the proposed measure of limiting exports of buses without roadworthiness which would lead to additional buses that have to be treated at European ATFs. It is expected that the revenues of materials sales to reuse will exceed the additional labour costs of the treatment.

Table 6-66 Calculated revenues, costs and job creation at ATFs due to the proposed mandatory treatment of buses at ATFs

Revenues of ATFs	**2022**	**2025**	**2030**	**2035**	**2040**
Steel	554.327 €	554.327 €	739.102 €	861.054 €	n.a.
Aluminium	5.035.852 €	5.035.852 €	6.714.470 €	7.822.357 €	n.a.
Iron	117.624 €	117.624 €	156.832 €	182.709 €	n.a.
Copper	169.272 €	169.272 €	225.696 €	262.936 €	n.a.
Glass	- €	- €	- €	- €	n.a.
Thermoplast	967.271 €	967.271 €	1.289.694 €	1.502.494 €	n.a.
Rubber	- €	- €	- €	n.a.	n.a.
Other	- €	- €	- €	n.a.	n.a.
vehicle hulk	4.055.769 €	4.201.658 €	4.412.799 €	4.639.785 €	4.933.124 €
Total revenues ATFs for busses	**10.900.115 €**	**11.046.004 €**	**13.538.593 €**	**15.271.336 €**	**4.933.124 €**
Costs of ATFs	**2022**	**2025**	**2030**	**2035**	**2040**
busses	6.914.529 €	7.163.250 €	7.523.215 €	7.910.196 €	8.410.299 €
Job creation ATFs	**2022**	**2025**	**2030**	**2035**	**2040**
busses	123	128	134	141	150

Source: OEKO model

It is further assumed that due to the additional EoL buses staying in the EU due to the export limitations of vehicles without roadworthiness, also the recycling treatment of buses will increase under the proposed policy options compared to the current situation; the respective revenues are displayed in Table 6-67.

Table 6-67 Calculated revenues of recyclers due to limiting the exports of buses

Revenues of recyclers	**2022**	**2025**	**2030**	**2035**	**2040**
Steel	1.841.942 €	1.841.942 €	1.578.808 €	1.839.311 €	n.a.
Aluminium	12.502.343 €	12.502.343 €	11.346.664 €	13.218.863 €	n.a.
Iron	390.847 €	390.847 €	335.012 €	390.289 €	n.a.
Copper	502.466 €	502.466 €	456.020 €	531.263 €	n.a.
Glass	- €	- €	- €	- €	n.a.
Thermoplast	677.089 €	677.089 €	677.089 €	788.809 €	n.a.
Rubber	- €	- €	- €	- €	n.a.
Other	- €	- €	- €	- €	n.a.
Total revenues recyclers for busses	**15.914.687 €**	**15.914.687 €**	**14.393.592 €**	**16.768.535 €**	**- €**

Source: OEKO model

As for HDVs, also to these costs and revenues, the same effectiveness rates as given in Table 6-61 for the measures under the policy options and the implementation period are applied to buses.

6.10.4 Measure "Advanced waste treatment requirements"

Amongst others, a proposed policy option might include additional requirements of the mandatory removal of materials and/or components prior to shredding/PST.

6.10.4.1 Methodology

EPR costs	Assumption: Glass is not to be considered as reuse material under policy option PO6B (currently not profitable to dismantle separately due to high effort of logistics); it rather is sent to recyclers for backfilling or use as construction material instead of high-quality recycling. Under PO6C, the separate dismantling of glass aimed at increasing high-quality recycling will be calculated for HDVs and buses => costs & revenues for ATFs (plus revenues for recyclers); costs for ATFs = might be covered by EPR costs

6.10.4.2 Calculation of costs and revenues for separate dismantling of glass windows of HDVs and buses to increase its high-quality recycling

6.10.4.2.1 Input data for the calculations

Table 6-68 below summarises the assumed input data for the calculation of costs and revenues for the separate dismantling of glass windows of HDVs and buses.

Table 6-68 Input data for calculating advanced treatment requirements, exemplified for separate dismantling of glass windows for increasing the potential of high-quality glass recycling

Dismantling time of all glass windows of trucks [hours]	0,50
Cost difference (= additional costs) for ATF operators [€/tonne]	164 €
Assumed share of dismantled glass which goes to the high-quality recycling route	80%
Costs of ATFs for storage and transport to recycler [€/tonne]	45 €
ATF revenues for glass sold directly to recyclers [€/tonne]	10 €
Additional revenue of recyclers compared to current use as backfilling material [€/tonne]	16,50 €
Dismantling time of all glass windows of trucks [hours]	1,48

Source: Different sources plus own assumptions

According to sections 3.1.8.1.4 and 3.1.8.1.4.2, for cars, an average of 6-8 minutes for the removal of all glass windows (windscreen, side windows and rear window) is reported. ADEME (2015) reported average dismantling times of 30 minutes according to an ATF survey (10 minutes on average for windscreen, 9.5 minutes for the side windows and 12 minutes for the rear window). As trucks have a similar number of windows, however, being larger, the higher dismantling time of 30 minutes is taken here. As buses have a higher number of larger side windows (assumed: 2x 6 side windows in addition), a higher dismantling time is taken here.

According to section 3.1.8.1.4.2, there is a cost difference at ATFs: costs when glass is dismantled and recycled separately (213€/tonne) compared to costs when glass is shredded and used for backfilling or construction (49 €/tonne).

Further, it is assumed that not the total mass of glass material sent to reuse will be available for high-quality recycling: According to section 3.1.8.1.4, Table 3-37, there will still be a share of glass remaining in components (doors) for remanufacturing / reuse, a further share being shredded and recycled; the table in the IA supporting study takes 70% of high quality recycling, however, assuming 13% losses of glass which does not reach the ATFs at all (losses prior to ATFs); as the material sent to reuse already has deducted these losses, the 70% share was related to the remaining glass reaching the ATFs, therefore resulting in 80% of glass going to high-quality recycling then.

For the transport of glass from a dismantler to a recycler, 45 €/tonne were assumed for both storage and transport (see section 3.1.8.1.4.2). According to OVAM (2012), ATF revenues for glass sold directly to recyclers is 10 €/tonne. The additional revenue of recyclers compared to current use as backfilling material is calculated with 16.5 €/tonne, assuming 1.5 € revenue per tonne when shredded glass is sent to backfilling (baseline) and 18 €/tonne when dismantled and sent as glass cullet for high-quality recycling.

6.10.4.2.2 Calculated costs, revenues and socio-economic impacts at ATFs and recyclers for the proposed separate dismantling and high-quality recycling of glass windows

Table 6-69 Calculated revenues, costs and job creation at ATFs and recyclers due to the proposed separate dismantling and high-quality recycling of glass windows of HDVs for the years 2022 (baseline), 2025, 2030, 2035 and 2040

Cost difference (= additional costs) for ATF operators [€]	1.738.127 €	1.860.711 €	2.759.347 €	3.026.634 €	3.238.502 €
Costs of ATFs for storage and transport to recycler [€]	381.540 €	408.449 €	605.710 €	664.383 €	710.891 €
Costs per EoL truck [€/ELV]	10 €	10 €	13 €	13 €	13 €
Revenues of ATFs from selling dismantled glass directly to recyclers [€]	84.787 €	90.766 €	134.602 €	147.641 €	157.976 €
Additional revenue of recyclers compared to current use as backfilling material [€]	139.898 €	149.765 €	222.094 €	243.607 €	260.660 €
Job creation ATFs	69	74	83	91	97

Source: OEKO model

Table 6-70 Calculated revenues, costs and job creation at ATFs and recyclers due to the proposed separate dismantling and high-quality recycling of glass windows of buses for the years 2022 (baseline), 2025, 2030, 2035 and 2040

Cost difference (= additional costs) for ATF operators [€]	566.236 €	566.236 €	754.981 €	879.553 €	n.a.
Costs of ATFs for storage and transport to recycler [€]	124.296 €	124.296 €	165.727 €	193.073 €	n.a.
Costs per EoL truck [€/ELV]	24 €	23 €	29 €	33 €	n.a.
Revenues of ATFs from selling dismantled glass directly	27.621 €	27.621 €	36.828 €	42.905 €	n.a.
Additional revenue of recyclers compared to current use as backfilling material [€]	45.575 €	45.575 €	60.767 €	70.793 €	n.a.
Job creation ATFs	27	28	29	30	32

Source: OEKO model

6.10.5 Summary of costs and revenues for ATF treatment and export reductions

For a basic policy option it is assumed that the required provision of dismantling information will not change the current market structure of ATFs and recyclers; it might result in a minor reduction of dismantling times due to better information, however, this is not calculated separately.

In a more advanced policy option, the additional numbers of HDVs and buses to be treated in ATFs due to the proposed requirement on export restriction of EoL vehicles without roadworthiness will cause lost revenues for exporters and additional dismantling costs at ATFs. However, it is expected that there will also be additional revenues for ATFs from removed materials which will compensate their costs. For the situation of shredders, no information was available to calculate their additional costs or revenues.

For the recyclers, no information was available on the costs of the measures, however, due to the additional material of the new vehicle types of the extended scope, the revenues of the recyclers will increase accordingly.

6.10.6 References

ICCT (2022): European vehicle market statistics 2021/22, Publisher: International Council on Clean Transportation (2022)

OVAM (2012): Study into the processing of glass from End-of-Live Vehicles: Analysis of the legislation and practice in European countries, focusing on selective removal. In collaboration with Eijkelenburg, L.V.

6.11 Ad-hoc contributions to the impact assessment of the EC: Recycled content steel in new vehicles

6.11.1 Background

The purpose of this ad-hoc contribution to the impact assessment of the EC is to investigate the potential uptake of recycled steel in new vehicles and whether the scrap sector can deliver the required volumes accordingly.

6.11.2 Supply

6.11.2.1 Ferrous Metals steel scrap (E40) from ELV in the EU

According to the fleet model used for this support study to the impact assessment, the following number of vehicles might be treated in the EU as displayed in Table 6-71. In consequence, the displayed mass of scrap becomes available if the preferred policy options as proposed by the EC are implemented in combination. The shares of Fe-scrap, steel (flat products and long products) and cast iron are calculated according to the data in Table 6-74.

Table 6-71 Scenario for the total mass of ferrous scrap in the EU (preferred option)

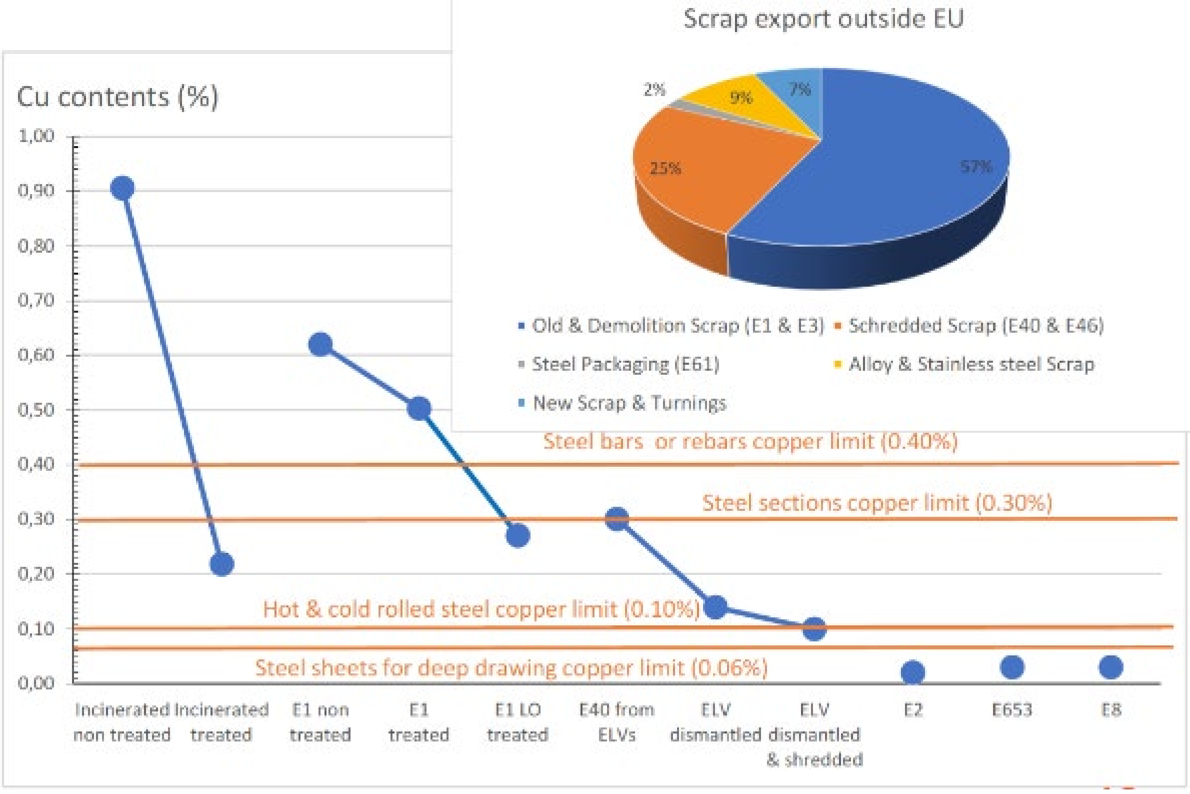
[1000 t]	2025	2030	2035	2040
ELVs treated in the EU	8 274	10 083	11 728	12 638
Fe-scrap (steel + cast iron) (without loses, without contamination)	8 065	9 780	11 191	11 617
Fe-scrap (steel + cast iron) (with loses, without contamination)	7 026	8 521	9 750	10 121
Thereof composed of:				
steel:	5 994	7 290	8 423	8 941
flat products	4 808	5 859	6 815	7 344
long products	1 186	1 431	1 608	1 597
cast iron	1 032	1 231	1 327	1 180

Source: Oeko model

6.11.2.2 Which qualities might be achieved with different recycling approach?

ArcelorMittal published a slide presenting the different qualities of scrap as displayed in the Figure 6-26 below.

Figure 6-26 Cu content in the Fe-scrap and scrap export outside EU



Source: Philippe Russo / Jan Bollen (ArcelorMittal); presentation IARC - July 5th, 2022

In the context of the research for this ad-hoc task, the study team visited a new processing line of a major player in the steel recycling sector. Although the front runner cannot be disclosed (yet), which agreed to share the following information with the EC:

"The input material to the plant is post-consumer steel scrap, mainly depolluted / dismantled ELVs, large appliances (category 4 of the WEEE Directive), mixed scrap.

The new processing line produces a high-quality recycled raw material, the quality of which is significantly higher than that of a classic E40, e.g. with a Cu content of < 0.1%. Other accompanying elements such as Cr, Mn, Mo, Ni, Ti are also adjusted according to the required specifications and guaranteed accordingly. In addition, the material is virtually free of organic and mineral impurities. This high quality is necessary to increase the recycling rate in flat steel production.

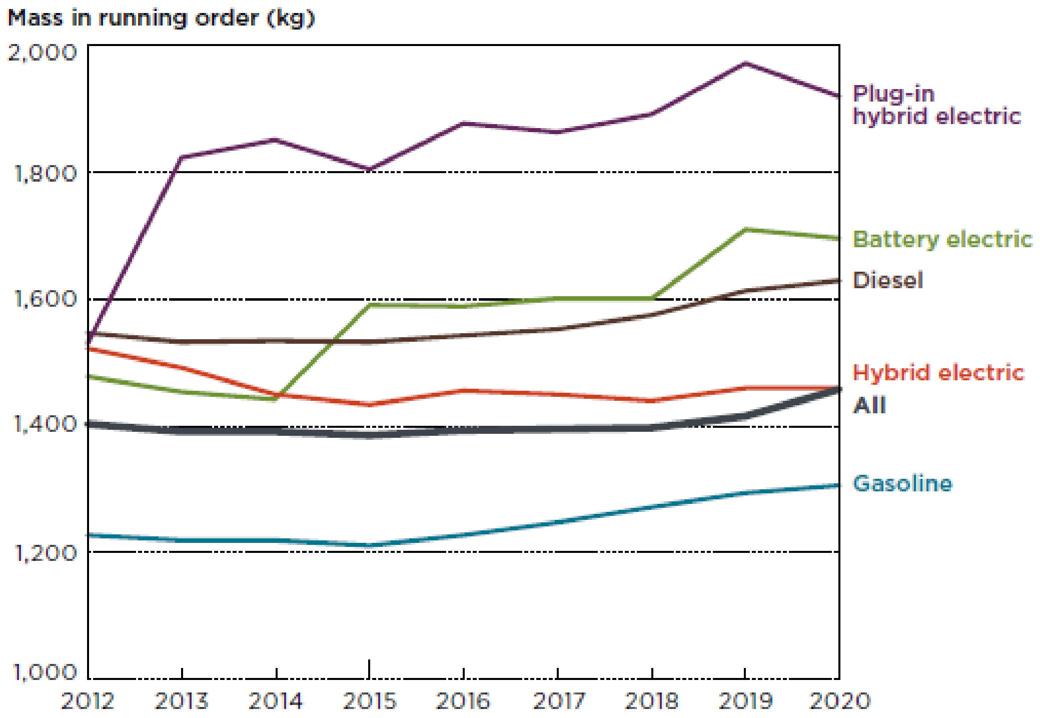
The planned full capacity of the new processing plant is over 300 000 t/a. A capacity of up to 1.5 Mio t will be built by 2026."

6.11.3 Demand

6.11.3.1 Weight of new vehicles

Figure 6-27 displays the development of the average mass per powertrain. According to the forecast, it must be considered that battery electric vehicles in 2020 had a relative high share of small / mid-sized vehicles included as Renault's Zoe was the top seller of BEV in 2020. In the coming years, the trend is likely to be that heavier BEV will be placed on the market.

Figure 6-27 Average mass in running order of new car registrations in the EU and the UK by powertrain type



Source: ICCT (2022)

Table 6-72 shows the average weights of the passenger cars for the different powertrain types in 2020 according to ICCT (2022). For the years 2025, 2030, 2035 and 2040, the same values were assumed. The number of new registrations is derived from the Oeko model. The mass flows were calculated from these two values.

Table 6-72 Scenario for the total mass of vehicles PoM in the EU

	2020	2025	2030	2035	2040
Average weight [kg], thereof average weight for:	1457	1457	1457	1457	1457
BEV	1696	1696	1696	1696	1696
HEV	1455	1455	1455	1455	1455
PHEV	1921	1921	1921	1921	1921
ICV Diesel	1625	1625	1625	1625	1625
ICV Gasoline	1315	1315	1315	1315	1315
Total new registrations [number], thereof:	11 050 026	14 756 084	14 852 129	15 024 844	15 232 296
BEV	387 130	1 472 273	6 215 999	15 024 716	15 232 275
HEV	1 175 336	4 049 413	2 298 513	0	0
PHEV	334 140	983 754	2 019 242	128	20
ICV Diesel	4 012 362	4 652 896	2 740 812	0	0
ICV Gasoline	5 141 058	3 597 749	1 577 563	0	0
Total mass flows [1000 t], thereof:	16 289 150	22 570 657	24 293 949	25 482 165	25 833 978
BEV	656 573	2 496 975	10 542 334	25 481 919	25 833 938
HEV	1 710 113	5 891 896	3 344 337	0	0
PHEV	641 883	1 889 791	3 878 964	246	39
ICV Diesel	6 520 089	7 560 956	4 453 819	0	0
ICV Gasoline	6 760 492	4 731 040	2 074 496	0	0

Source: New Registrations and Production: Oeko model; Average weight: ICCT (2022)

6.11.3.2 Ferrous metal in new vehicles (2025, 2030, 2035, 2040)

To model the material composition of passenger cars, data from JRC-RMIS[386] on the composition of passenger cars was used, supplemented by data from the Greet model (Argonne 2021). The support study distinguished regards ferrous metals steel and cast iron.

Based on a literature survey and stakeholder interviews Dworak and Fellner (2022) distinguish different quality classes as displayed Table 6-73. Many more steel alloys / product definitions / standards exist.

Table 6-73 Quality classes based on max. tolerable proportion of accompanying elements

Quality class	Maximal content of tramp elements	Typical steel products in the class
Q1	<0,18	Mainly cold rolled flat products
Q2	0,18-0,25	Tubes, plates, hot rolled flat products
Q3	0,25-0,35	Hot rolled bar products, slabs for the construction sector
Q4	>0,34	Reinforcing steel, rails, profiles

Source: Dworak and Fellner (2022)

For the different applications, different quality requirements might apply, and producers (customs of the steel mills) might define stricter requirements for their production purposes.

6.11.3.3 Assumption for the share of flat steel and long products in new vehicles

6.11.3.3.1 Long products in ICV

Long products "are mainly formed into parts or components which are used, among others, in the energy sector, in mechanical engineering, in the construction industry, but above all in the automotive sector. In this article, we will focus on the passenger car sector: on average, 165 kg of long products can be found in a passenger car (see also Figure 6-28). These are forged, machined, cold-formed, heat-treated, rolled as well as drawn parts. Main applications of our products: Engine, transmission, powertrain, steering and suspension. Examples: Crankshafts, connecting rods, fuel injectors, engine mounting bolts, transmission shafts, pinions, wheel hubs, ring gears, steering, axle and clutch springs, ball studs, wheel caps, wheel nuts, flange shafts, ball bearings, cable pulls, drive shafts, windshield wiper arms, tire cords, and more."[387]

[386] https://rmis.jrc.ec.europa.eu/apps/veh/#/p/viewer

[387] https://germany.arcelormittal.com/Innovation/Loesungen-aus-Stahl/Autos/Langstahlprodukte-in-ihrem-Fahzeug

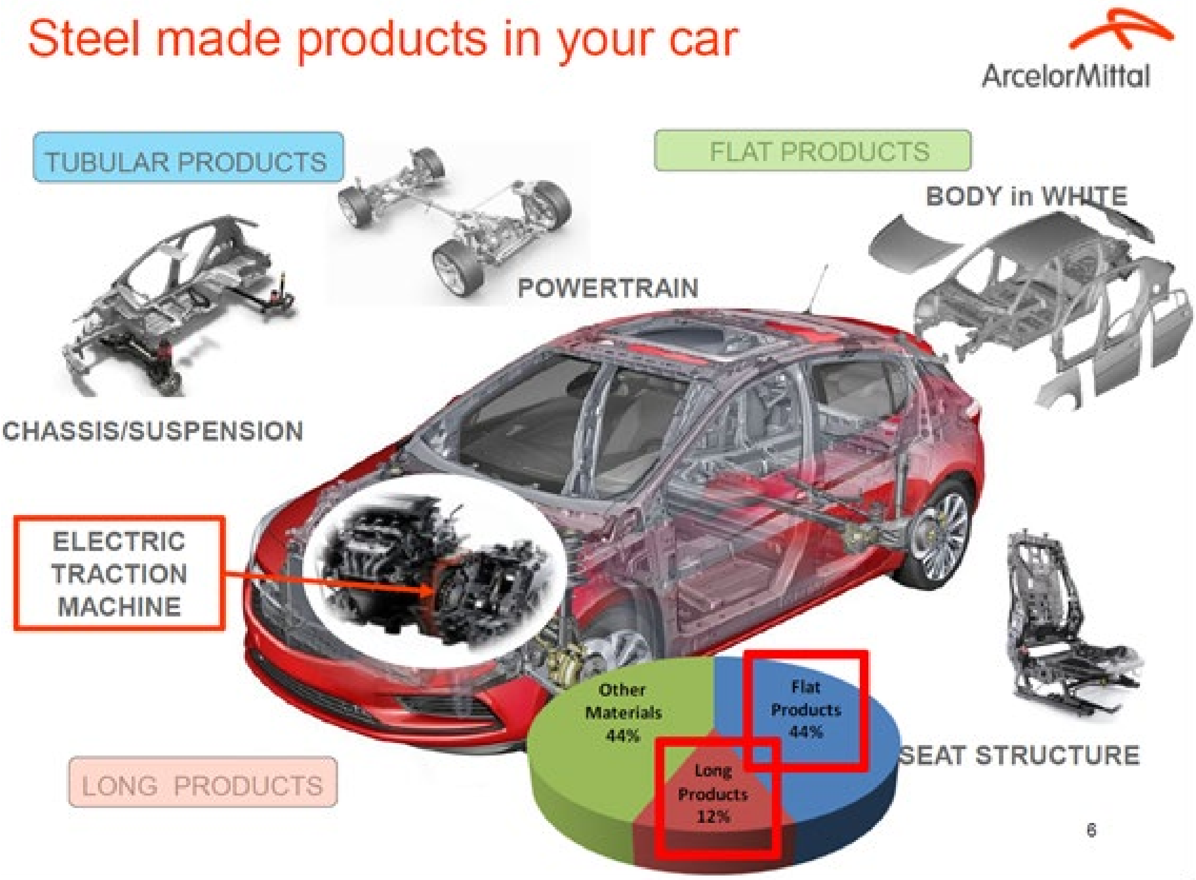
Figure 6-28 Share of long products in ICV

Source: ArcelorMittal (retrieved 27.04.2023)[388]

In a previous publication in 2018, ArcelorMittal mentions a share of 44% of flat products and 12% of long products and 44% other materials as displayed below in Figure 6-29 below.

[388] https://automotive.arcelormittal.com/products/long

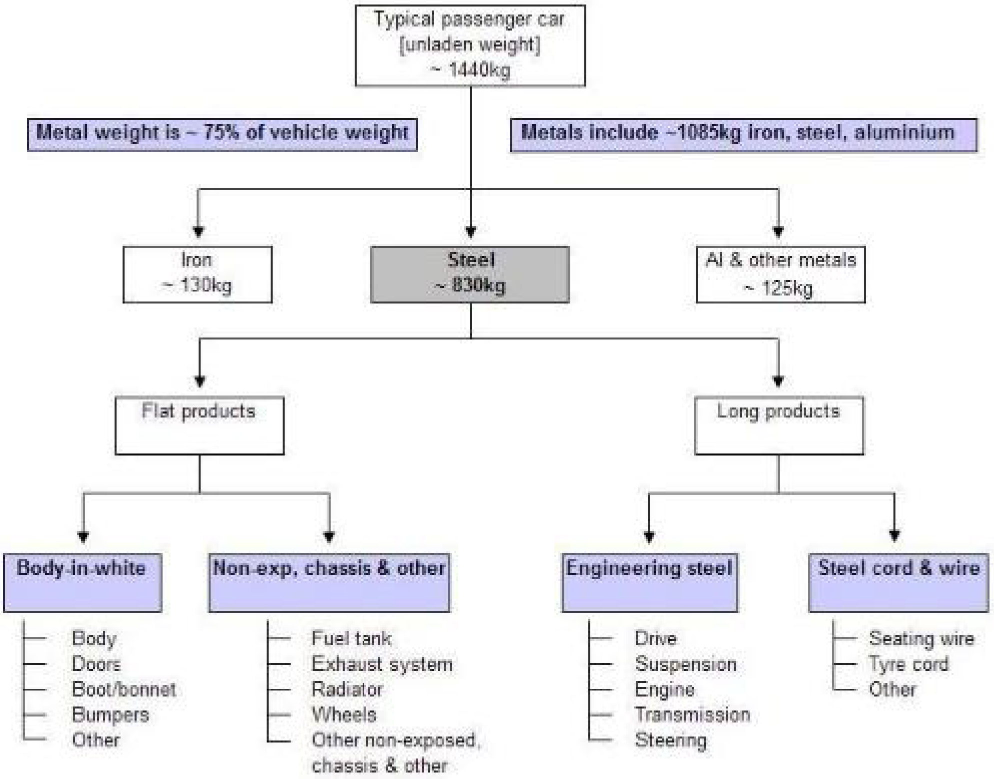
Figure 6-29 Share of long products in ICE



Source: Jan Bollen, ArcelorMittal (2018): New steels driving the circular economy, innovative solutions for future mobility, presentation at the International Automotive Recycling Conference, Vienna, 2018-03-14

As a second source, a survey by Steelonthenet revealed an average total weight of 1440 kg per passenger car. Of this, 1085 kg (75 %) is metal (including iron, steel, aluminium, magnesium, copper, and zinc), see also Figure 6-30. The steel content was 830 kg (58%). In this assessment, flat steel products amount to 667 kg (46%) and long products to 163 kg (11%).

Figure 6-30 Share of metal content in passenger cars



Source: Steelonthenet.com[389] (retrieved 2023-04-27)

6.11.3.3.2 Long products in BEV

Battery electric vehicles neither have a crank shaft nor a piston. Therefore, the assumption is that fewer long products are needed for BEV.

To estimate the share of different steel qualities in BEV, the study team forwarded questions to Volkswagen, Porsche and Mercedes Benz and VDA, Voestalpine and ArcelorMittal.

By 2023-04-27, only one reply was available from ArcelorMittal, estimating the share of long steel in BEV at about 100 kg/BEV, compared to 165 kg/ICE-vehicle. Other stakeholders replied that they will investigate the issue and will report accordingly. However, they have not replied at that time.

For the purpose of this preliminary ad-hoc study, the study team assumes that the share of long steel for BEV will be 40% less compared to ICE vehicles.

6.11.3.4 Assumptions for the modelling

Due to the different quality requirements, the following table distinguishes between flat steel and long products.

[389] https://www.steelonthenet.com/files/automotive.html

Table 6-74 Considerations for the model calculations including break down for flat steel and long products for vehicles PoM (no variation over years considered)

Material	ICEV	HEV	PHEV	EV
Steel	57.4%	58.0%	54.6%	56.5%
Flat steel	46.0%	46.5%	43.8%	49.1%
Long products	11.4%	11.5%	10.8%	7.4%
Cast Iron	57.4%	58.0%	54.6%	56.5%

Source: Oeko model, expressed in %; additional assumptions for flat steel and long products

6.11.3.5 Demand for the production of new vehicles

The following tables show the total mass of the different ferrous products in passenger cars placed on the market (PoM) in the EU in the corresponding year according to the Oeko model. The mass share of ferrous products per vehicle has remained stable over the years for the different drive types, but the number of vehicles PoM to 2040 has been varied according to the Oeko model.

Table 6-75 Scenario for the total mass of ferrous products in vehicles PoM in EU

	2020	2025	2030	2035	2040
Total long products [1000 t], thereof:	1 834	2 536	2 703	2 827	2 866
BEV	73	277	1 170	2 827	2 866
HEV	195	671	381	0	0
PHEV	69	203	416	0	0
ICV Diesel	735	852	502	0	0
ICV Gasoline	762	533	234	0	0
Total flat products [1000 t], thereof:	7 503	10 379	11 059	11 570	11 730
BEV	298	1 134	4 787	11 570	11 730
HEV	797	2 746	1 559	0	0
PHEV	282	829	1 702	0	0
ICV Diesel	3 008	3 488	2 054	0	0
ICV Gasoline	3 118	2 182	957	0	0
Total cast iron [1000 t], thereof:	1 397	1 812	1 352	357	362
BEV	9	35	148	357	362
HEV	152	524	298	0	0
PHEV	54	159	326	0	0
ICV Diesel	580	673	396	0	0
ICV Gasoline	602	421	185	0	0
Total mass of ferrous products	10 734	14 727	15 115	14 754	14 958

Source: Oeko model, additional assumptions for flat steel and long products

6.11.3.6 How much more uptake of post-consumer ELV scrap is possible in flat products

6.11.3.6.1 Research Project REDERS

In 2021, ThyssenKrupp and TSR started work in the research project REDER with the aim to develop an advanced shredder technology, producing a steel fraction ready to be used in the flat steel production[390]. In the meantime, the new TSR shredder plant in Duisburg is operative. The plant is expected to process up to 450 000 tons of different input materials annually - such as end-of-life vehicles, mixed scrap or large household appliances[391].

6.11.3.6.2 Research Project MaterialLoop

OEM Audi reported in March 2023 on the MaterialLoop research project, in which a recycling uptake rate of 12 percent is being achieved for deep-drawing steel. The research project is being implemented at running industrial sites, together with TSR for sorting and Voestalpine adding the scrap in the converter of the blast furnace. Studies carried out as part of the project show that the proportion of steel recycled from vehicles in the coil could be increased even further in the future[392].

6.11.3.6.3 Research Project Car2Car

In April 2023, BMW reported about the research project Car2Car. The project will focus on several materials, including aluminium, steel, glass, copper, and plastic. According to BMW, “innovative dismantling and automated sorting methods should allow for far lag quantities of the resources to be recovered from ELVs to be made suitable for use in the production of new cars than has been the case to date.”

In addition to several universities and trade groups, the Car2Car consortium partners include BMW, Scholz Recycling GmbH; Steinert UniSort GmbH; Thyssenkrupp Steel Europe AG; Salzgitter Mannesmann Forschung GmbH; Aurubis AG; Novelis Deutschland GmbH; Oetinger Aluminium GmbH; and Pilkington Automotive Deutschland GmbH.

6.11.3.6.4 Full scale project at industrial scale

In the context of the research for this ad-hoc project, the study team visited a new processing line of a major player in the steel recycling sector. Although the front runner cannot be disclosed (yet), which agreed to share the following information with the EC:

“The input material to the plant is post-consumer steel scrap, mainly depolluted / dismantled ELVs, large appliances (category 4 of the WEEE Directive), mixed scrap.

The new processing line produces a high-quality recycled raw material, the quality of which is significantly higher than that of a classic E40, e. g. with a Cu content of < 0.1 %. Other accompanying elements such as Cr, Mn, Mo, Ni, Ti are also adjusted according to the

[390] https://www.thyssenkrupp-steel.com/de/newsroom/pressemitteilungen/steel-und-tsr-testen-innovatives-verfahren-zum-einsatz-von-hochwertigem-schrott-im-hochofen.html

[391] https://www.euwid-recycling.de/news/wirtschaft/schrottrecycler-tsr-nimmt-in-duisburg-neue-aufbereitungsanlage-in-betrieb-280423/

[392] https://www.audi-mediacenter.com/de/pressemitteilungen/aus-alt-mach-neu-projekt-materialloop-testet-kreislaufwirtschaftspotenziale-von-altfahrzeugen-15205

required specifications and guaranteed accordingly. In addition, the material is virtually free of organic and mineral impurities. This high quality is necessary to increase the recycling rate in flat steel production.

Compared to hydrogen, the material is already available today and can thus make a significant contribution to CO2 reduction through its use in the steel industry.

The recycled raw material can be used both in the blast furnace (BF) with 10-15% and in the converter with 25-30%. In total, the recycled raw material can feed 32-40% for flat steel and deep drawing steel.

With the future electric arc furnace (EAF) route for flat steel, a recycling rate of up to 60% could be possible.

The planned full capacity of the new processing plant is over 300 000 t/a. A capacity of up to 1.5 Mio t will be achieved by 2026."

6.11.3.7 Total potential uptake of post-consumer uptake

In order to identify the total potential uptake of recycled steel and iron from post-consumer scrap, three scenarios were calculated for the potential recycled content in flat product, long products and cast iron, see Table 6-76.

Scenario 1 is basically a kind of baseline, where no uptake of post-consumer flat steel products is possible. Scenario 2 considers an advanced share of uptake in long steel products and in cast iron and a moderate increase in the uptake of post-consumer scrap in the flat steel production. Scenario 3 takes into account a transition of the steel market to direct reduced iron and a subsequent EAF route for the flat steel and availability of high-quality post-consumer scrap.

Table 6-76 Considerations for the model calculations of Oeko Institut including potential recycled content rates for steel and cast iron

Material	Recycled content Scenario 1	Recycled content Scenario 2	Recycled content Scenario 3
Steel, thereof:			
Long products	50%	75%	75%
Flat products	0%	15%	60%
Cast Iron	50%	75%	75%

Source: Own representation

Table 6-77 shows the calculated results for the total mass of potential uptake of recycled steel and iron from post-consumer scrap in the three scenarios based on the number of passenger cars PoM.

Table 6-77 Results for the total mass of potential uptake of recycled steel and iron from post-consumer scrap[393]

	2025	2030	2035	2040
Long products [1000 t]				
Total Scenario 1	1 233	1 162	938	951
Total Scenario 2	1 849	1 743	1 407	1 426
Total Scenario 3	1 849	1 743	1 407	1 426
Flat products [1000 t]				
Total Scenario 1	0	0	0	0
Total Scenario 2	1 568	1 715	1 877	1 903
Total Scenario 3	6 271	6 861	7 508	7 612
Cast iron [1000 t]				
Total Scenario 1	906	676	178	181
Total Scenario 2	1 359	1 014	268	271
Total Scenario 3	1 359	1 014	268	271

Source: Oeko model

6.11.4 Comparison of demand and supply for recycled content

The following tables display the demand for the production of new vehicles and the demand for the different steel qualities. As demonstrated, flat steel can become the most in-demand material, if the potential uptake of 60% in scenario 3 will become effective. To feed this demand, the transition to EAF for flat steel production and the provision of high-quality steel scrap with low copper content are preconditions. In the case of scenario 3, the supply of recycled material from end-of-life vehicles will not be sufficient to meet demand in 2025 and 2030. However, it is questionable whether the demand conditions in scenario 3 can be fully met in 2025 and 2030.

Table 6-78 Comparison of total supply and demand for scenario 1[394]

Scenario 1 [1000 t]	2025	2030	2035	2040
Demand long products	1 233	1 162	938	951
Demand flat products	0	0	0	0
Demand cast iron	906	676	178	181
Total demand	**2 139**	**1 838**	**1 116**	**1 132**
Total Fe-scrap supply (with losses, without contamination)	**7 026**	**8 521**	**9 750**	**10 121**

Source: Oeko model

Table 6-79 Comparison of total supply and demand for scenario 2[397]

Scenario 2 [1000 t]	2025	2030	2035	2040
Demand long products	1 849	1 743	1 407	1 426
Demand flat products	1 568	1 715	1 877	1 903
Demand cast iron	1 359	1 014	268	271
Total demand	**4 776**	**4 472**	**3 552**	**3 600**
Total Fe-scrap supply (with losses, without contamination)	**7 026**	**8 521**	**9 750**	**10 121**

Source: Oeko model

[393] The calculation is based on the number of passenger cars placed on market (PoM) in the corresponding year according to the Oeko model.

[394] The calculation for the demand is based on the number of passenger cars placed on market (PoM) in the corresponding year according to the Oeko model.

Table 6-80 Comparison of total supply and demand for scenario 3[397]

Scenario 3 [1000 t]	2025	2030	2035	2040
Demand long products	1 849	1 743	1 407	1 426
Demand flat products	6 271	6 861	7 508	7 612
Demand cast iron	1 359	1 014	268	271
Total demand	**9 479**	**9 618**	**9 183**	**9 309**
Total Fe-Scrap supply (with losses, without contamination)	**7 026**	**8 521**	**9 750**	**10 121**

Source: Oeko model

6.11.5 Outlook for a more comprehensive study

For further assessment whether a recycling content target for vehicles might be meaningful, the study team sees the following aspects:

Supply: What are realistic scenarios for the ramp-up of advanced shredder technology? Consider not the full shredder capacity in the EU, but the capacity for depolluted ELVs, depolluted WEEE cat 4, and mixed scrap only. Investigate the total capacity and the volumes of the above-mentioned waste streams. Investigate the age of the existing shredder plants in the EU with the aim to assess the timing for the replacement of the current plants and the ramp-up to get sufficient capacities for high-quality steel-scrap with accompanying elements of less than 0.1%. Investigate required investment costs (and depreciation losses in case of very fast transition?)

Relevant stakeholders / sources: EURIC, Eurofer, Galloo, TSR, Scholz Recycling and other operators of shredders (see also list of auto shredders in the EU[395]):

Demand: What are realistic scenarios for the ramp-up of a) BF and converters capable of making use of high-quality steel scrap, b) DRI feed EAF, fully integrated for flat steel production. What might be the total demand of steel mills a) for the production of vehicles (instead PoM as calculated in this report) for high-quality scrap, b) beyond the automotive industry (and including demand for export of products and export of steel)? Is the EU ETS-sufficient to trigger the transition of the steel sector and to trigger the uptake of more scrap for the flat steel production, or is a recycled content target needed for flat steel or for specific products (like vehicles)? Relevance of import and export of scrap and products (intermediate products like flat steel and final like vehicles) and timing of protective regulations for EU industry.

Relevant stakeholders / sources: Eurofer but also the steel producers themselves, like Tata, ArcelorMittal, ThyssenKrupp, Voestalpine and the EAF in Italy.

Demand, quality aspects: gain deeper insight, beyond the copper content, with regard to potential limitations from accompanying elements (other than copper) or opportunities for steel alloying for the uptake of (high quality) steel scrap.

Relevant stakeholders / sources: Eurofer but also the steel producers themselves, like Tata, ArcelorMittal, ThyssenKrupp, Voestalpine and the EAF in Italy. And furthermore, producers maintaining their own raw material specifications (like many OEMs in the automotive sector).

Economic impacts for the sectors / industrial stakeholders, considering the global market for scrap, iron, steel, and products from iron/ steel. How to deal with imports and exports and what timing is needed to address these global market implications.

[395] https://www.recyclingtoday.com/article/rtge0914-european-union-auto-shredding/

Environmental impacts a) for the EU, b) from a global perspective

Resource supply impacts: a) for the EU, b) from a global perspective

Supply and demand: Develop coherent scenario(s) for the ramp-up of supply and demand under different policy scenarios.

6.11.6 References

Argonne (2021): Argonne National Laboratory. GREET Model: The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model. 2021. GREET2: vehicle manufacturing cycle model of vehicle technologies. Available online: https://greet.es.anl.gov

Dworak and Fellner (2022): J., Dworak, S., Fellner, J., Beermann, M. et al. Stahlrecycling – Potenziale und Herausforderungen für innovatives und nachhaltiges Recycling. Österreichische Wasser- und Abfallwirtschaft 75, 97–107 (2023). https://doi.org/10.1007/s00506-022-00903-3

ICCT (2022): European vehicle market statistics 2021/22, Publisher: International Council on Clean Transportation (2022)

Philippe Russo / Jan Bollen (ArcelorMittal); presentation IARC - July 5th 2022

6.12 Ad-hoc contributions to the impact assessment of the EC: Assumptions for the impact assessment of the introduction of criteria for the export of used cars

6.12.1 Background

The purpose of this ad-hoc contribution to the impact assessment of the EC is to provide assumptions for the impact assessment of the introduction of criteria for the export of used cars. Background: In the context of the revision of the ELV Directive and the 3R Directive one measure proposes to introduce criteria for the allowance to export used vehicles. The preferred option proposes to introduce the requirement of a valid roadworthiness certificate for the vehicles to be exported to non-EU countries

6.12.2 Abstract

According to an assessment by Dutch authorities for the years 2017/2018, the majority of vehicles exported to top 12 countries in Africa are in conformity with emission standard Euro 3 only or even with the worse emission standard 1 or 2. With emission standard Euro 4, obligatory for vehicles first registered by January 2006, a significant improvement was achieved in the reduction of NO_x emissions from gasoline engines. A similar break through is achieved with Euro 5 for Particulates (PM1) from diesel engines, effective for new vehicles first registered by January 2011. Most vehicles exported have only limited exhaust treatment and cause emissions at relevant levels for health at urban areas.

In the context of export restrictions, it is often argued that it would be a waste of resources and also not CO_2-efficient if a used car for which there is a demand / market in extra-EU countries were to be scrapped "early" due to export rules.

Such arguments neglect national regulations of the importing countries to reduce the national emission of NOx and particles and the shared responsibility of exporters and importers to enforce such regulations. Secondly, it neglects the (current) lack in waste management in most of the receiving countries. And thirdly, it appears that, at least for the EU “scrappage premium”, the CO_2-balance of such scrappage premium was positive. While not 100% comparable, the study team looked with this regard in evaluations of the scrappage premiums in 2008/2009:

Two studies (ifeu (2009); HIS (2010)) assessed the impact of the “scrappage premiums” in 2008/2009 and concluded it had positive impacts on air pollution particularly due to the scrapping of vehicles with EU emission standard below Euro 4. Furthermore, fossil fuel consumption was reduced significantly. The studies further compare the CO_2 emissions during the use phase (either continuing use of the old used vehicle or emissions of the new subsidised vehicle) with the CO_2 emissions caused by the production and recycling. In result the reduced emission during the use phase can compensate the emissions caused by the reduced lifetime.

However, within the limited time frame of this study to provide ad-hoc support to the ELV impact assessment, it was not possible to develop a comprehensive fleet model (and assumptions for future developments / scenarios) for the receiving countries and to use advanced assessment tools like LCA for a global impact assessment. However, a separate section describes the tasks that need to be performed to establish such quantitative modelling.

6.12.3 Economic impacts

Economic impacts on commercial stakeholders in the EU are described in detail in section 3.2.5. Particular impacts on ATFs can be found in 3.2.5.4 and on used car dealers in section 3.2.5.5. According to this assessment, ATFs and car dealers will be exposed to relevant losses of profits due to the introduction of the requirement to demonstrate that the car to be exported has a valid roadworthiness certificate. These assessments on economic impacts are “conservative” assumptions as it considers that all vehicles potentially falling today under the criteria “no roadworthiness certificate” or “not in compliance with the requirements in the receiving countries” will be not exported but scrapped in the EU. However, it is not unlikely that a certain share of the losses for dealers will be compensated by the export of vehicles in better condition and exporters might seek to get roadworthiness certificates for the vehicles for export. Insofar the economic impacts to the commercial stakeholders might be less harmful than described in the support study. In addition, the study team expects a continuing demand for qualified spare parts for vehicles running in receiving countries. Since this demand can no longer be met with end-of-life vehicles (two vehicles become one), the market for exporting used spare parts could grow.

The impact on consumers is not addressed in model calculations of this IA support study. However, it assumed that the demand in the EU for old vehicles in poor condition will decline and prices / revenues for the owners of such vehicles will decline too. This might be possibly compensated by increasing demand for mid-aged vehicles when a shift of the demand from non-EU countries becomes effective (see above).

The economic impact for the receiving countries is not assessed in model calculations in this IA support study. Presumably, the demand for affordable vehicles in the receiving countries will persist. At the same time several governments aim to regulate the (emission) quality of the imported vehicles either by age or emission level as reported in section 6.5.1.2 and 6.5.1.5. In 2020, 82 non-EU countries in Africa and Eastern Europe, the Caucasus, Central Asia, and Middle East, receive vehicles from the EU. 59 of the 82 countries have regulations for the import of used vehicles either by age or emission class (or both). 82% of the used vehicles exported to non-EU countries in Africa and Eastern Europe, the Caucasus, Central Asia, and Middle East are exported to these 59 countries. However, most of them face difficulties in enforcing their import regulations for diverse reasons. Therefore, the governments and the UN claim a joint responsibility of the importing countries and also the exporting countries (here EU).

The governments for the receiving countries are well aware that prices for (younger) vehicles with less emission might increase the prices for transport.

6.12.4 Environmental impacts and aspects regarding circular economy

Environmental impacts can be expected for different impact categories as

- Younger fleet, with more advanced emission reduction, will help to improve the air quality in the receiving countries (in particular in the cities where traffic congestion is often the norm) and support the advanced countries in their national strategy accordingly (“shared responsibility”).
- Since in non-EU countries repair with local labour and with used components is more affordable than in the EU, vehicles exported to non-EU countries often have a service life of up to 30 years. If fewer EU vehicles are exported, this could shorten the lifespan of vehicles first brought to market in the EU. Shorter lifetime increases the demand of resources for the production of additional vehicles. Shorter lifetime and at the same time

the same number of vehicles per capita in a global perspective is increasing the demand of resources (including non-renewable) for the production of vehicles.

- Younger fleet will possibly also consume less fuel per km and thus the consumption of fossil fuels during the use phase might be less than for an older fleet.
- Many of the receiving countries do not have effective recycling infrastructure in place and hence a lot of the recycling potential is lost when vehicles are exported to these countries. The lack of a recycling structure goes hand in hand with a lack of infrastructure for depollution and waste disposal, e.g. for the treatment of waste oil, tyres, refrigerants from air-conditioning systems and, last but not least, for the recycling of lead batteries. Unfortunately, the dangerous pollution caused by this lack of infrastructure cannot be reduced by the requirement that exported vehicles be accompanied by a valid roadworthiness certificate.
- In cases where importing countries can enforce regulations on imported vehicles, vehicles not meeting national standards are impounded at the ports of entry and left to deteriorate. These vehicle ´graveyards´ present another environmental challenge to those countries that do not have the recycling facilities mentioned above.

In the following the assumptions for the above mentioned aspects are outlined:

6.12.4.1 Emission-characteristics of vehicles exported to Africa

The Dutch ILT-IDlab carried out in 2020 inter alia a desk study and assessed the vehicles exported to the top 12 countries in Africa in 2017 / 2018 (in total 30,083). These countries are three countries in North Africa (12,404 vehicles), eight (ECOWAS) countries in West Africa (17,868), and one country in East Africa (1,068 vehicles).[396]

According to this study “the majority of used vehicles exported from the Netherlands to top 8 West African countries have Euro standard 0, 1, 2, and 3.” One exception is Ghana, which also receives a significant share of Euro 4 vehicles. Another exemption is Morocco, strictly applying the import requirement that the maximal age of imported vehicles is 5 years and that the imported vehicles must comply with Euro 4 standard (Baron et. al (2020)). Details of the distribution of emission level for the assessed countries are displayed in Annex A.

6.12.4.2 Euro emission standard and real-world emissions

Emissions regulations in the EU date back to 1970. The regulations define acceptable limits for exhaust emissions of new vehicles sold in the EU. Table B-1 in Annex B displays the emission standards Euro 1 to Euro 7 for passenger cars (Category M1) and Table B-2 to B-4 display the emission standards Euro 1 to Euro 6d for light commercial vehicles (Category N1 and N2)

Because petrol and diesel engines produce different types of emissions, they are subject to different standards.

However, the reals world emissions of the vehicles do not always match well with the standards as it became obvious in 2015 with the so called “diesel gate”. TNO has undertaken emission testing for the Dutch government continuously since the 1980’s. There are comprehensive programmes to test passenger cars, vans, trucks, buses and two-wheelers. The main purpose of the measurement programmes is to determine the on-road, in-use

[396] Source Used Vehicles Exported to Africa, Netherlands Human Environment and Transport Inspectorate, Ministry of Infrastructure and Water Management, 2020

emission performance of vehicles relevant to Dutch air quality. The emissions factors for different road types and congestion levels are updated annually on the basis of new measurement results. The reports and the results are available on-line. In Annex B a table is displayed summarising the main results for NOx and exhaust PM emissions (particulate mass).[397]

Leaving aside for a moment all the specifics of the emission standards, the different methods used to measure emissions, and the reasons for continuous improvements, it can be seen from the real emissions reported by TNO that a significant improvement was achieved with the introduction of Euro 4, obligatory for vehicles first registered by January 2006 for NOx from gasoline engines. A similar break through is achieved with Euro 5 for Particulates (PM1) from diesel engines, effective for new vehicles first registered by January 2011. For NOx from diesel engines, a relevant change in real emissions can only be observed with Euro 6 RDE.

For more details refer to Table 6-81 and Table 6-82 below and to Annex C.

Table 6-81 Changes in real-world emissions for passenger cars with petrol engine on urban roads

Emission standard	Unit	NOx	Particles (PM1)
Euro 3	(g/km)	0.15 to 0.21 g/km	0.0046
Euro 4	% change compared to Euro 3	-62 to -64 %	0%
Euro 5		-70 to -71 %	-20%
Euro 6		-70 to -71 %	-20%

Source: own calculations with data from: Ligterink, Norbert, TNO (2017): Real-word Vehicle Emissions; Discussion Paper No. 2017-06; Prepared for the report "Strategies for Mitigating Air Pollution in Mexico City"

Table 6-82 Changes in real-world emissions for passenger cars with diesel engine on urban roads

Emission standard	Unit	NOx	Particles (PM1)
Euro 4	(g/km)	0.43 – 0.69 g/km	0.033 to 0.051
Euro 5	% reduction compared to Euro 4	+ 45 to +56 % (!)	-98 to -99%
Euro 6		0 to -20 %	-98 to -99%
Euro 6 RDE		-47 to -55 %	-98 to -99%

Source: own calculations with data from: Ligterink, Norbert, TNO (2017): Real-word Vehicle Emissions; Discussion Paper No. 2017-06; Prepared for the report "Strategies for Mitigating Air Pollution in Mexico City"

6.12.4.3 Conclusion on impacts on air pollution

If roadworthy

[397] Source: Ligterink, Norbert, TNO (2017): Real-word Vehicle Emissions; Discussion Paper No. 2017-06; Prepared for the report "Strategies for Mitigating Air Pollution in Mexico City"

- all gasoline vehicles sold from January 2006 (today, in 2023, 17 years old) comply with Euro 4 emission standard and
- all diesel vehicles sold from January 2011 (today, in 2023, 12 years old) comply with Euro 5 emission standard.

Compared to older vehicles or vehicles which are not roadworthy, e.g. by not functioning exhaust treatment, the above-mentioned Euro 4 and Euro 5 vehicles reduce the emission level in the receiving countries, if they replace an older vehicle.

The qualitative assumption for the impact assessment is that the measure to establish a valid roadworthiness certificate as a condition for the export will accelerate the shift from below Euro 4 to vehicles complying with Euro 4 and better and thus support the national governments in their effort to improve the air quality in African cities. The problematic air quality is outlined above in section 6.5.1.7 of this study.

A quantitative modelling will need assumptions for the composition of the total fleet (and possibly a breakdown for the agglomerations / large cities, as here the air quality is problematic) and the development of the composition of the fleet under BAU conditions and the development of the composition of the fleet under a policy option with criteria for the export of vehicles.

6.12.4.4 Less emissions and fossil fuel consumption by a younger fleet

In the context of export restrictions, it is often argued that it would be a waste of resources and also not CO2-efficient if a used car for which there is a demand / market in extra-EU countries were to be scrapped "early" due to export rules.

At first glance these arguments neglect demand of the importing countries to reduce their national emissions of NOx and particles and the shared responsibility of exporters and importers as mentioned in the sections before. Secondly it neglects the (current) lack in waste management in most of the receiving countries as mentioned in a separate section of this report.

While it is not possible in the given time to develop a comprehensive fleet model for the receiving countries and to use advanced assessment tools like LCA for a global impact assessment, some conclusions might be taken two studies evaluating the “scrapping premiums” during the financial crisis in 2008/2009.

In January 2009, the German Federal Government introduced an "Umweltprämie” (an environmental bonus) in the amount of € 2,500 as part of the Konjunkturprogramm II (an Economic Stimulus Programme). It was granted as a one-time state subsidy if a private owner purchases a new passenger car or annual car and at the same time demonstrably scraps a passenger car that is at least 9 years old and was previously registered to the owner for at least 1 year. The effects of this "Umweltprämie” on the environment were examined in an expert report by ifeu on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (ifeu 2009). Due to the premium pot of €5 billion, the study assumed around 2 million cars scrapped in 2009 and 2010, representing around 4.8% of the entire German fleet of passenger cars.

The results show that the Umweltprämie led to a reduction in air pollutant emissions from motor vehicle traffic. When they were first registered, passenger cars had to comply with the standards in force at the time. This meant that they were allowed to emit considerably more air pollutants (nitrogen oxides, benzene, hydrocarbons, carbon monoxide and particulates) with their engine exhaust than they do today. The newly registered vehicles meet the limit value levels 4 and 5 valid in 2009 and, as diesel passenger cars, usually also have a particulate filter. The older the old vehicle, the greater the difference in emissions compared to new vehicles. According to ifeu 2009, 9 % of benzene, 7 % of carbon monoxide, 5 % of nitrogen oxides and just over 4 % of diesel particulate emissions from the entire German passenger car fleet were saved (ifeu 2009).

The CO_2 emissions of new cars were calculated in ifeu 2009 at 160 g CO2/km. This value was 40 g/km and thus 20% below the average of 200 g/km for the scrapped passenger cars. The difference between the old cars and the new cars replacing them is therefore 1.7 l petrol/100 km and 1.5 l diesel/100 km respectively. This resulted in a saving of around 340 million litres of fuel or 1 million tonnes of CO_2, if the emissions from fuel production are also considered. This CO_2 saving corresponds to just under 1% of all passenger car emissions in Germany. The fact that this effect is so small is because the substituting passenger cars only account for 4 % of the mileage of all passenger cars.

The CO_2 emission caused by the production of a new vehicle and the recycling of a typical end-of-life vehicle was assumed to be 4.5 tonnes. This environmental burden can be depreciated over the distance driven or the age of the car. With an average use of 15.4 years, this amounts to 290 kg CO_2 per year of life. If the car is scrapped one year earlier, i.e. at 14.4 years (average age of cars now scrapped), 290 kg CO_2 remain as undepreciated residual debt. This CO_2 emission arises from the consumption of 100 litres of petrol. The residual debt can therefore be paid off with the saving of 100 litres of petrol and thus after 6,000 km, since the new cars consume on average 1.7 l/100 km less than the scrapped ones. After that, the new vehicle is in the plus in terms of CO_2. (ifeu 2009)

In the same year that the “Umweltprämie” was introduced in Germany (2009), scrapping incentives have been enacted in thirteen member states of the EU. These scrappage programs were in operation in markets that typically represent 85% of total vehicle sales in the EU. The 'typical' scheme required the scrapping of a vehicle with a minimum age of 10 years and provided an incentive of € 1,500 for the purchase of a new car. In total, scrapping schemes have cost European governments a total of €7.9 billion in outlay plus the cost of administration. In a study published in 2010, IHS Global Insight, on behalf of DG Enterprise and Industry, examined the short- and medium-term effects of vehicle scrappage schemes introduced in Member States in 2009 in terms of economic, environmental and safety impacts (IHS Global Insight 2010a; IHS Global Insight 2010b).

The average new car bought in 2009 under the scrappage scheme has estimated CO_2 emissions of only 135.9 g/km, 18 g/km below the EU market average in 2008. According to the calculations (IHS Global Insight 2010a), the average CO_2 emissions of the entire fleet have been reduced to about 145 g/km. This means that 1.05 million tonnes of CO_2 were saved at EU level during 2009 as a direct result of the scrappage schemes introduced. This corresponds to an average saving of 0.49 tonnes per additional vehicle sold. The cumulative CO_2 emissions saved were estimated at a total of 1.79 million tonnes by the end of 2010 and 2.3 million tonnes by the end of 2011. Under the programs, over one million Euro 1 and pre-Euro 1 standard cars and almost one million Euro 2 cars were withdrawn from use and were replaced by a mix of 84% Euro 4 and 16% Euro 5 vehicles. This leads to a reduction in both NOx and particulate matter (IHS Global Insight 2010a).

6.12.4.5 Increasing the demand of resources for the production of vehicles

New export requirements (valid roadworthiness certificate) might shorten the lifetime of vehicles placed first at the EU market. Shorter lifetime increases the demand of resources for the production of additional vehicles. Different scenarios might apply for the replacement of these not exported EU vehicles in the receiving countries.

a) The receiving countries replace these cars with newer used cars from the EU-Market (as far as the total service life remains as long as before (e.g. 30 years), this will not change in the global demand for resources).

b) The receiving countries seek to import the same kind of (old) used vehicles from other markets (US / Japan / China(?)).

c) The receiving countries increase the share of new vehicles placed on the market, possibly not EU-brands but other brands. The expected lifetime is to be assessed.

In the studies of ifeu (2009) and IHS Global Insight (2010), the demand of resources was only taken into account with regard to the resulting emissions of CO_2 and air pollutants. Results from the calculations of the used and recycled materials were not published. Other studies on this question could not be found in the time available.

A calculation of possible additional resource consumption depends strongly on the assumptions how the receiving countries will compensate for changed EU-export requirements and on the expected lifetime of vehicles placed on the market in the receiving countries. Different scenarios could be modelled based on an extended Oeko model.

6.12.4.6 Lack in waste management and lost secondary raw materials due to missing recycling infrastructure in receiving countries

Many of the receiving countries have no effective recycling infrastructure in place and a lot of the recycling potential is lost when vehicles are exported to these countries.

The problem anyhow exists, also without the import of (old) used vehicles. Thus, there is an urgent need to start establishing advanced recycling capacities (feeding national industries).

Exports of (very) old vehicles increase the problem compared to the import of younger imports as the following assumption demonstrates:

If the vehicle is imported at an age of 5 years and complies with Euro 4 (respectively 5 for diesel) it will possibly last another 25 years in the country of destination before becoming an ELV. An imported vehicle with an age of 18 years might last another 12 years in the receiving country before becoming waste. Thus, the waste generated for the same service is twice as much when old vehicles are imported.

If this waste cannot be treated as hazardous waste and not recycled, the impact in the receiving country is a risk of environmental pollution and for the global perspective secondary resources are wasted.

6.12.5 What tasks need to be performed to establish quantitative modelling covering the beforementioned environmental impacts

For further assessment whether a shortened lifespan for vehicles might be meaningful, we see the following aspects:

The introduction of stricter criteria for the export of vehicles to non-EU countries will be examined using the export of used cars from the EU to West Africa as an example. Here, the effects will be examined if the used cars are no longer exported but remain in the EU and are scrapped here instead. Based on the previous calculations with the Oeko model for recycling, possible impacts can be modelled up to 2030/2040. A distinction would be made between impacts in the European Union and impacts in West Africa.

Several options are possible for the modelling:

- A ban on the export of used cars to West Africa with a constant useful life in the EU.
- A ban on the export of used cars to West Africa with an extension of the useful life in the EU.

Environmental impacts that should be considered:

- CO_2 emissions
- Emissions of air pollutants
- Resource consumption for the production of new cars
- Secondary materials available from recycling

For the modelling, we propose to extend the fleet model for passenger cars in the EU to include production phase and use phase. Furthermore, a simplified model of the car fleet in West Africa should be created in order to model in particular the current and perspective composition of the car fleet there (under BAU conditions and under policy option with criteria for the export of vehicles) and to be able to assess the resulting environmental impacts and resource flows.

6.12.6 References

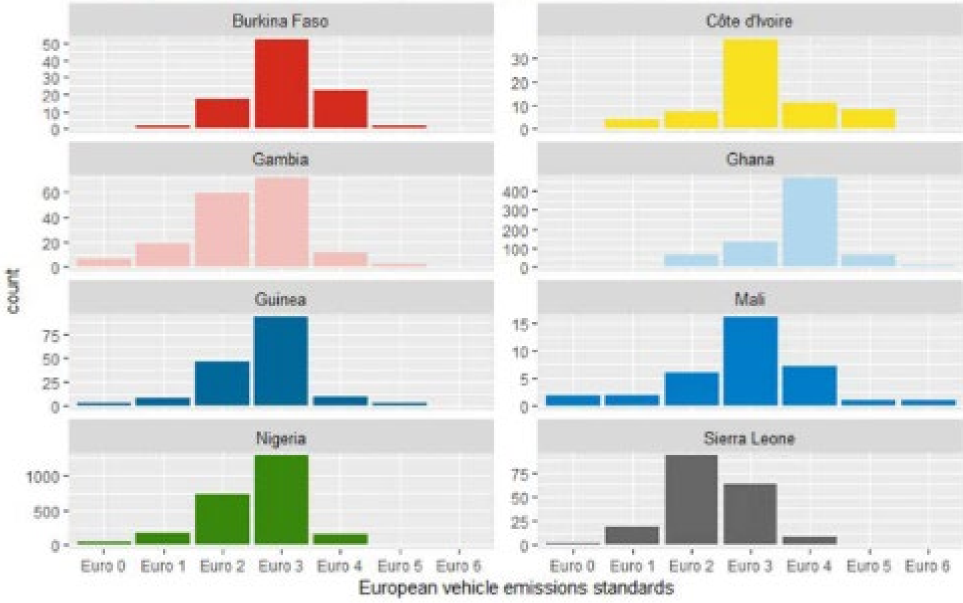
Ifeu 2009: Abwrackprämie und Umwelt – eine erste Bilanz. Gutachten im Auftrag des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit (BMU). Fachliche Bearbeitung: Dr. Ulrich Höpfner unter Mitarbeit von Dr. Jan Hanusch und Dipl.-Phys. Udo Lambrecht. ifeu – Institut für Energie-und Umweltforschung Heidelberg GmbH. Heidelberg 2009.

IHS Global Insight 2010a: IHS Global Insight: Assessment of the Effectiveness of Scrapping Schemes for Vehicles Economic, Environmental, and Safety Impacts. Prepared for European Commission, DG Enterprise and Industry, Automotive Industry. Final Report March 2010. Online available under: https://circabc.europa.eu/sd/a/bcc4c732-6f54-4047-b661-42a5f3d1c490/report_scrapping_schemes_en.pdf, last access 29 May 2023

IHS Global Insight 2010b: IHS Global Insight: Assessment of the Effectiveness of Scrapping Schemes for Vehicles. Country Profile Annex. . Prepared for European Commission, DG Enterprise and Industry, Automotive Industry. Final Report March 2010. Online available under: https://circabc.europa.eu/sd/a/b34363fe-8903-4d9c-a2f1-aa38733f0500/report_scrapping_schemes_annex_en.pdf, last access 29 May 2023

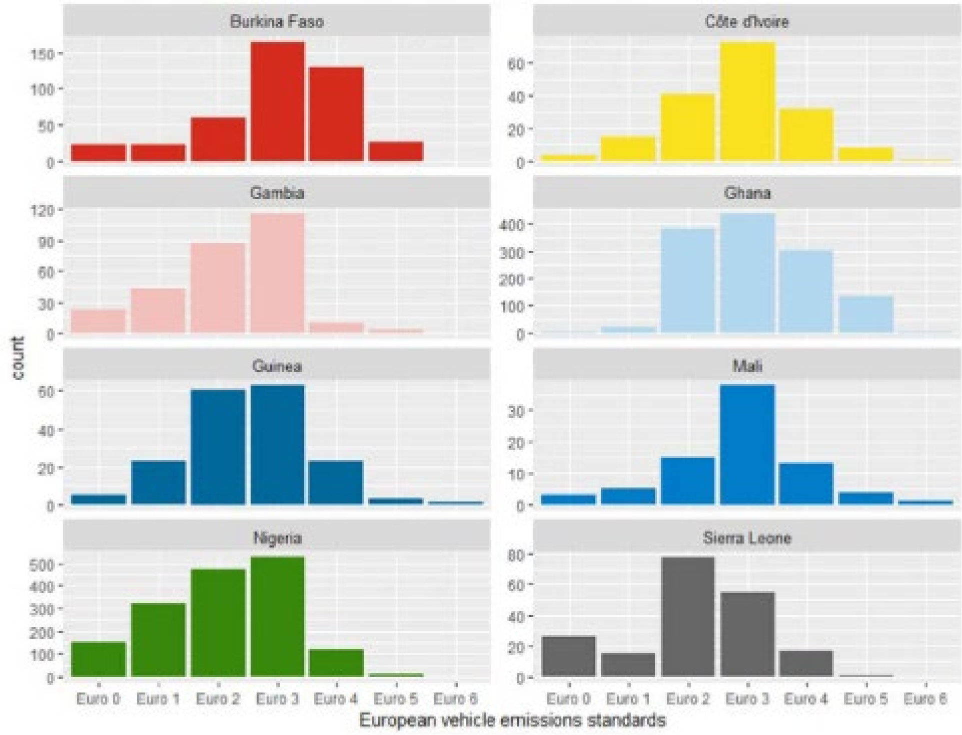
6.12.7 Annex A: EU vehicle emission standards of exported vehicles to selected countries

Figure 6-31 EU vehicle emission standard of retrieved petrol vehicles exported to West African countries in the top 12



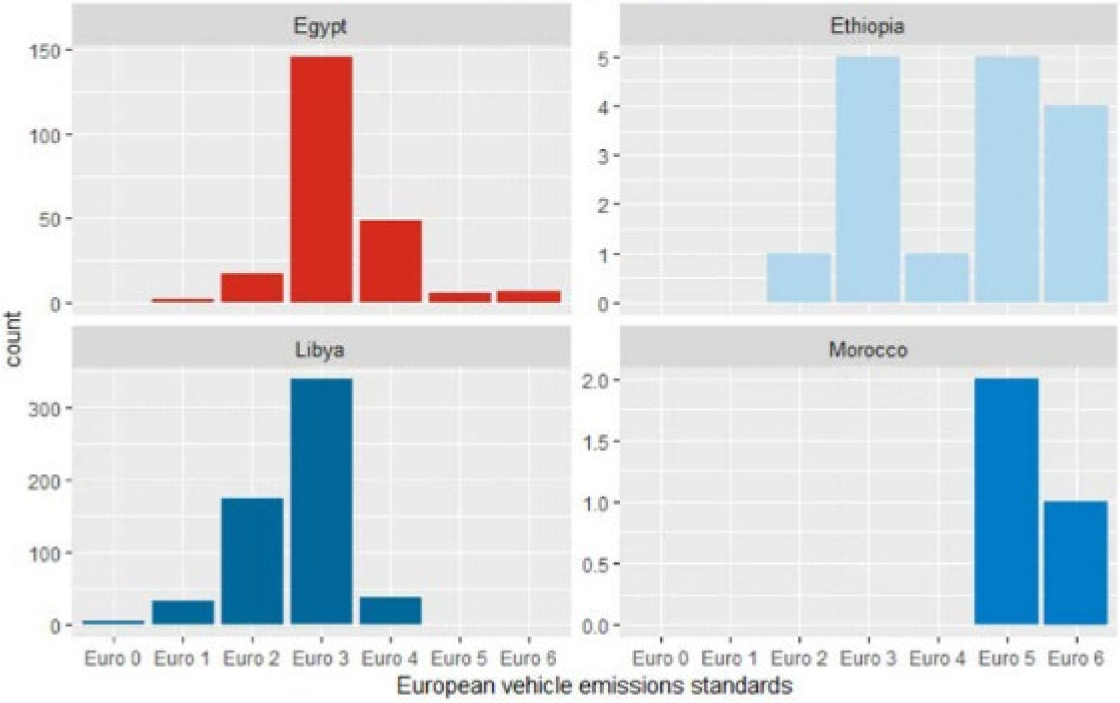
Source / Data: combined Customs and RDW. © ILT-IDlab

Figure 6-32 EU vehicle emission standard of retrieved diesel vehicles exported to West African countries in the top 12



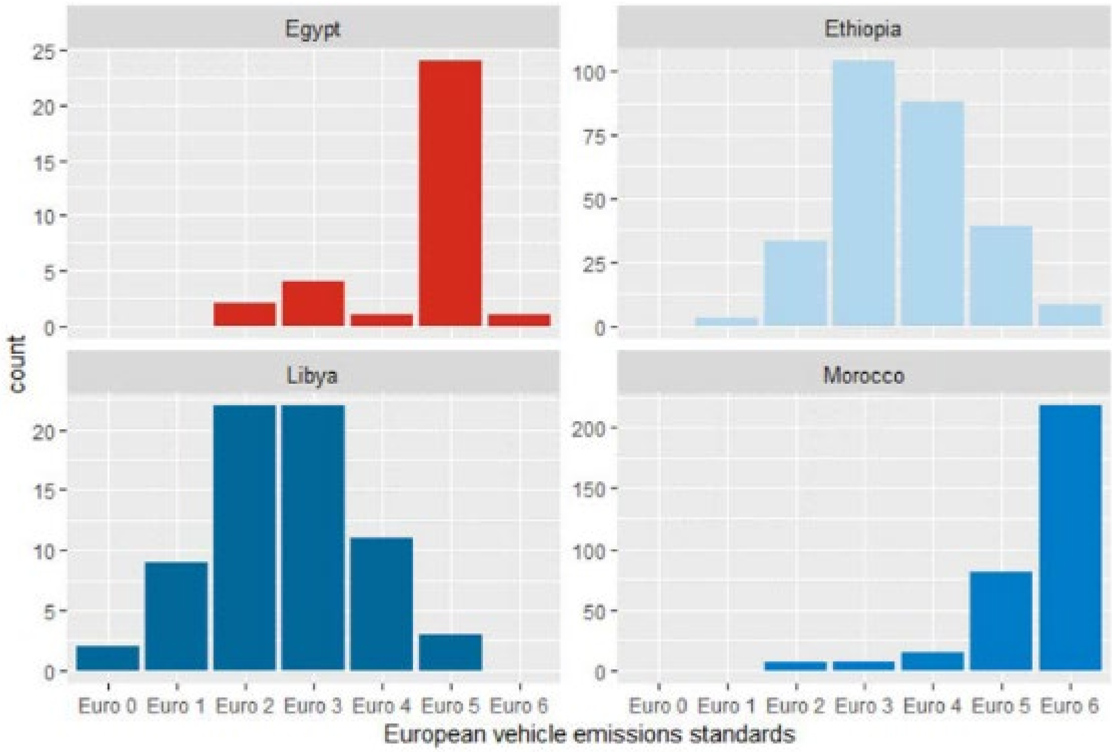
Source / Data: combined Customs and RDW. © ILT-IDlab

Figure 6-33 EU vehicle emission standard of retrieved petrol vehicles exported to other countries in the top 12



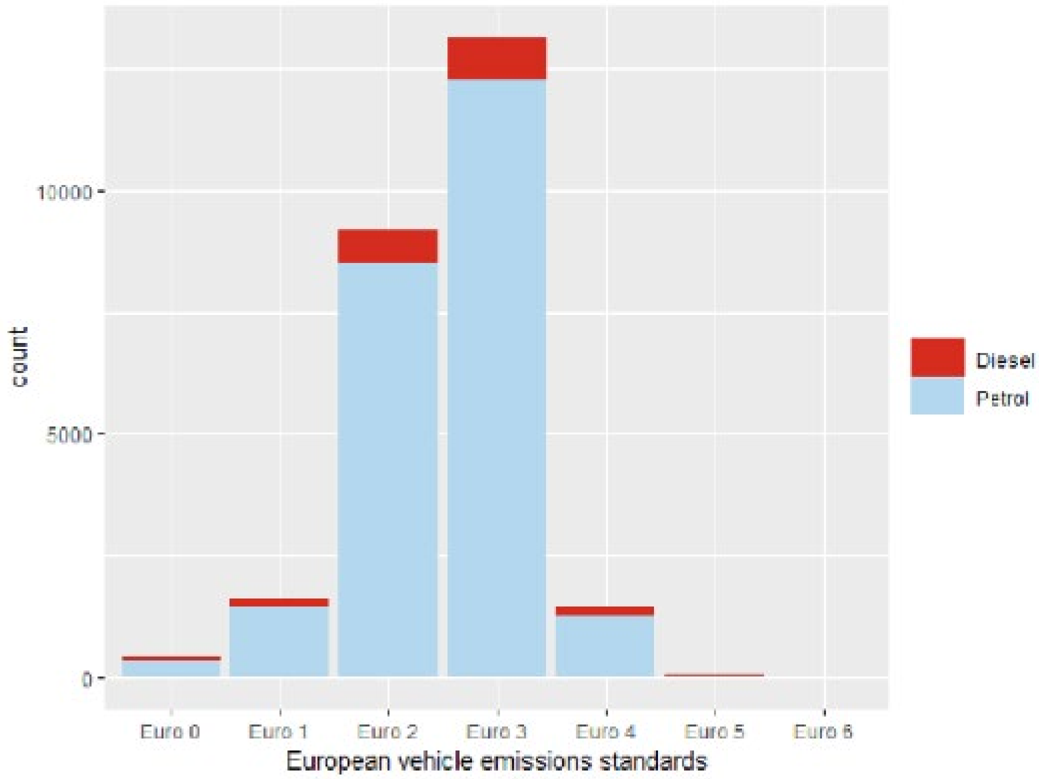
Source / Data: combined Customs and RDW. © ILT-IDlab

Figure 6-34 EU vehicle emission standard of retrieved diesel vehicles exported to other countries in the top 12



Source / Data: combined Customs and RDW. © ILT-IDlab

Figure 6-35 EU vehicle emission standard of retrieved diesel vehicles exported to Lybia



Source / Data: combined Customs and RDW. © ILT-IDlab

6.12.8 Annex B: Development of EU Emission standards

Table 6-83 EU Emission standards for passenger cars (Category M) [(a);] g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NH_3	NO_x	$HC+NO_x$	PM	PN [#/km]	Brake PM_{10}[b]
Diesel											
Euro 1[c]	July 1992	January 1993	2.72 (3.16)	–	–	–	–	0.97 (1.13)	0.14 (0.18)	–	–
Euro 2	January 1996	January 1997	1.0	–	–	–	–	0.7	0.08	–	–
Euro 3	January 2000	January 2001	0.66	–	–	–	0.50	0.56	0.05	–	–
Euro 4	January 2005	January 2006	0.50	–	–	–	0.25	0.30	0.025	–	–
Euro 5a	September 2009	January 2011	0.50	–	–	–	0.180	0.230	0.005	–	–
Euro 5b	September 2011	January 2013	0.50	–	–	–	0.180	0.230	0.0045	6×10^{11}	–
Euro 6b	September 2014	September 2015	0.50	–	–	–	0.080	0.170	0.0045	6×10^{11}	–
Euro 6c	–	September 2018	0.50	–	–	–	0.080	0.170	0.0045	6×10^{11}	–
Euro 6d-Temp	September 2017	September 2019	0.50	–	–	–	0.080	0.170	0.0045	6×10^{11}	–
Euro 6d	January 2020	January 2021	0.50	–	–	–	0.080	0.170	0.0045	6×10^{11}	–
Petrol											
Euro 1[c]	July 1992	January 1993	2.72 (3.16)	–	–	–	–	0.97 (1.13)	–	–	–
Euro 2	January 1996	January 1997	2.2	–	–	–	–	0.5	–	–	–
Euro 3	January 2000	January 2001	2.3	0.20	–	–	0.15	–	–	–	–
Euro 4	January 2005	January 2006	1.0	0.10	–	–	0.08	–	–	–	–
Euro 5a	September 2009	January 2011	1.0	0.10	0.068	–	0.060	–	0.005[d]	–	–
Euro 5b	September 2011	January 2013	1.0	0.10	0.068	–	0.060	–	0.0045[d]	–	–
Euro 6b	September 2014	September 2015	1.0	0.10	0.068	–	0.060	–	0.0045[d]	6×10^{11}[e]	–
Euro 6c	–	September 2018	1.0	0.10	0.068	–	0.060	–	0.0045[d]	6×10^{11}	–
Euro 6d-Temp	September 2017	September 2019	1.0	0.10	0.068	–	0.060	–	0.0045[d]	6×10^{11}	–
Euro 6d	January 2020	January 2021	1.0	0.10	0.068	–	0.060	–	0.0045[d]	6×10^{11}	–
Petrol and diesel											
Euro 7[12][f] (proposed)	July 2025[12]	July 2025[12]	0.50	0.10	0.068	0.02	0.060	–	0.0045	6×10^{11}	0.007

a. ^ Before Euro 5, passenger vehicles > 2,500 kg were type approved as light commercial vehicles N_1 Class I
b. ^ Brake particle emissions (PM_{10}). Only regulated for M1, N1 vehicles and only as PM - not PN. After 2035 the limit drops to 0.003. HDV will still not be subject to brake particle emissions regulation even after 2035.
c. ^ a b Values in parentheses are conformity of production (COP) limits
d. ^ a b c d e f Applies only to vehicles with direct injection engines
e. ^ 6×10^{12}/km within first three years from Euro 6b effective dates
f. ^ Euro 7 harmonizes emission limits for all N1 and M1 vehicles

Source: https://en.wikipedia.org/wiki/European_emission_standards

Table 6-84 EU Emission standards for light commercial vehicles with <= 1 305 kg reference mass (Category N1, Class I), g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO_x	$HC+NO_x$	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	2.72	–	–	–	0.97	0.14	–
Euro 2	January 1997	October 1997	1.0	–	–	–	0.7	0.08	–
Euro 3	January 2000	January 2001	0.64	–	–	0.50	0.56	0.05	–
Euro 4	January 2005	January 2006	0.50	–	–	0.25	0.30	0.025	–
Euro 5a	September 2009	January 2011	0.500	–	–	0.180	0.230	0.005	–
Euro 5b	September 2011	January 2013	0.500	–	–	0.180	0.230	0.0045	6×10^{11}
Euro 6b	September 2014	September 2015	0.500	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6c	–	September 2018	0.500	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	0.500	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6d	January 2020	January 2021	0.500	–	–	0.080	0.170	0.0045	6×10^{11}
Petrol									
Euro 1	October 1993	October 1994	2.72	–	–	–	0.97	–	–
Euro 2	January 1997	October 1997	2.2	–	–	–	0.5	–	–
Euro 3	January 2000	January 2001	2.3	0.20	–	0.15	–	–	–
Euro 4	January 2005	January 2006	1.0	0.10	–	0.08	–	–	–
Euro 5a	September 2009	January 2011	1.000	0.100	0.068	0.060	–	0.005[a]	–
Euro 5b	September 2011	January 2013	1.000	0.100	0.068	0.060	–	0.0045[a]	–
Euro 6b	September 2014	September 2015	1.000	0.100	0.068	0.060	–	0.0045[a]	6×10^{11}
Euro 6c	–	September 2018	1.000	0.100	0.068	0.060	–	0.0045[a]	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	1.000	0.100	0.068	0.060	–	0.0045[a]	6×10^{11}
Euro 6d	January 2020	January 2021	1.000	0.100	0.068	0.060	–	0.0045[a]	6×10^{11}

a. ^ a b c d e f Applies only to vehicles with direct injection engines

Source: https://en.wikipedia.org/wiki/European_emission_standards

Table 6-85 EU Emission standards for light commercial vehicles with 1 305 – 1760 kg reference mass (Category N1, Class II), g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO_x	$HC+NO_x$	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	5.17	–	–	–	1.4	0.19	–
Euro 2	January 1998	October 1998	1.25	–	–	–	1.0	0.12	–
Euro 3	January 2001	January 2002	0.80	–	–	0.65	0.72	0.07	–
Euro 4	January 2006	January 2007	0.63	–	–	0.33	0.39	0.04	–
Euro 5a	September 2010	January 2012	0.630	–	–	0.235	0.295	0.005	–
Euro 5b	September 2011	January 2013	0.630	–	–	0.235	0.295	0.0045	6×10^{11}
Euro 6b	September 2015	September 2016	0.630	–	–	0.105	0.195	0.0045	6×10^{11}
Euro 6c	–	September 2019	0.630	–	–	0.105	0.195	0.0045	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	0.630	–	–	0.105	0.195	0.0045	6×10^{11}
Euro 6d	January 2021	January 2022	0.630	–	–	0.105	0.195	0.0045	6×10^{11}
Petrol									
Euro 1	October 1993	October 1994	5.17	–	–	–	1.4	–	–
Euro 2	January 1998	October 1998	4.0	–	–	–	0.6	–	–
Euro 3	January 2001	January 2002	4.17	0.25	–	0.18	–	–	–
Euro 4	January 2006	January 2007	1.81	0.130	–	0.10	–	–	–
Euro 5a	September 2010	January 2012	1.810	0.130	0.090	0.075	–	0.005[a]	–
Euro 5b	September 2011	January 2013	1.810	0.130	0.090	0.075	–	0.0045[a]	–
Euro 6b	September 2015	September 2016	1.810	0.130	0.090	0.075	–	0.0045[a]	6×10^{11}
Euro 6c	–	September 2019	1.810	0.130	0.090	0.075	–	0.0045[a]	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	1.810	0.130	0.090	0.075	–	0.0045[a]	6×10^{11}
Euro 6d	January 2021	January 2022	1.810	0.130	0.090	0.075	–	0.0045[a]	6×10^{11}

a. ^ a b c d e f Applies only to vehicles with direct injection engines

Source: https://en.wikipedia.org/wiki/European_emission_standards

Table 6-86 EU Emission standards for light commercial vehicles with > 1760 kg reference mass max 3 500 kg (Category N1, Class III & N2), g/km

European emission standards for light commercial vehicles > 1,760 kg reference mass max 3,500 kg. (Category N_1 Class III & N_2), g/km

Tier	Date (type approval)	Date (first registration)	CO	THC	NMHC	NO_x	HC+NO_x	PM	PN [#/km]
Diesel									
Euro 1	October 1993	October 1994	6.9	–	–	–	1.7	0.25	–
Euro 2	January 1998	October 1999	1.5	–	–	–	1.2	0.17	–
Euro 3	January 2001	January 2002	0.95	–	–	0.78	0.86	0.10	–
Euro 4	January 2006	January 2007	0.74	–	–	0.39	0.46	0.06	–
Euro 5a	September 2010	January 2012	0.740	–	–	0.280	0.350	0.005	–
Euro 5b	September 2011	January 2013	0.740	–	–	0.280	0.350	0.0045	6×10^{11}
Euro 6b	September 2015	September 2016	0.740	–	–	0.125	0.215	0.0045	6×10^{11}
Euro 6c	–	September 2019	0.740	–	–	0.125	0.215	0.0045	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	0.740	–	–	0.125	0.215	0.0045	6×10^{11}
Euro 6d	January 2021	January 2022	0.740	–	–	0.125	0.215	0.0045	6×10^{11}
Petrol									
Euro 1	October 1993	October 1994	6.9	–	–	–	1.7	–	–
Euro 2	January 1998	October 1999	5.0	–	–	–	0.7	–	–
Euro 3	January 2001	January 2002	5.22	0.29	–	0.21	–	–	–
Euro 4	January 2006	January 2007	2.27	0.16	–	0.11	–	–	–
Euro 5a	September 2010	January 2012	2.270	0.160	0.108	0.082	–	0.005[a]	–
Euro 5b	September 2011	January 2013	2.270	0.160	0.108	0.082	–	0.0045[a]	–
Euro 6b	September 2015	September 2016	2.270	0.160	0.108	0.082	–	0.0045[a]	6×10^{11}
Euro 6c	–	September 2019	2.270	0.160	0.108	0.082	–	0.0045[a]	6×10^{11}
Euro 6d-Temp	September 2018	September 2020	2.270	0.160	0.108	0.082	–	0.0045[a]	6×10^{11}
Euro 6d	January 2021	January 2021	2.270	0.160	0.108	0.082	–	0.0045[a]	6×10^{11}

a. ^ a b c d e f Applies only to vehicles with direct injection engines

Source: https://en.wikipedia.org/wiki/European_emission_standards

6.12.9 Annex C: Development of real world emissions under Euro emissions standards

Table 6-87 Real emission standards for passenger cars (Category M) [(a);] g/km

Table A1			Main results of NOx and exhaust PM emissions							
			Urban congested		Urban normal		Rural		Motorway	
		Component	NOx	Particulates (PM1)	NOx	Particulates (PM1)	NOx	Particulates (PM1)	NOx	Particulates (PM1)
			[g/km]	[g/km]	[g/km]	[g/km]	[g/km]	[g/km]	[g/km]	[g/km]
		Legislation								
Passenger cars	Petrol	Euro-1	1.29	0.108	0.72	0.067	0.47	0.0068	0.25	0.0025
		Euro-2	0.69	0.0046	0.47	0.0046	0.21	0.0023	0.20	0.0050
		Euro-3	0.21	0.0046	0.15	0.0046	0.059	0.0023	0.036	0.0050
		Euro-4	0.079	0.0046	0.054	0.0046	0.025	0.0023	0.015	0.0050
		Euro-5	0.063	0.0037	0.043	0.0037	0.020	0.0019	0.012	0.0050
		Euro-6	0.063	0.0037	0.043	0.0037	0.020	0.0019	0.012	0.0050
	Diesel	Euro-1	1.92	0.372	1.06	0.236	0.45	0.101	0.69	0.081
		Euro-2	1.10	0.162	0.80	0.111	0.55	0.045	0.67	0.092
		Euro-3	1.23	0.043	0.80	0.031	0.55	0.026	0.70	0.052
		Euro-4	0.69	0.051	0.43	0.033	0.38	0.016	0.51	0.035
		Euro-5	1.00	0.0005	0.67	0.0005	0.53	0.0005	0.59	0.0015
		Euro-6	0.55	0.0005	0.43	0.0005	0.34	0.0005	0.41	0.0015
		Euro-6 RDE	0.31	0.0005	0.23	0.0005	0.17	0.0005	0.17	0.0015
Light Trucks		pre-Euro	12.4	0.971	7.7	0.54	6.4	0.3273	7.0	0.27
		Euro-1	8.1	0.477	5.0	0.26	4.2	0.1588	4.5	0.13
		Euro-2	8.7	0.192	5.4	0.107	4.4	0.0771	4.6	0.067
		Euro-3	10.3	0.224	5.7	0.124	3.9	0.0747	4.2	0.054
		Euro-4	10.1	0.046	6.3	0.025	3.3	0.0138	3.3	0.0102
		Euro-5	7.4	0.016	4.6	0.0099	2.8	0.0066	1.7	0.0055
		Euro-5 with OBI	7.5	0.014	4.7	0.0087	2.7	0.0057	1.8	0.0048
		Euro-6	0.44	0.010	0.28	0.0061	0.19	0.0042	0.17	0.0037

Source: Ligterink, Norbert, TNO (2017): Real-world Vehicle Emissions; Discussion Paper No. 2017-06; Prepared for the report "Strategies for Mitigating Air Pollution in Mexico City"

ANNEX II: ASSESSMENT OF THE 3R DIRECTIVE AND ITS EFFECTIVENESS

submitted as part of the study request "Develop and assess options to review Directive 2005/64/EC and integration of the results into the impact assessment of the ELV Directive, to be performed under the study request No 070201/2020/839200/SFRA/ENV.B3"

7. Assessment of the 3R Directive and its effectiveness

7.1 Introduction

7.1.1 Study objectives and scope of this report

According to the terms of reference of this study[398], a targeted review of the 3R Directive shall be performed. Its main part consists of an evaluation of the effectiveness of certain elements of the 3R Directive and their linkage to the ELV Directive, a proposal of policy options and related measures to address any shortcomings and identified needs for revision and their analysis. This report presents the results of the 3R Directive evaluation performed in this respect. Other parts of the work have been integrated into the report of the ELVD IA Supporting Study ("main study") performed to support the impact assessment of the ELV Directive of the European Commission. The following table (Table 7-1) details the general objectives, i.e., tasks specifying which parts are included in this report and which have been included in the main report (with cross references).

Table 7-1 List of tasks and references to the location of contents in the reports

Steps	Description	Where it can be found
1	Assessment of the effectiveness of the Directive 2005/64/EC with a view to ensure reusability, recyclability and recoverability of vehicles to be placed on the market.	This report
2	Identification of policy options and measures for reviewing the ELV Directive in relation to the 3R Directive shortcomings	ELVD IA Supporting Study report, section 3.1.2
3	Analysis of the environmental, economic and social impacts of the policy options and related measures presented to review the Directive 2005/64/EC (task 2)	ELVD IA Supporting Study report, section 3.1.4
4	The assessment of the interrelations with general type approval, the ISO 22628: 2002 and other international regulations like UN ECE Regulation No. 133.	This report
5	Stakeholder Consultation • Stakeholder consultation, with a view to collecting data for the tasks above, including performing 10 targeted interviews with stakeholders involved in the type approval procedures; and targeted consultation per survey of additional stakeholders (type approval authorities, technical services, vehicle manufacturers and component suppliers) • Contribution to the stakeholders' workshop on issues of 3R type approval Directive.	ELVD IA Supporting Study report, 0Annex III: Stakeholder consultation (synopsis report), and this report (*)

(*) A summary of the main results of the consultation of stakeholders on the 3R Type approval and its relation to the ELVD is included in this report.

Source: Terms of reference

[398] Develop and assess options to review Directive 2005/64/EC and integration of the results into the impact assessment of the ELV Directive, to be performed under the study request No 070201/2020/839200/SFRA/ENV.B3

Thus, the scope of this report (annex to the main report) is the evaluation of the effectiveness of the 3R Directive (step 1 above) and the assessment of its interrelations with the ISO 22628: 2002 and UN/ECE Regulation No. 133 (step 4 above). It concludes with a specification of the shortcomings and areas requiring revision. This work does not comprise a full evaluation, but only looks at the effectiveness of the Directive in achieving objectives and provisions related to its linkage with the ELVD. Areas identified under the evaluation (steps 1 and 4) were the focus in the development and analysis of policy options and measures addressed under steps 2 and 3 above. Information collected through the interviews and surveys performed under step 5 above has been integrated in the stakeholder consultation synopsis compiled for the ELVD IA Supporting Study. A summary of input, opinions and information provided by stakeholders is included in section 7.3.

7.1.2 Methodology

To develop the framework for the evaluation, the 3R Directive was screened to identify the various provisions and obligations related to the ELV Directive and potentially contributing to the circularity of vehicles and their link to design and end-of-life requirements. A summary of this screening process is detailed in section 7.2.

The following was initially identified to focus the screening stage and to identify how the intention of the regulators is expressed in the origin and the objectives of the 3R Directive in relation to:

- The **scope** of the 3R type approval, whether it is aligned with the ELVD and how this would be affected should the scope of the ELVD is to be extended.
- How ELVD **design requirements** (e.g. the ELVD Article 4(2) substance prohibitions) are taken into consideration in the 3R Type approval provisions and process.
- How **ELVD end-of-life requirements** (e.g. the reuse + recycling target of 85% and reuse + recovery target of 95%, thereafter referred to as 3R targets) are taken into consideration in the 3R Type approval provisions and process.
- What **information** is collected as part of the 3R Directive processes and how does this relate to information that is needed for the implementation of the ELVD?

On the basis of these main areas, the following questions have been formulated for the evaluation of the effectiveness of the 3R Directive:

Table 7-2 Evaluation Matrix

Main area for screening and evaluation	Evaluation questions
The origin and objective of the 3R Directive	• Does the 3R Directive effectively transpose the intention of regulators in relation to Art. 7(4) of ELVD?
The scope of the 3R Directive	• Is the scope of the 3R Directive effective in ensuring that its provisions will be implemented in relation to the vehicles to which it applies? • Is the scope of the 3R Directive aligned with the ELVD at present or in the case that the scope of the ELVD is to be changed in the future?
ELVD design requirements	• Is the way that the 3R Directive refers to the ELVD hazardous substance prohibitions and plastic coding provisions effective in terms of ensuring that vehicles put on the market comply with the related ELVD requirements? • Will the way that the 3R Directive addresses substance prohibitions and plastic coding remain effective in case such prohibitions (or their

Main area for screening and evaluation	Evaluation questions
	exemptions, if applicable) and coding requirements will change in the future? • Will the way that the 3R Directive addresses substance prohibitions remain effective in case such prohibitions (and/or their exemptions) will be regulated by another legislation (e.g. REACH? • Is the 3R Directive effective in ensuring that vehicles put on the market are more circular? • Is the 3R Directive suitable for ensuring in the future that vehicles put on the market will comply with future ELVD provisions on circularity (e.g. recycled content targets)?
ELVD end-of-life requirements	• Is the 3R Directive effective in ensuring that vehicles put on the market enable the reuse of their components and parts to the highest potential? • Is the 3R Directive effective in ensuring that vehicles put on the market enable the recycling of their components and parts to the highest potential? • Is the 3R Directive effective in ensuring that vehicles put on the market are composed of materials that can be recycled to a sufficient degree? • Is the 3R Directive effective in ensuring that vehicles put on the market can fulfil the ELVD 3R targets at present or in case their ambition is increased in the future? • Would the 3R Directive remain effective in ensuring that vehicles put on the market comply with ELVD if requirements would be added to make certain waste management treatments obligatory, e.g., certain post shredder technologies?
Information collected through the 3R Directive processes	• Is the 3R Directive effective in ensuring that ATFs have enough information on vehicles put on the market to allow their waste management in compliance with the ELVD 3R targets?
Alignment of the 3R Directive with the ISO 22628: 2002	• Is the use of the ISO 22628: 2002 in the 3R Type approval process effective in ensuring that type approved vehicles put on the market comply with the ELV provisions? • Is the use of the ISO 22628: 2002 in the 3R Type approval process effective in achieving the objectives of the 3R Directive?
Alignment and coherence with the UN ECE Regulation 133	• Is the 3R Directive coherent with the UN ECE Regulation 133?

For each of the areas identified, the evaluation considers how the current legal text affects the implementation of the 3R type approval and indirectly how it affects the implementation of the ELVD provisions related to the design of vehicles and their waste management. These are looked at in relation to the effectivity of their implementation. As the framework of the assessment includes the linkage to the ELVD, to the ISO 22628: 2002 and to the international UN/ECE Regulation No. 133, coherence of these legislations and frameworks will also play a role.

7.1.3 Structure of the report

In relation to the structure of the report, this introduction is followed by three chapters: section 7.2 describes the current situation. It explains the origin of the 3R legislation and interrelations with ELVD. Furthermore, it outlines the general Type approval legislation, the main provisions of the 3R Directive and the 3R type approval process, as well as the implementation or the

3R Directive. The section that follows (section 7.3) is a summary of the input, opinions and information provided by stakeholders in the stakeholder consultation in relation to the 3R Directive specifically. The consultation strategy is described in the stakeholder consultation synopsis report of the ELVD IA Supporting Study. The evaluation of the results of the effectiveness of the 3R Directive is presented in section 7.4, structured in sub-sections that follow the main areas for screening and include an evaluation of questions listed in the evaluation matrix (Table 7-2). Finally, section 7.5 presents a summary of the main results.

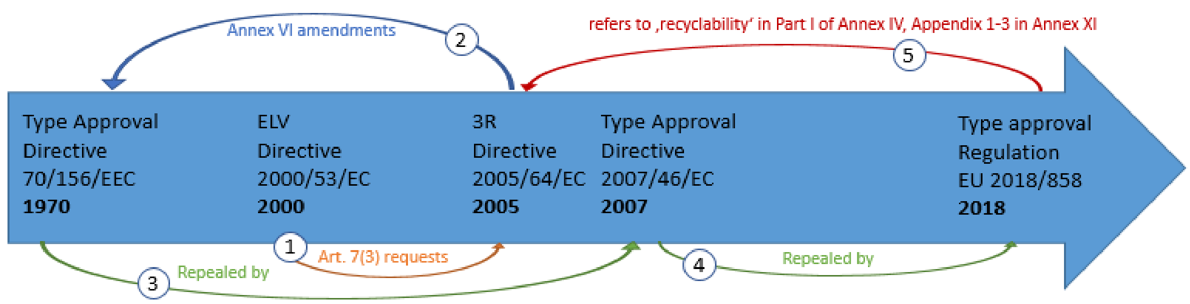
7.2 The current situation

7.2.1 Background to the 3R Directive and its interrelations to the Regulation on Type approval and to the ELV Directive

Directive 2000/53/EC of 18 September 2000 on end-of-life vehicles (hereinafter ELVD) regulates the design and waste management of vehicles throughout their life cycle. Article 7(4) of the ELVD required the Commission to amend Directive 70/156/EEC on type approval in order to make sure that vehicles "*are re-usable and/or recyclable to a minimum of 85 % by weight per vehicle and are re-usable and/or recoverable to a minimum of 95 % by weight per vehicle*". To this end, Directive 2005/64/EC[399] on the type approval of motor vehicles with regard to their reusability, recyclability and recoverability (3R Directive) was adopted in 2005. This relates to steps 1 and 2 detailed in Figure 7-1.

After two revisions, Directive 70/156/EC was repealed by Directive 2007/46/EC at first, and later by Regulation 2018/858/EU (see steps 3 and 4 in Figure 7-1 below). The changes made in the Regulation on Type approval following the amendment prescribed in Annex VI of Directive 2005/64/EC have been maintained throughout the revisions. As a consequence, the Regulation on Type approval from 2018 further relates to the 3R Directive (step 5 in Figure 7-1). Based on the amendment that 3R Directive, Annex VI stipulates for the general type approval that, if the manufacturer does not meet the requirements of the 3R Directive, no type approval shall be granted.

Figure 7-1 Timeline of amendments of ELVD, 3R Directive and Directives and Regulation on type approval



Source: Own illustration, Oeko-Institut 2021

The 3R Directive interrelates the lifecycle steps of the vehicle design and end-of-life by requiring that the design of a vehicle type be investigated to ensure that it will not hinder the achievement of the ELVD 3R targets that are otherwise relevant at the end-of-life stage of a vehicle.

[399] Directive 2005/64/EC of the European Parliament and of the Council of 26 October 2005 on the type-approval of motor vehicles with regard to their Reusability, Recyclability and Recoverability and amending Council Directive 70/156/EEC

It is noted that the 3R Directive (2005/64/EC) refers to Articles of the general type approval legislation in its previous version, i.e. Directive 70/156/EEC. However, some of these have become obsolete or requirements have changed since the Directive's amendments in 2005 and 2018. To give an example: When the 3R Directive came into force, the annual limits for Member States for 'small series' were higher than the limit values stipulated in the 2018 Regulation[400]. In other words, the consequences of certain changes on the 3R Directive, might not have been in the focus of the revisions of general type approval legislation, e.g., the lower limits for small series.

7.2.2 Main provisions of the 3R Directive and relations to other policies

In order to make clear what are the objectives and main provisions of the 3R Directive in its current version in terms of design, reuse, recycling and recovery, related articles and annexes and relations to other policies, namely ELVD, general type approval, WFD and Circular Economy Action Plan are described below.

7.2.2.1 Objective of the 3R Directive

The 3R Directive aims to ensure that type-approved vehicles placed on the market fulfil certain provisions of the ELVD, namely the 85% reuse and/or recycling and 95% reuse and/or recovery targets (Art. 7 of ELVD, Recital 1 and Annex I of 3R Directive). Art. 1 of the 3R Directive stipulates that 'this Directive lays down the administrative and technical provisions for the type approval of vehicles covered by the Art 2 [the scope of 3R Directive], with a view to ensuring that their component parts and materials can be reused, recycled and recovered in the minimum percentages set out in Annex I. It lays down specific provisions to ensure that the reuse of component parts does not give rise to safety or environmental hazards'.

In order to facilitate the treatment of vehicles at their end of life, 'manufacturers should be requested to include [reusability, recyclability and recoverability] at the earliest stages of the development of new vehicles' (Recital 2 of 3R Directive). This is rephrased in Recital 15 of the 3R Directive which states that 'the objective of this Directive [is] to minimize the impact of end-of-life vehicles on the environment by requiring that vehicles be designed from the conception phase with a view to facilitating reuse, recycling and recovery'. Both Recitals point out to the importance of the design phase to ensure the effectiveness of the ELVD, in other words the importance of design for recycling. The Circular Economy Action Plan (COM(2015) 614 final 2015) also emphasized the importance of the design phase when stating that 'the Commission will also propose to revise the rules on end-of-life vehicles […] linking design issues to end-of-life treatment […] and improving recycling efficiency'.

Therefore, the compulsory whole vehicle type approval system which covers all categories of vehicles shall include measures on reusability, recyclability and recoverability (Recital 4 of 3R Directive). As a consequence, manufacturers shall provide new and additional data in the processes of the general type approval which therefore shall be amended (Recital 13 of 3R Directive).

[400] In Directive 70/156/EEC, annual limits per Member State are 500 units for M1, N1, O1, O2, and 250 for M2, M3, N2, N3, O3, O4; except for mobile cranes which have a limit of 20 units. In Regulation 2018/858, the general type-approval regulation in force today, annual limits per Member State are 500 units for O1, O2, and 250 for M1, M2, M3, N1, N2, N3, O3, O4. The EU-wide annual limits are 1 500 for M1, N1, N2, N3, and 0 for other categories.

7.2.2.2 The scope of the 3R Directive

The scope of the 3R Directive is detailed in Art. 2 'Scope' and Art. 3 'Exemptions'. Vehicles in scope of the 3R Directive are M1 and N1 vehicles (explicitly named) as well as new and reused components of such vehicles. Special purpose vehicles, including as per definition (in Directive 70/156/EEC) motorcaravans, armoured vehicles, ambulances, hearses, trailer caravans, mobile cranes and others, multi-stage build vehicles of N1 type and vehicles produced in small series, are exempted. The latter includes historic cars.

Articles 2 and 3 of 3R Directive have cross-references to the Directive 70/156/EEC, more specifically, to Part A of Annex II in relation to the definitions of M1, N1 vehicles and special purpose vehicles, and to Art. 8(2) in relation to exemptions (from general type approval) for vehicles produced in small series.

The 3R Directive scope does not refer to the scope of the ELV Directive.

7.2.2.3 Requirements addressing the design of vehicles

Design requirements addressed in this section and mentioned in the 3R Directive are hazardous substance requirements and plastic coding.

Hazardous substance prohibitions under the 3R Directive

Avoiding hazardous substances in vehicles contributes to minimizing hazardous waste and increases the recyclability of material streams at the end-of-life. Hazardous substance provisions, i.e., Art. 4(2) of Directive 2000/53/EC (ELVD), is/are referred to in Art. 6(2) of the 3R Directive.

Compared to other provisions of the 3R Directive, for the hazardous substance provision, the 3R Directive sets a direct link to the ELV Directive. The 3R Directive obliges the Member States to ensure that 'materials used for the construction of a vehicle type comply with the [hazardous substance] provisions'. Formulated in a very similar way, Art. 4(2) of the ELVD obliges Member States to ensure that 'materials and components of vehicles […] do not contain lead, mercury, cadmium or hexavalent chromium other than in cases listed in Annex II' (of ELVD).

Art. 9 of the 3R Directive addresses amendments of the type approval due to 'scientific and technical progress' which shall follow the general type approval update/amendment procedure (as described in the general type approval legislation, referenced as Art. 13(3) of Directive 70/156/EEC). The procedure might become relevant in relation to hazardous substances, if an ELVD, Annex II exemption is not required anymore, or if technical progress newly requires the use of one of the substances prohibited through Art. 4(2) of ELVD.

Plastic coding

According to Art. 8(1) of the ELVD, 'Member States shall take the necessary measures to ensure that producers, in concert with material and equipment manufacturers, use component and material coding standards, in particular to facilitate the identification of those components and materials which are suitable for reuse and recovery'. This requirement facilitates the end-of-life treatment of plastic parts, as acknowledged by the legislative text, but it is to be considered in the design of component parts, so it can be considered a design requirement. Annex IV point 3(f) of 3R Directive refers to this ELVD provision in the way that 'the competent body [within the preliminary assessment of the manufacturer] shall ensure that the manufacturer has taken the necessary measure to mark the component parts made of polymers and elastomer […].' For this purpose, the Commission Decision 2003/138/EC has established component and material coding standards for vehicles pursuant to Directive 2000/53/EC (ELVD).

Other aspects of design

Next to the hazardous substances and the plastic coding, other decisions of manufacturers in relation to design are covered in different ways:

- In some cases, the 3R Directive's text makes references to some design aspects, e.g., for the selection of the reference vehicle according to Annex I, points 3 to 5, the trim levels as well as available optional equipment shall be decisive, providing examples like upholstery, EEE equipment, air-conditioning, alloy wheels etc. This, however, is understood to mean that in the choice of the vehicle version to be subjected to the 3R type approval process, that consideration of vehicle versions under a certain vehicle type with different trim levels (and also with different optional equipment) should ensure that all vehicle versions of the type (with differing trim and/or additional equipment) comply with the 3R provisions. In other words, it cannot be seen as a design requirement.
- While from the perspective of the ELVD, reuse, recycling and recovery targets relate to the end of life, the hypothetical character of the ISO 22628:2002 calculations ('recycling shall be assumed') inhibits looking at reuse, recycling, and recovery the other way around, from the design. This is to say that through the use of the ISO standard calculation, recyclability of a material is considered based on an assumption whether its recyclability will reach maturity by the EoL of the vehicle, but it is not considered in the design phase as a criterion that requires the material chosen for a certain component to be recyclable at the time of design.
- In the strategy for dismantling etc. that the manufacturer submits during the preliminary assessment, other design aspects might be addressed that relate to the strategic goals of the manufacturer. Stakeholders explained for example that this strategy refers to recycled content in vehicles.

7.2.2.4 Requirements addressing the waste management of vehicles

The Directive addresses the waste management of vehicles through the reference to the ELVD 3R targets. The provisions of the 3R Directive in relation to reuse, recycling and recovery are listed in

- Art. 5 'Type approval provisions' detailed in
  - Annex I 'Requirements' which the manufacturer shall fulfil,
  - Annex II 'Information document for EC vehicle type approval' which the manufacturer shall use to provide information to verify compliance with Annex I requirements,
  - Annex III 'Model of EC type approval certificate' which is given to manufacturers when granting the type approval,
- Art. 7 'Reuse of component parts', more specifically, Annex V 'Component parts deemed to be non-reusable'.

Annex I requirements include the 3R targets, the obligation to submit Annex A and Annex B documents of ISO 22628:2002, a declaration on dismantlable parts, incl. dismantling stage and process recommended for treatment, criteria for the selection of the reference vehicle, the obligation to make available vehicles and components to the type approval authority, and few others.

Under Art. 7, reuse is only 'negatively' addressed, i.e., component parts are listed which shall not be reused. No positive list of component parts proposed for reuse or any other provision supporting the reuse of specific parts exists.

The following references to other legislative texts, namely Directive 70/156/EEC, ISO 22628:2002, and ELVD (Directive 2005/64/EC) are made:

- MS shall ensure that manufacturers provide the requested information on reusability, recyclability and recoverability pursuant to the general type approval application process of Art. 3(1) of Directive 70/156/EEC 'Application for type approval'.
- When granting an EC general type approval based on Art. 4(3) of Directive 70/156/EEC 'The type approval process', the 3R type approval certificate (Annex III of 3R Directive) shall be used.
- In the construction of vehicles covered by the general type approval, i.e. scope of Directive 70/156/EEC, no component parts listed in Annex V shall be used.
- Annex A and B of ISO 22628:2002
- Part C of Annex II to Directive 70/156/EEC
- The EC type approval certificate shall indicate that the (initial grant / extension / refusal of a) type approval is provided/refused 'with regards to Directive 2005/64/EC' (Annex III of 3R Directive).
- The 3R Directive refers to the ELVD its definitions (Article 4) for end-of-life-vehicle, reuse, recycling, energy recovery and recovery. Aside from the direct reference to the ELVD substance prohibitions and plastic coding standards, this is the only direct reference to the ELVD in the legal text (as opposed to in recitals that show an intention but do not guarantee its implementation). An indirect link is the repetition of the minimum reusable and/or recyclable as well as the recyclable and/or recoverable mass in Annex I of 3R Directive. However, this is not directly linked to the ELVD, despite originating from its provisions.

7.2.3 The 3R Type-Approval Process

Based on the amendments to Directive 70/156/EEC, Annex VI of the 3R Directive, general type approvals include the 3R type approval. Table 7-3 provides an overview of 3R type approval specific process steps. For the process of 3R type approvals, it is important to differentiate between the preliminary assessment of the manufacturer (step 2 in Table 7-3) and the process of type approval as such (step 3 in Table 7-3). Initially, Member States appointed a 'competent body', criteria for the selection are described in Annex IV point 2 of 3R Directive. It is expected that this was a one-time decision by MS with the coming into force of the national transpositions of the 3R Directive.

Table 7-3 Type approval provisions and preliminary assessment of the manufacturer

Step	Description	Art. Of 3R Directive	Related Art. Of UN ECE 133
1	MS appoints a „competent body“	6(4)	6.6
2	Preliminary assessment		
	• Manufacturer recommends a strategy to ensure dismantling & 3R	6(3)	6.5
	• Ensuring the compliance with Art, 4(2)(a) of ELVD (haz. subst. prohibitions)	6(2)	6.2
	• If appropriate, the MS "competent body" grants the *certificate of compliance* (appendix to Annex IV) which includes the strategy to ensure dismantling and 3R (see step 2), with a validity period of 2 years	6(5) & 6(6)	6.3, 6.7 & 6.8
	• Manufacturer shall report any significant changes to the competent body	6(7)	6.9
3	Type approval		
	• Manufacturer fills in Annex II ("Information Document for EC vehicle type approval")	5(2) & 5(3)	3.1 -3.4
	• MS "competent body" checks against requirements in Annex I, e.g. 3R calculations as in ISO 22628:2002,	5(1)	4.1
	• If appropriate, the MS "competent body" grants the type approval certificate (Annex III) with a validity period of 2 years	5(4)	4.2

Preliminary Assessment

The preliminary assessment of the manufacturer is described in Art. 6 of the 3R Directive (or Art. 6 of the UN ECE 133 document, see the comparison in the next chapter). In this stage, the Member State competent body performs checks to ‘ensure that the manufacturer has put in place the necessary arrangements and procedures’, the exact data and information to be checked, and how such data shall be prepared by the manufacturer for the purpose of the preliminary assessment is detailed in Annex IV of 3R Directive. Some of the information to be checked is referred to in articles specifically, e.g., Art 6(2) refers to hazardous substances, other information to be checked is “only” referred to in Annex IV. In addition to the checks, in the preliminary assessment, the manufacturer presents a ‘strategy to ensure dismantling, reuse of component parts, recycling and recovery of materials’. In some cases, this strategy comprises of a few pages of text (VW/Porsche 2022). An interviewed stakeholder (Stellantis 2022) reports on ‘the aim – to show how we support the recycling and the process globally – how this is linked with design of the car’. The strategy was sent to the consultant under confidentiality. However, an indication of content of the strategy can be provided. The text contains a description of how the OEM is managing the material composition data of a car, then, the commitment to integrate recycled material and to improve recyclability, in addition, that and how the OEM supplies dismantlers with information, and the commitment ‘to look at the recycling and its effect at the early stage of design’. It is important to understand that the dismantling information provided to dismantlers ‘is a completely different document than the strategy prepared to comply with 3R Directive Art 6(3)’. It is provided via IDIS.

3R type approvals

Generally, type approvals are assessed (and granted) for the so-called 'worst case', thus, the selection of the worst case is not specific to 3R type approvals but is generally applied before any vehicle type approvals. This is specified in Recital (58) of Regulation 2018/858[401]. However, it is again referred to in Annex I of the 3R Directive where the 'worst case' is named the 'reference vehicle' or 'most problematic version within a type of vehicle'. Annex I of the 3R Directive adds criteria to the list of selection criteria for the 'worst case': the type of bodywork, the available trim levels, and available optional equipment, e.g. leather upholstery, in-car radio equipment, air-conditioning, alloy wheels, etc.

While OEMs select the worst-case variants / configuration of the vehicle type to be approved and compile data to prepare the necessary documentation for the process for the selected variant/ configuration (step 3 in Table 7-3, first bullet), they are often assisted with type approval service providers ('technical services'). In the case of a certification to a certain standard, technical services check the validity of the compiled data. From exchange with type approval service providers, it can be understood that in recent years (since 2015) at least one service provider also visits ATFs to see how vehicles are dismantled in practice. However, this will not necessarily be on vehicles that they type approve, but rather the vehicles being dismantled at the time of visit. They will look at:

- Disassembly instructions: availability and applicability/feasibility at the AFT,
- Principles and feasibility of the vehicle treatment,
- Sampling of parts and in terms of their mass (measurement), composition (= consistency of ISO 22628 calculation), and consistency with the supplier/OEM definitions
- Verification of polymer markings.

As part of step 3 (Table 7-3), 3R calculations as prescribed in ISO 2268:2002 have to be performed. To conclude whether a material is recyclable, as specified in the ISO, OEMs use a list of "proven recycling technologies". In line with the ISO, technologies that have been successfully tested on a laboratory scale or above are considered to be "proven". The list is managed by the automotive association. The assessment of recyclability is done on a yes/no basis: When a material is considered recyclable (technology readiness level 4 and above), its full amount is counted towards recycling. This disregards any material losses related to the efficiency of recycling technologies or the level of quality of the resulting recyclates. It is expected that 3R Type approval calculated rates will differ from the actual achievable ones. This is understandable due to the long lifetime of vehicles, however there is no guarantee that a material with a recycling TRL of 4 (*laboratory scale*) at the time of 3R Type approval will be recyclable by the time it reaches EoL. Type approval authorities, asked about the appropriate level, recommended at least 6 (*technology demonstrated in relevant environment*) and above.

The ISO standard refers to additional lists of "proven technologies for fastening" and "proven technologies for dismantling". OEMs probably have an idea of relevant technologies; however, such lists are not used in the type approval process to conclude on the dismantlability of a part and its potential for reuse. The reuse of parts is not considered

[401] Regulation EU 2018/858, Recital (58): 'When performing compliance verification testing, technical services should be able to choose the parameters of the tests freely and in a non-predictable manner from within the range provided for in the relevant regulatory acts. This should help them verify that the vehicles tested are compliant across the whole range of parameters, including the parameters that correspond to the worst case for the test'. UN Regulation E/ECE/TRANS/505/Rev.3 explains that 'the approval authority shall apply the principle of "worst-casing", by selecting the variant or version from the specified type that for the purpose of testing will represent the type to be approved under the worst conditions.' In the general type approval, the manufacturer shall explain and provide justification for the selection.

towards the calculation and in that sense though it can be concluded that the process may facilitate recycling and recovery, it is not clear why it is assumed to facilitate reuse.

One OEM that participated in the interviews indicated that in 2021 they managed 9 type approvals (Stellantis 2022). From other interviews, e.g. VW/Porsche, it is understood that this number strongly varies between different years.

7.2.4 Interrelation of the 3R Directive to the international regulation UN ECE Regulation No. 133 and to ISO 22628:2002

ISO 22628:2002

The ISO 22628:2002 is the standardized calculation method for the recyclability and recoverability of road vehicles. In the introduction, the ISO explains that 'as part of the road vehicle life cycle, it is essential that recovery issues [in other words: end-of-life requirements] be taken into consideration during the design phase for environmentally sound treatment to be ensured. […] Recyclability/recoverability rates depend on the design and material properties of new vehicles, and on the consideration of proven technologies – those technologies which have been successfully tested, at least on a laboratory scale'. The text of the standard consists of the definitions, explanations of variables, the calculation method in a written and a tabular format (Annex B) and how the data shall be presented (Annex A). In the definitions, ISO 22628 refers to ISO 1177 on Road vehicles – Masses – vocabulary and codes.

Besides brand name and model (variant/configuration), basic data to be provided by the OEM includes the vehicle mass and a material mass (in kg) composition differentiating between seven different material classes:

- Metals
- Polymers (excl. elastomers)
- Elastomers
- Glass
- Fluids
- Modified organic natural materials (MONM)
- Others.

Asked to specify example materials and their relative importance in the vehicle in the class of 'others', Stellantis (2022) answered that they consider mainly electronic components in the class of 'others', which are very small and have complex compositions and ceramics; 'the amount of this category is less than 1% of the car weight.' VW/Porsche (2022) explained that 'in the beginning the category was used for parts where recyclability potential was not yet clear'

The calculation is done in five steps[402]:

1. In the first step of the calculation, the masses of all component parts and all fluids dismantled (e.g., depolluted) in the step of the pre-treatment are added. These are listed explicitly and encompass fluids, battery, oil filters,

[402] Component parts and materials can only be counted once under one of the steps 1-4.

LPG tanks, CNG tanks, tyres and catalytic converters. According to Art. 5.3.1 of ISO 22628:2002, 'for the purpose of the calculation, these component parts and materials are considered reusable or recyclable'.

2. In the second step, component parts for dismantling 'as declared by the vehicle manufacturer' are listed with name and mass in kg. However, for the component part to be considered reusable or recyclable, (a) accessibility, fastening and dismantling technology shall be assessed in relation to the dismantlability, (b) safety and environmental hazards shall be assessed in relation to reuse, and (c) material composition and proven recycling technology shall be assessed in relation to recyclability. From the sum of dismantlable components, a total mass of dismantled components is obtained. No material composition must be provided for the dismantlable component parts through the data presentation sheet.
3. Then, in the third step, all ferrous and non-ferrous metals which have not already been accounted for in dismantled parts shall be taken into account and summed up – they are considered recyclable.
4. For the non-metallic materials, there is a recyclable and recoverable fraction. For the recyclable materials, technologies shall be provided by name together with the mass of material recycled from this technology. Then, a material is counted as 'recoverable' if it 'can potentially be used for energy recovery'. The ISO contains the note that 'technologies for energy recovery of polymers and elastomers are industrialized on a large scale world-wide. Therefore, polymers, elastomers and other MONM can potentially be recovered through those technologies'
5. Finally, the recyclability and recoverability rates are calculated as a mass fraction in percent. For the recyclability rate, pre-treated, dismantled, metallic and recyclable non-metallic masses are included in the calculation. For the recoverability rate, the mass of the recoverable non-metallic material is included in the calculation in addition to the masses included in the calculation of the recyclability rate.

The data presentation sheet is a one-page tabular document.

UN ECE No. 133

The title of UN ECE regulation No. 133 is "Uniform provisions concerning the approval of motor vehicles with regard to their reusability, recyclability and recoverability". This is very similar to the title of the 3R Directive "on the type approval of motor vehicles with regards to their reusability, recyclability and recoverability". It is thus not surprising that the UN ECE 133 has the same function at the international level as the 3R Directive has in the EU. A vehicle type approved on the basis of the UN ECE 133 can be placed on the EU market and does not need to go through the 3R Directive type approval process (and vice versa).

As part of this study, a comparison has been made to see where differences are apparent between the two legislations. In 2018, (Mitic & Blagojevic 2018) wrote that "comparing with Directive 2005/64/EC, it was noticeable that all requirements were almost the same, and it was on the line with EU legislative and UN Regulations harmonization process." VW /Porsche agree ('there are no relevant differences between the two legislations'). In the stakeholder workshop[403], when asked about the equivalence of the 3R Directive and the UN ECE regulation, a few stakeholders further stressed the importance of the similarity, which can help 'lean up the necessary documentation activities'. Still, slight differences have been identified in relation to the definitions of the 3R, mainly in relation to 'recovery'. Definitions of the 3R in the various legislative texts are displayed in Table 7-4**.** ELVD and 3R Directive are more detailed in their definition of recovery than in the UN ECE 133 Document and the ISO 22628.

[403] Results of Slido question "For the purpose of obtaining an EU Whole Vehicle Type Approval, a certificate in accordance with UN Reg.133 is accepted as alternative to Directive 2005/64/EC. How important is it to keep such equivalence with UN ECE legislation and why?"

Table 7-4 Definitions in ELVD, 3R Directive, UN ECE 133 and ISO 22628

	ELVD	3RD	UNECE 133	ISO 22628
Reuse	'reuse' means any operation by which components of end-of life vehicles are used for the same purpose for which they were conceived;	Means reuse as defined in point 6 of Art. 2 of ELVD	Reuse means any operation by which components of end-of-life vehicles are used for the same purpose for which they were conceived	Same as in ELVD / UN ECE
Recycling	'recycling' means the repro-cessing in a production process of the waste materials for the original purpose or for other purposes but excluding energy recovery.	Means recycling as defined in point 7 of Art. 2 of ELVD	Means the reprocessing in a production process of the waste materials for the original purpose or for other purposes but excluding energy recovery	Same as in ELVD / UN ECE
Recovery	'recovery' means any of the applicable operations provided for in Annex IIB to Directive 75/442/EEC[404];	Means recovery as defined in point 8 of Art. 2 of ELVD	Means reprocessing in a pro-duction process of the waste materials for the original pur-pose or for other purpose to-gether with processing as a means of generation energy	Same as in UN ECE

Looking closely on the core of the 3R Directive, Annex I requirements, some minor differences can be identified, see Table 7-5. This table compares the UN ECE 133 and 3R Directive Annex I requirements. In relation to the Annex I requirements, there are differences in requirements No. 2.2 reference to the proven technology list, No. 4 & 5 on the selection criteria for the reference/problematic vehicle ('worst case'), and No. 10 and 11 in relation to the manufacturer's declaration for compliance with hazardous substances prohibitions and parts' coding.

Table 7-5 Comparison 3R Directive and UN ECE 133 Annex I requirements

UN ECE 133	3R Directive
1. Vehicles belonging to category M1 and those belonging to category N1 shall be so constructed as to be:	
(a) Reusable and/or recyclable to a minimum of 85 per cent by mass, and	
(b) Reusable and/or recoverable to a minimum of 95 per cent by mass,	
as determined by the procedures laid down in this annex.	
2. For the purposes of type approval, the manufacturer shall submit a data presentation form duly completed, established in accordance with Annex A to ISO standard 22628: 2002. It shall include the materials breakdown.	
2.1. It shall be accompanied by a listing of the dismantled component parts, declared by the manufacturer with respect to the dismantling stage and the process he recommends for their treatment.	

[404] Previous version of the Waste Framework Directive, today, Directive 2008/98/EC

UN ECE 133	3R Directive
2.2. The process shall be based on a technology which has been successfully tested, at least on a laboratory scale (proven technology).	X
3. For the application of paragraphs 1. and 2. of this annex, the manufacturer shall demonstrate to the satisfaction of the Type approval authority that the reference vehicles meet the requirements. The calculation method prescribed in Annex B to ISO standard 22628: 2002 shall apply.	
3.1. However, the manufacturer shall be in a position to demonstrate that any version within the vehicle type complies with the requirements of this Regulation	
4. For the purposes of the selection of the reference vehicles, a vehicle shall be selected with the following criteria:	4. For the purposes of the selection of the reference vehicles, account shall be taken of the following criteria:
(a) Lightest engine;	— the type of bodywork,
(b) Lightest manual gearbox;	— the available trim levels[a],
(c) Smallest tyres, no spare wheel;	— the available optional equipment which can be fitted under the manufacturer's responsibility[a].
(d) No trailer coupling;	
(e) No all-wheel drive;	.
(f) Bodywork saloon or station wagon;	
(g) (Leather trim).	
5. The manufacturer and the Type approval authority jointly identify the reference vehicle in accordance with the criteria listed under paragraph 4. above.	5. Should the type approval authority and the manufacturer fail jointly to identify the most problematic version within a type of vehicle, in terms of reusability, recyclability and recoverability, one reference vehicle shall be selected, within: (a) each 'type of bodywork', as defined in point 1 of part C of Annex II to Directive 70/156/EEC in the case of M1 vehicles; (b) each 'type of bodywork', i.e. van, chassis-cab, pick-up, etc., in the case of N1 vehicles
6. For the purposes of calculations, tyres shall be considered as recyclable.	
7. Masses shall be expressed in kg with one decimal place. The rates shall be calculated in percent with one decimal place, then rounded as follows:	
(a) If the figure following the decimal point is between 0 and 4, the total is rounded down;	
(b) If the figure following the decimal point is between 5 and 9, the total is rounded up.	
8. For the purposes of checking the calculations referred to in this annex, the type approval authority shall ensure that the data presentation form referred to in paragraph 2. of this annex is coherent with the recommended strategy annexed to the Certificate of Compliance referred to in paragraph 6.3. of this Regulation.	

UN ECE 133	3R Directive
9. For the purposes of checks of the materials and masses of component parts, the manufacturer shall make available vehicles and component parts as deemed necessary by the type approval authority.	
10. For the purpose of identification of components in the recycling process, the manufacturer declares that processes to comply with the labelling of plastic components in accordance with paragraph 3.3. of Annex 5 to this Regulation, and the labelling of rubber components in accordance with paragraph 3.4. of Annex 5 to this Regulation, apply to this vehicle type.	x
11. For the purposes of informing about materials and substances used in the vehicle construction the manufacturer declares that processes to comply with the materials and substances restrictions apply to this vehicle type.	x

a- i.e. leather upholstery, in-car radio equipment, air-conditioning, alloy wheels, etc.

Source: Own compilation, Oeko-Institut e.V. 2022

In addition, and in contrast to the process under 3R Directive, the process as laid out in the UN ECE 133 includes provisions on marking, i.e. the competent authority provides a communication form (UN ECE 133 Annex III) and a marking (according to UN ECE 133 Annex IV). This should not be confused with the plastic coding laid down in Commission Decision 2003/138/EC. Instead, this marking refers to the country where the type approval has been granted.

7.3 Summary of the main results of the consultation of stakeholders on the 3R Type approval and its relation to the ELVD

In total, four 3R Directive-specific interviews were conducted. Answers of two of these interviews cannot be cited from freely, however have been anonymized. Additional information was received from three more organisations/stakeholder groups (see table Table 8-4; one position paper, one interview in the main study was used to get specific information on the 3R Directive (i.e., with UNEP and UN ECE representatives), and one e-mail with additional explanatory information was received, in relation to the information provided in one of the specific interviews by a technical service provider). In the survey, five Member States participated (1 MS was interviewed, 3 provided the filled-out survey, 1 provided short input per email), and one OEM sent a confidential contribution. In the round of written feedback in April 2022 (after the stakeholder and MS workshop in March 2022) a further written contribution from Germany was received. For the survey and interviews the same questionnaire was used. The questionnaire was agreed on and is available to the European Commission. Based on the indication of a lot of stakeholders, most of the information cannot be cited in this report as information has been provided on a confidential basis or interview documentations have not been confirmed by interviewees. In such cases, aggregation or anonymization has been used where possible to allow consideration of the various inputs given.

General comments in relation to the link and the possibility of merging of the two directives are described in the following:

In the course of the evaluation, the question was looked at – and stakeholder positions are mentioned, where applicable – from the perspectives of the main aspects of evaluation:

- Of the interviewed stakeholders, one is of the opinion that there is a missing link and missing references between 3R Directive and ELVD.
- No stakeholder clearly indicated its preference to merge the 3R Directive and ELVD or that it would be meaningful. At least, two times China was provided as an example where one legal instrument is in place, however, the European market would be more diverse. Looking at the stakeholder groups that provided their input on this topic, it should be noted that the stakeholders rarely take the perspective of the end-of-life.
- In the inputs, the 3R Directive is not looked at in the same way as the regulator might have looked at it (i.e., as understood to be initially intended in ELVD Article 7(4 &5)), i.e., following the idea to use the type approval to ensure compliance with vehicle design requirements specified in ELVD. Thus, it is questionable whether the interviewed stakeholders see the link between the two Directives as described in the section on the origin of the 3R Directive (see section 7.2.1).
- For Germany, 'it is important that existing requirements of the ELV Directive on waste recovery and recycling are supplemented by corresponding requirements on design in the "3R type approval" Directive.' (BMUV 2022)
- An ACEA position paper (ACEA 2022) (2022) refers to the positions of the automotive industry in relation to the merge of 3R Directive and ELVD: ACEA "call[s] for the current legal framework to be maintained." Rather than focusing on recyclability, they would like to see their engagement in the field of emission reductions during the use phase, i.e., strategies focusing on light weight, acknowledged framing it Design for Sustainability.[405]
- Another argument put forward (anonymous stakeholder contribution) is that, currently, the responsibilities are distributed, i.e., recyclers fulfil the ELVD and manufacturers fulfil 3R Directive requirements. A merge of the Directives producing a legislation with joint responsibilities could increase innovation times and create longer discussion processes.
- Stakeholders are of different opinion in relation to whether the 3R Directive facilitates "high-quality" recycling.

Other than this, questions were asked to understand better the role of type approval technical services', the Type approval Authorities' and the OEMs' in the process of type approvals in general as well as the special part of the 3R type approval in particular. Where applicable, opinions of stakeholders are referenced in the section on the process and its implementation (section 7.2.3).

A third cluster of question was asked regarding the possible future amendments of the ELVD:

A number of aspects under discussion to enhance circularity of new vehicles discussed in the course of the ELVD revision were presented to stakeholders in the stakeholder consultation activities for this study. These include:

- Design requirements that affect repairability, repairability / durability, referring to recycled content or the use of certain materials, or possible restrictions or prohibition of materials which have a potential to render recycling particularly challenging.
- Amendment of the methodology of calculation of the potential for e.g. reuse, recycling, and recovery, e.g. to be aligned to a minimum Technology Readiness Level (TLR),

[405] ACEA „want to point out that necessary new and innovative materials for achieving the ambitious goals for targeted carbon neutrality in 2050 for vehicles might not have appropriate recycling technologies on industrial scale available yet."

- Obligations for OEMs and suppliers to support reuse of parts and components and high-quality recycling and to identify hazardous components or materials to be dismantled through making available more information, e.g. make digital keys digitally available in a non-discriminating and harmonised manner to professional operators (e.g. Authorized Treatment Facilities (ATFs) and free garages),
- Consideration of economic viability of (deep) dismantling, sorting (including shredding and post-shredding) and (high-quality) recycling via a link to the enhanced producer responsibility (EPR), e.g. through requirements to conduct dismantling tests with the aim to determine the duration of dismantling and the tools needed to dismantle certain parts of a vehicle at end-of-life
- Possible extension of the 3R type approval process to other vehicle types (e.g. trucks, busses, motorcycles).

In general, little to no input was provided on impacts of introducing certain measures proposed to be changed in the 3R Directive.

One stakeholder (anonymous stakeholder contribution) is of the opinion, that the scope of the 3R Directive should be extended to include additional vehicles.

Finally, in the stakeholder workshop, additional questions were asked through the use of an interactive application (slido):

The following reproduces the main inputs provided through this format:

- Question: 'Since its adoption in 2005, do the economic and environmental benefits achieved by the 3R Directive in your view outweigh the cost of its implementation?' Of a total of 31 stakeholders who answered, 20 did not provide an answer, however of those that did, the majority (5 stakeholders) considered that benefits are high or that costs are low (3 stakeholders) or both (1 stakeholder). Only 2 stakeholders stated that benefits are too low and costs too high and 1 stakeholder that benefits are too low.
- Question: 'How high do you estimate the added value of having EU harmonised rules for vehicle reusability, recyclability, and recoverability, compared to what could have been achieved at merely national level? In the chat, please explain and provide supporting data.' From 34 stakeholders that answered, 30 agreed that the harmonized rules have a higher or somewhat higher added value then the case of national legislation. Others did not know.
- Question: 'In your view, does it make sense to move away from a type approval Directive on vehicle reusability, recyclability & recoverability to a type approval Regulation on vehicle reusability, recyclability & recoverability? Please provide supporting data.' Of 35 stakeholders that answered, 21 state that it made sense to move to a regulation, while 1 did not agree and the others did not know.
- Question: 'Please indicate whether to consider inclusion of the following vehicles for RRR type-approval, as currently these are exempt (article 3).' Of 33 stakeholders that answered, 11 indicated special purpose vehicles, 12 indicated multi-stage vehicles, 8 referred to small series vehicles and 9 stated that the exemptions should not change. The rest dd not know.
- Question: 'One of the objectives of the 3R Directive is to prevent safety and environmental hazards through restrictions on re-use of certain component parts (e.g., airbags, seat belt assemblies). Has this objective been achieved in your view?' Of 34 stakeholders that answered, 9 agreed that this objective was met, 5 did not agree and the rest did not know.
- Question: 'Is it correct to assume that including multi-stage built vehicles in the scope of the 3R Type Approval would allow ensuring that they can achieve the 3R Targets, having a positive impact on the design and circularity of such vehicles?' Of 31 stakeholders that answered, 13 agreed and 3 did not. The rest did not know.

- Question: 'Could data that needs to be accessible to ATFs be included in the Certificate of Conformity?' Of 16 stakeholders that answered, 5 agreed and 4 did not. The rest did not know.

7.4 Evaluation results of the effectiveness of the 3R Directive and its relation to the ELVD

This chapter is the core of the evaluation report as it provides answers to each of the evaluation questions. For most of the evaluation questions, the analysis has been grouped. Each individual question is specifically addressed in the conclusion section of each group of questions. The question groups are as presented above.

For each group of questions, we present our analysis drawing on the research methods applied such as literature and data review, Online Public Consultation (OPC), targeted surveys and targeted consultation in the form of interviews and the workshop.

The evaluation is performed for three different possible cases: First (comprising the core part of the evaluation) the case of how the current version of the 3R Directive performs in relation to the questions; secondly, questions are assessed for the case in which the ELVD is amended but not the 3R Directive, in order to show the implications of this case; and finally (but not relevant for all questions) the case where ELVD and 3R Directive could be merged is referred to.

Sidenote on the merge of the two Directives

To address some of the concerns raised by stakeholders, the consultants would first like to address some aspects of the possible merging of the two directives. It should be noted that the merging – if decided by the legislator– shall be independent of the vehicle type, resulting in one legislation that covers all types of vehicles which were decided to be in scope of that legislation. In the view of the consultants, merging the directives is a matter of legal decision that is independent of the decision of the extension of scope of the ELVD and independent of whether the requirements set out in the 3R Directive shall apply to new vehicle types or not. Should the legislator decide for the option to continue with two separate directives and provided that 3R type approval requirements shall apply to vehicles other than M1 and N1, the scope of both directives would need to be extended. On the other hand, if the decision is taken to extend the scope of the ELV legislation to more vehicle types than M1 and N1, and if also the idea is followed to merge the directive, but if it is decided to not set 3R type approval requirements for all vehicle categories, it will be possible to express this decision in legal terms, e.g. through exempting some vehicles from certain articles of the legislation.

7.4.1 The origin and objective of the 3R Directive

7.4.1.1 Analysis

The adoption of the 3R Directive was the result of the ELVD provision specified in Art. 7(4) 'that the European Parliament and the Council, on the basis of a proposal from the Commission, shall amend Directive 70/156/EEC [general type approval] so that vehicles type-approved in accordance with that Directive and put on the market after three years after the amendment of the Directive 70/156/EEC are re-usable and/or recyclable to a minimum of 85 % by weight per vehicle and are re-usable and/or recoverable to a minimum of 95 % by weight per vehicle'. It is assumed that the intention of regulators embodied in ELVD Art. 7(4) was to use the type approval process to ensure that vehicles placed on the market comply with the ELVD Art. 7 3R targets. Targets gradually increased from the time when the ELVD came into force, i.e., the values of 85% and 95% weren't the initial targets, see ELVD Art. 7(2). Thus, further it can be assumed that the regulator had in mind to use the targets as a means to tighten the regulation of vehicles in relation to reuse, recycling and recovery.

In the text of the 3R Directive, the importance of the 3R targets can be identified by the fact that they are named in Recital 1, in Art. 1 and that the targets are the first of the Annex-I-provisions. However, except for the Recital, the values of the targets are written down explicitly, i.e., without reference to the ELVD. There is no 'dynamic link'. For the current versions of the legislative texts, the values of the targets, i.e., 85% (reuse and/or recycling target) and 95% (reuse and/or recovery target), are identical in both the (current) ELVD and the 3R Directive. Thus, in relation to the targets, currently, no discrepancy between the two Directives exists, but the situation may change with amendments of the ELVD, should the 3R Directive not be amended accordingly.

Following the assumed intention of the regulators formulated above, an amendment of the 3R targets in the ELVD inevitably requires an amendment of the 3R Directive to be able to ensure the compliance of new vehicles put on the market with amended ELVD requirements. It may even be assumed that any new provisions targeting reusability and/or recyclability and/or recoverability, i.e., future amendments in the ELVD other than an amendment of the 3R targets, would require the subsequent amendment of the 3R Directive as well.

ELVD Art. 7(4) refers to 3R targets as the only provision for which the type approval shall be used to ensure the compliance. In addition, Art. 7(5) of ELVD states that amendment of Directive 70/156/EEC should also take consideration that the reuse of components does not give rise to safety or environmental hazards. Though this is not considered by the consultant to refer to specific provisions of the ELVD, it is reflected in the 3R Directive in its Article 7 that refers to the list of 'Component parts deemed to be non-reusable' specified in its annex V that cannot count toward recyclability and recoverability rates and that cannot be used in the construction of vehicles covered by type approval legislation. Though the ELVD prohibits hazardous substances (ELVD Article 4(2)) and requires the vehicle producers use component and material coding standards (ELVD Article 8), it does not refer to these provisions in article 7(4 & 5) which addresses the amendment of Directive 70/156/EEC. Thus, references in the 3R Directive to provisions on hazardous substance and plastic coding are considered as two examples where the 3R Directive goes beyond the objective formulated in ELVD Art. 7(4). The fact that additional provisions of the ELVD are being 'checked' through the type approval processes supports the assumption that the process of type approval was intended to and is suitable to check compliance with design requirements specified in ELVD.

7.4.1.2 Conclusion

Does the 3R Directive effectively transpose the intention of regulators in relation to Art. 7(4) of ELVD?

Currently, due to the fact that the ambition level of the 3R targets is identical in the ELVD and the 3R Directive, it is concluded that the 3R Directive is effectively transposing the regulation intention of Art. 7(4) of the ELVD. Nonetheless, in case of an amendment of the ELVD in relation to the targets or other measures to support reuse and recycling, due to the lack of a dynamic reference to the ELVD, the intention of the regulators to use the type approval to ensure compliance with vehicle design requirements specified in ELVD would no longer be guaranteed without amending the 3R Directive.

Though not part of the ELVD intention for the 3R directive, the same is also true for the ELVD material coding standards, where the 3R Directive only makes the reference to Commission Decision 2003/138/EC and not to any further coding standards, should these be introduced through other legal documents adopted according to ELVD Article 8.

In the case of a merge of ELVD and 3R Directive, and assuming that the regulator continuously intends to use the process of type approval to ensure compliance with ELVD vehicle design requirements to support circularity, the future regulation will require (dynamic) references to the general type approval legislation.

For the hazardous substance prohibitions, also not part of the ELVD intention for the 3R directive, the case if different. Here, there is a dynamic reference to ELV Article 4(2)(a), which ensures compliance with any changes in the substances prohibited through this article or changes to the list of exemptions from these prohibitions listed in Annex II of the ELV.

7.4.2 The scope of the 3R Directive

The questions addressed in this section are:

- Is the scope of the 3R Directive effective in ensuring that its provisions will be implemented successfully in relation to the vehicles to which it applies?
- Is the scope of the 3R Directive aligned with the ELVD at present or in the case that the scope of the ELVD is to be changed in the future?

7.4.2.1 Analysis

Currently, the scopes of ELVD and 3R Directive are similar but not identical, see section 2.4.2 (main report) and section 7.2.2.2 (this report). Exemptions from the Directive vary among the two legislations. Both include passenger cars classified as M1[406] and light-commercial vehicles classified as N1[407] (< 3.5 tonnes) in the scope. The ELVD includes three-wheel motor vehicles but excludes motor tricycles, both defined in the type-approval of two- or three-wheel vehicles and quadricycles[408]. The 3R Directive does not refer to the three-wheel motor vehicles but includes new and reused components of M1 and N1 vehicles. In terms of the exemptions, small series and multi-stage built vehicles are generally exempt from 3R Directive but not mentioned in ELVD. Special purpose vehicles are generally exempt from the 3R Directive too, however, they are in scope of ELVD[409] but exempt from Art. 7 provisions of ELVD. A tabular overview is provided in Table 7-6.

The fact that the multi-stage built vehicles and small series are not specifically mentioned under ELVD effectively means that the ELVD requirements, including the Art. 7 (3R targets), apply for multi-stage built vehicles and vehicles produced in small series, if M1 and N1 type-approved. An example for multi-stage built M1 and N1 vehicles are VW camper-vans (or comparable vehicles) manufactured by an OEM, Volkswagen in this case, but where additional exterior or interior constructions for camping or when used by professionals are done by a third party (e.g., Westphalia Mobil or Malibu Carthago[410]). For example, a municipality or an energy/water provider could have such vehicles equipped for certain assignments. As long as the general vehicle form is that of M1 and N1 vehicles, such vehicles fall under the ELVD. On the one hand, these vehicles might be produced in small series, but in that case, there is no exemptions for them in the ELVD, thus, they need to comply with ELVD. On the other hand, these vehicles might comply with the criteria for special-purpose vehicles specified in the general type approval (Regulation 2018/858, Annex I Part A). If so, they are exempted from Article 7 provisions of ELVD (but not generally). To conclude, if multi-stage built M1 or N1 vehicles (whether produced in a small series or not) do not fulfil the criteria for special purpose vehicles, it is assumed that the compliance with the 3R targets, hazardous substance provisions etc. is not ensured. There is no statistical evaluation performed at EU level as to the extent of the problem, nor at MS level as the data is most likely not collected.

Table 7-6 Comparison of the scopes of ELVD and 3R Directive

Vehicles	3R Directive	ELVD
Passenger cars (M1)	Included	Included
Light commercial vehicles (N1)	Included	Included

[406] Category M1: Motor vehicles designed and constructed primarily for the carriage of persons and their luggage and comprising not more than eight seating positions in addition to the driver's seating position. Vehicles belonging to category M 1 shall have no space for standing passengers. The number of seating positions may be restricted to one (i.e. the driver's seating position). See Regulation (EU) 2018/858.

[407] Category N1: Motor vehicles designed and constructed primarily for the carriage of goods and having a maximum mass not exceeding 3,5 tonnes. See Regulation (EU) 2018/858.

[408] Council Directive 92/61/EEC of 30 June 1992 relating to the type-approval of two or three-wheel motor vehicles (repealed by Directive 2002/24/EC, again repealed by Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles)

[409] In its frequently asked questions chapter, the ELV Guidance Document (EU, 2005) clarifies that motor caravans are in scope. This is explained based on Directive 70/156/EEC which defines motor caravans as a special purpose M category vehicle.

[410] See for example: https://www.westfalia-mobil.com/en/, https://www.malibu-carthago.com/en/

Vehicles	3R Directive	ELVD
Three-wheel motor vehicles as defined in Directive 92/61/EEC[411]	Not mentioned	Included
New and reused components of M1 and N1 vehicles	Included	Not mentioned
Small series (includes heritage cars)	Generally exempted	Not mentioned
Special-purpose vehicles (includes motorcaravans, armoured vehicles, ambulances, hearses, trailer caravans, mobile cranes and others)	Generally exempted	Art. 3(4) of the ELV Directive exempts special-purpose vehicles from the provisions of Art. 7 'Reuse and recovery' of the ELVD
Multi-stage build vehicles	Generally exempted	Not mentioned
M2-, M3-, N2-, N3-, and O-type-approved vehicles	Not included	Not included

Source: ELVD and 3R Directive

Against the background that for the revision of ELVD it is under consideration to amend the scope of ELVD, it should be noted that the articles specifying the scope and exemptions of the 3R Directive make no reference to the ELVD and its scope (and vice versa, which is logical as the 3R Directive came into force after the ELVD, which has not been revised since it came into force in 2000). However, amendments to the scope of ELVD without parallel amendments in the scope of the 3R Directive could create regulatory inefficiencies for vehicles that newly enter the scope of ELVD and for which 3R targets, design requirements and other provisions checked through the 3R type approval apply. Though in hypothetically such requirements would need to be complied with, there is currently no other compliance mechanism in the ELVD applying to new vehicles put on the market, possibly creating a loophole or resulting in MS applying different efforts and methods to ensure compliance.

In the case of a merge of the ELVD and 3R Directive, it is assumed that the combined legislation would generally have an identical scope for provisions, incl. 3R type approval provisions. The various provisions to be included could also apply only to parts of the general scope, i.e., some vehicle categories of the future legislation, or exempt certain vehicles from certain provisions. However, this would then be the result of a conscious decision and not of legislation incoherencies. In such a case it is thus not expected that a merge would create extra inefficiencies, per se.

7.4.2.2 Conclusions

Is the scope of the 3R Directive effective in ensuring that its provisions will be implemented in relation to the vehicles to which it applies?

As such, the 3R Directive is a stand-alone legislation because of the lack of a (dynamic) link to the articles specifying the scope of the ELVD. Looking at the 3R Directive as such, it is a legislation with a comprehensive scope, i.e., it is clearly defined what is in scope and what is exempt, and expressions used in the legislation are defined in relation to the general type approval legislation (in its version of 1970). The scope of 3R Directive covers M1 and N1

[411] See footnote 408

vehicles, that is the majority of road vehicles by unit (see main report). Thus, from this perspective the scope of the 3R Directive is currently assumed to be effective.

Is the scope of the 3R Directive aligned with the ELVD at present or in the case that the scope of the ELVD is to be changed in the future?

The scope of the 3R Directive is not aligned, nor dynamically linked (no reference to respective articles of ELVD) to the scope of the ELVD. Currently, the lack of alignment is in relation to M1 and N1 multi-stage built vehicles and vehicles produced in small series (if not special-purpose vehicles). ELVD requirements apply to these vehicles, but compliance is not checked during type approval processes (because of an exclusion from scope of the 3R Directive). Thus, it is concluded that the scope of the 3R Directive is not effective in ensuring that vehicles put on the market comply with design requirements formulated in ELVD, i.e. not effective in transposing the assumed regulators' intention described above.

In the case that the scope of the ELVD is to be changed in the future, without parallel amendments of the 3R Directive, the scopes would still not be aligned, however the range of discrepancies would increase. To give an example, N2 and N3 vehicles are multi-stage built for the majority of vehicles. If they should enter the scope of ELVD, assuming that the regulator would decide to further use the process of type approval for ensuring compliance, but the 3R Directive scope is not to be amended, their compliance would not be ensured. If multi-stage built vehicles continue to be excluded from the 3R Directive, for a considerable number of vehicles the compliance with certain ELVD requirements will not be ensured – neither for the base vehicle, nor for the later assembled multi-stage components. Thus, it is recommended to have a dynamic link or cross-reference from the 3R Directive to the ELVD in relation to scope, ensuring amendments and alignment in case of change.

In case of a merge of the directives, obviously, the legislation will have one scope only, it is recommended to regulate exemptions in relation to a single or multiple provisions, also with the obligation to perform 3R type approvals, rather than putting exemptions generally upfront (as currently applied in Art. 3 of 3R Directive). An example for the proposed way of regulation is the Art. 3(4) of the ELVD which exempts special-purpose vehicles from the provisions of Art. 7 (of ELVD).

7.4.3 ELVD design requirements

The questions addressed in this section are:

- Is the way that the 3R Directive refers to the ELVD hazardous substance and plastic coding provisions effective in terms of ensuring that vehicles put on the market comply with the related ELVD requirements?
- Will the way that the 3R Directive addresses substance prohibitions and plastic coding remain effective in case such provisions (or their exemptions, if applicable) will change in the future?
- Will the way that the 3R Directive addresses substance prohibitions remain effective in case such prohibitions (and/or their exemptions) are moved to another legislation (e.g., REACH?
- Is the 3R Directive effective in ensuring that vehicles put on the market are more circular?
- Is the 3R Directive suitable for ensuring in the future that vehicles put on the market will comply with future ELVD provisions on circularity (e.g., recycled content targets)?

7.4.3.1 Analysis

As mentioned above, the main design requirements in addition to material and fastening technologies affecting the 3R are the hazardous substance restrictions, the plastic coding and where the text of the 3R Directive touches on a few smaller aspects, e.g., the trim level being a criterion for the selection of the reference vehicle.

Hazardous substance and plastic coding provisions are specifically part of the checks to be performed by the competent body (3R Directive, Annex IV). The legal text states that 'the competent body shall ensure that the manufacturer has taken the necessary measures' and that 'the vehicle manufacturer shall be required to demonstrate' that compliance is ensured. There are additional explanations as to what is accepted as a necessary measure, e.g., supply chain management and communication with the manufacturer's staff. It is expected that where the competent body is checking these requirements, they will find the requested information, as the legal text appears clear for this aspect. In both cases, that is point 3.1(f) of Annex IV for the coding and Article 6(2) of the 3R Directive and subsequently article 4.1 and 4.2 of Annex IV for the hazardous substances, there is a reference made to the ELVD. It should be understood that these requirements being checked in the preliminary assessment means that they are not checked per type to be approved. The 3R Directive, Annex II ('Information Document for EC vehicle type approval') does not contain an information request on hazardous substances and/or material coding. As a consequence, documents and data as to how the manufacturer organizes the information flows on hazardous substances and plastic coding in his value chain is being checked every ~ two years with the update of the preliminary assessment. But, for the types approved, there is no indication whether they contain hazardous substances, e.g., where ELVD annex II exemptions cover the use of a prohibited substance in a material and/or component part. On the other hand, the masses obtained in the steps of the ISO 22628 calculation, i.e., recyclability and recoverability are indicated for each new type to be approved. Even if this anticipates the question of alignment with UN ECE, looking at the UN ECE 133 Annex I requirements (Table 7-5) there are two additional points (point 10 and 11) that requests the manufacturer to declare that 'processes comply with the labelling of plastic components […] and the labelling of rubber components' as well as that 'processes comply with the materials and substances restrictions' applying to this vehicle type.

To conclude on this aspect, it is assumed that the 3R Directive is effective in terms of ensuring that supply chain communication and management on hazardous substances and measures of plastic to be coded are being checked. It is assumed that these measures indirectly (but not explicitly) ensure that vehicles put on the market comply with the related ELVD requirements. Though this topic was not raised as a problem for the implementation of the 3R Directive, the question remains whether the checks in the preliminary assessment suit the intention (of ELVD and the role of 3R Directive), and whether it is intended to check design requirements in different steps of the process, i.e., hazardous substances and plastic coding in the preliminary assessment but not per vehicle type, and recyclability per vehicle type.

In addition to the assessment of the current status of effectiveness in relation to design requirements, the questions of the evaluation refer to the future possible requirements and the future legislation to cover the hazardous substance requirements. For the moment, coherence in relation to the substance prohibitions is ensured whenever the legal text of 3R Directive makes a reference to ELVD Art. 4(2) for the hazardous substances. In this case the 3R Directive will remain effective. For the plastic coding, there is no reference to ELVD Art. 8(1) but only to Commission Decision 2003/138/EC. Only the compliance with requirements amended in this Commission decision would be ensured at present, and only in this case would the 3R Directive remain effective in this case. However, compliance with any changes to ELVD Article 8(1) or new coding standards introduced through other legislation adopted in line with ELVD Article 8 would not be ensured.

In the case of merging ELVD and 3R Directive and should hazardous substance provisions of the ELVD be moved to another legislation, e.g. REACH, it might be relevant that the (dynamic) reference to the legislation where hazardous substance provisions will be regulated in the future is amended to ensure compliance is checked through the 3R approval process. Alternatively, any legislation addressing prohibitions for vehicles in the future would need to address how compliance is to be ensured or how the future 3R type approval process works in relation to hazardous substance provisions.

A second part of this analysis shall focus on whether the 3R Directive is effectively ensuring that vehicles POM are more circular and will comply with future ELVD provisions on circularity. One instrument to ensure circularity of vehicles is the ‘strategy for dismantling, reuse of component parts, recycling and recovery of materials’. Generally, the manufacturer submits the strategy for dismantling etc. during the preliminary assessment. Though, the ‘strategies of the OEMs are approved by type approval authorities’ (VW/Porsche 2022), in practice this strategy does not go beyond commitments to certain strategic goals of the company and is not specific to the vehicles to be type-approved. It can be assumed that this is because there are no explicit requirements as to the content of the strategy, except for that it ‘shall take into account the proven technologies available or in development at the time of the application for a vehicle type approval’. The purpose of the dismantling strategy whether its implementation suits this 3R Directive goals can be questioned. Another means, for reuse specifically, is the Article 7 on reuse of component parts. However, this is only referring to what should not be reused (due to safety reasons), but not the other way around, i.e., the reuse of which parts should be encouraged, e.g. through provision of data as to dismantling method. Measures to increase reuse are discussed in the main ELV IA report (chapter 2.1.5.32.1.5.2). Another instrument is of course the 3R targets, that will be analysed specifically in the next chapter. It can be said at this point, that the calculation for the 3R targets specifically focuses on recyclability and recoverability. To conclude on the evaluation question, it should clearly be mentioned that different levels of the waste hierarchy are being addressed in a different manner in the 3R Directive. Prevention and reuse are not promoted through the 3R Directive (see also the next chapter). Also, 3R Directive does not provide an incentive to improve recyclability with an increasing ambitious level, as long as the 3R targets are being reached across most of the MS. There is the clear finding here, that the 3R Directive is not effective in ensuring that vehicles POM increase in circularity. As for future provisions on circularity, the level of effectiveness will depend on whether or not the future provisions fine-tune or amend those that are already being covered with lower ambition today, e.g., amendments of the 3R targets or adding additional materials to be coded. If the 3R Directive is not amended in a way that it supports the implementation of future ELVD provisions on circularity, where applicable, it will only be possible to tailor these future ELVD provisions on circularity in a way that the support of 3R type approval checks for what is put on the market.

In this respect, it should be mentioned that following the above-mentioned intention of regulation, the 3R Directive was set up as a market-control instrument to support ELVD, i.e., waste legislation. However, from the interviews and workshop participants, specifically the MS representatives’ workshop, it became clear that the 3R Directive is more often connected to the general type approval legislation rather than to the ELVD, as usually, both are handled in the Member States in ministries of transport or economics. If expected by the regulator that in the future, the 3R Directive is a means to interlink design and end-of-life, and that the 3R Directive shall contribute to the ELVD objectives and effectively ensure that vehicles put on the market are more circular, such intention is to be made more explicit in the 3R legal text and to be communicated to stakeholders.

7.4.3.2 Conclusions

Is the way that the 3R Directive refers to the ELVD hazardous substance and plastic coding provisions effective in terms of ensuring that vehicles put on the market comply with the related prohibitions (and with related exemptions) ELVD requirements? AND Will the way that the 3R Directive addresses substance prohibitions and plastic coding remain effective in case such prohibitions (or their exemptions, if applicable) will change in the future?

It is concluded that the 3R Directive is effective in ensuring that vehicles POM comply with current prohibitions and exemptions of hazardous substances and with plastic coding standards. However, in the future, only compliance with the substance prohibitions would be ensured, based on the dynamic cross-reference in 3R Directive linking Art. 4(2) of the ELVD. Another indicator for effectiveness in this case is the fact that the hazardous substances related articles in ELVD and 3R Directive formulated in a very similar way. Though the wording of the articles could change, as long as the cross-references are kept, it is assumed that substance prohibitions will be effective.

As for coding standards, compliance is only ensured as far as the 3R directive is linked to Commission Decision 2003/138/EC, however compliance with changes resulting from amendments to ELVD Art. 8 would not be ensured.

It should be noted that ELVD does not refer to the intention for 3R Directive check compliance with the hazardous substance prohibitions and the and plastic coding requirements. In both cases, the ensured compliance can be considered as an added benefit of the 3R Directive.

Will the way that the 3R Directive addresses substance prohibitions remain effective in case such prohibitions (and/or their exemptions) are moved to another legislation (e.g. REACH)?

As said above, the key for ensuring that 3R legislation is effectively addressing substance prohibitions is the direct cross-reference to Art. 4(2) in the ELVD. It is expected that it should be possible to add the direct cross-reference to another legislation, e.g., a respective article and/or Annex in REACH. However, looking at the fact that REACH has the possibility to prohibit substances, e.g. substances of very high concern, without any link to the field of application of the substance, it is expected that the more vehicle-specific prohibitions and exemptions are formulated, the better type approval authorities can connect the exemptions with their daily field of work.

Is the 3R Directive effective in ensuring that vehicles put on the market are more circular?

As the different R's are differently addressed, and due to recyclability being the focus of 3R Directive, it is concluded that the 3R Directive is not sufficiently effective in ensuring that vehicles POM are more circular. Furthermore, prevention is not an aspect of 3R Directive. However, based on the assumed intention of the regulator, the 3R Directive has the potential to contribute a lot to the circularity of vehicles in connecting EoL requirements with the vehicle type approval.

Is the 3R Directive suitable for ensuring in the future that vehicles put on the market will comply with future ELVD provisions on circularity (e.g., recycled content targets)?

As a precondition to effectively ensure that vehicles POM will comply with future ELVD provisions on circularity, the assumed regulation intention formulated earlier needs to be confirmed by the regulators, e.g., through amendments / additions of Recitals. Moreover, for sure, amendments of 3R Directive in relation to future ELVD provisions on circularity are necessary, e.g., providing additional information on components beyond 3R Directive Annex I (Requirements), Annex II (Information Document for EC vehicle type approval), and Annex IV (Preliminary Assessment).

7.4.4 ELVD end-of-life requirements

The questions addressed in this section are:

- Is the 3R Directive effective in ensuring that vehicles put on the market enable the reuse of their components and parts to the highest potential?
- Is the 3R Directive effective in ensuring that vehicles put on the market enable the recycling of their components and parts to the highest potential?
- Is the 3R Directive effective in ensuring that vehicles put on the market are composed of materials that can be recycled to a sufficient degree?
- Is the 3R Directive effective in ensuring that vehicles put on the market can fulfil the ELVD 3R targets at present or in case their ambition is increased in the future?
- Would the 3R Directive remain effective in ensuring that vehicles put on the market comply with ELVD if requirements would be added to make certain waste management treatments obligatory, e.g. certain post shredder technologies?

7.4.4.1 Analysis

Article 1 of the 3R Directive clarifies that its objective is to ensure that the component parts and materials of vehicles that have been type-approved based on its rules can be reused, recycled and recovered, as a minimum fulfilling the 3R targets which are mentioned in Annex I of the 3R Directive[412]. For this purpose, the 3R type approval process requires manufacturers to compile various data on the vehicle being type-approved as a means of showing its potential reusability, recyclability and recoverability. This creates an impression that all of the 3Rs are part of the type approval process, in which OEMs need to provide evidence as to how they comply with the ELVD 3R targets. However, in practice, how the process is conducted relates differently to each of the 3Rs. For example, looking at the general type approval legislative text where the 3R Directive is referred to, 'recyclability' is mentioned but not the other R's.

This can already be observed in the ISO 22628: 2002 that is prescribed as the standardised method for the calculation of the 3Rs. The scope of the ISO standard refers to its use for the purpose of calculating the "recyclability rate" and the "recoverability rate". Reuse is covered by these two rates but is not specified individually and thus there is also no requirement to report on reuse individually in the calculation. The standard defines "reusability" separately and also specifies criteria for when a component can be considered as "reusable, recyclable or both based on its dismantlability", however, here too, there is no obligation for manufacturers to provide separate data about e.g., the total weight and composition of components with a potential for reuse. Components removed for reuse or recycling prior to the shredder can be specified in the data provided on the "pre-treated" fraction and on the "dismantled" fraction. For the former, the standard specifies a list of components and materials for which data must be provided. Many of these component parts and materials appear under the ELVD Annex I, part 3 and 4 (e.g., depollution and removal requirements), though not all. For the latter, i.e., the 'dismantled fraction', there is no specification, however

[412] The target of 85% and 95% is explicitly named in Annex I, as described before, however, neither in Art. 1 nor in the Annex I is there a link to the ELVD.

the calculation format provided in Annex A of the standard requires that data provided is specified in relation to a specific component. In practice, it is understood that each manufacturer will specify different components in this section, “based on the dismantling strategy”. This observation is based on documents submitted as examples of type-approval submissions by a type-approval Authority), and confirmation with other stakeholders (MS type-approval Authorities). It was further explained by an MS type approval authority that the strategies and insofar also the type of components specified for dismantling are often of the same kind in terms of the cost/benefit of dismantling of a specific component. i.e., highest material weights in relation to the lowest dismantling costs. However, different type approval documents submitted to the consultants as part of the stakeholder input suggest that the number of components specified can vary greatly. Of two submission examples, one specified a single component (material composition was not specified) and the other close to 20, of which all were composed of plastic aside from a reference to glass. Based on the component types and composition, the consultants assume that in the latter case the components were mainly considered dismantlable for the purpose of recycling. As dismantled components can be relevant for reuse and/or recycling, it is concluded that a vehicle can reach type approval without actually referring to components that are relevant for reuse. This was explicitly confirmed by an interviewed stakeholder and generally, most stakeholders stated that reuse of parts and components of ELVs is not facilitated through the 3R type approval.

On this basis, it appears that despite the reference to the reuse and recycling target and various references to reuse in the 3R Directive and the ISO standard, that the type approval process does not promote reuse in practice. In the legislative text, 'reuse' is only referred to in relation to component parts which shall not be reused, but there is no reference to components, the reuse of which is to be promoted. Most stakeholders who were interviewed or surveyed (e.g., MS type approval authorities but also OEMs) support this view and specified that reuse is not taken into consideration in the type approval process. Various stakeholders (e.g., (Stellantis 2022; VW/Porsche 2022)) explained that reuse is solely based on market demand and that, in principle, every part is reusable – however it is not possible in the design phase to estimate what will be reused when the demand is not yet known. This may explain why asking for specific quantities of reused parts under the 3R type approval calculation is meaningless. However, there is room to consider how the 3R type approval process could facilitate reuse.

Looking at recycling, it is observed that a core part of the 3R type approval process is based on the specification of components and materials that are considered to be recyclable, i.e. through the requirement to calculate the recycling rate. This is addressed in the ELV “pre-treatment” and “dismantled” fractions that are addressed in the ISO standard calculation, as explained in the first paragraphs of this section for reuse. It is also addressed in the ISO standard calculation section on “metal separation” (i.e., all metals separated from the vehicle through shredding) and on non-metallic residue treatment (specification of recyclable materials). All materials considered to be recyclable are calculated to account for compliance with the “reuse and recycling” target. Two limitations are observed here in terms of the 3R type approval process facilitating recycling.

- For the case of materials for which there are no available recycling capacities in the EU at the time of type approval, the ISO standard specifies that a material will be considered recyclable when there are “technologies which have been successfully tested, at least on a laboratory scale”. The logic behind this is that vehicles have a long service life (15-20 years) in which it can be expected that a technology at laboratory stage would reach maturity in terms of available recycling capacities. However, it is observed that vehicles that have been type-approved may include materials in large amounts that are not recyclable at EoL. For example, the BMW placed first models of the i3 on the market in 2013, using carbon fibres as a main material for the vehicle body instead of metal to reduce the weight of the vehicle[413]. In a comparison of the weight reduction effect with the Mazda 2, Marklines (2015) Automotive Industry Portal[414] estimates that the BMW i3 is "90kg (39%) lighter than that of a Mazda2-based steel-made vehicle of the same size". Nonetheless, according to this source, the BMW i3 contains 68.5 kg of Carbon Fiber Reinforced Plastics (CFRP). Based on interviews with waste management operators, capacities for the recycling of this material are still not available for ELV waste management, resulting in a large share of the vehicle weight not being recycled (Egara 2021). Looking at other vehicles, most vehicles do not use CFRP and yet the 85% reuse and recycling target is not significantly "over-achieved". It is thus assumed that the BMW i3 and similar vehicles using large amounts of CFRP have been type approved with the assumption that this material would be recyclable at EoL. The understanding that vehicle manufacturers constantly search for materials that could help reduce the vehicle weight to reduce vehicle emissions means that this could become a more significant problem in the future. In other words, there may be room to consider how such materials should be treated in the future under the 3R type approval process, to ensure that compliance with the 3R targets is not impaired.

- As for material that can be recycled, in such cases the ISO standard prescribes that the full weight of the material is considered for the calculation of the share of the vehicle that is reused and recycled. Consideration as to material losses during waste operations are not made, even though materials are not recycled at 100% efficiency. For example, EUROFER (27.10.21) stated that a level of 90% recycling is typically achieved for steel as each marginal increase results in a significant increase in the cost of treatment. In addition, there is no differentiation in this case between high quality recycling which generates secondary material that can be used in vehicle manufacture or equivalent uses, and between downcycling like backfilling or construction filling materials. For example, glass is sent with the ELV to the shredder in most MS, and is part of the mineral fraction generated from shredder heavy fraction used for backfilling or as a construction filling material (OVAM 2012?).

Considering the development of vehicles towards increasing use of light-weight materials[415] and considering possible changes of the ELVD, (e.g., the increase of the reuse and recycling targets, changes the way that it is to be monitored and reported on or introduction of material specific recycling targets), there may be room to change the way that such materials are perceived. Against this background Type approval Authorities were asked if they perform any sort of monitoring of the differences between the achievability of the 3R targets in the type approval phase and at end-of-life. Most admitted to not performing such monitoring, or studies that look at this aspect. Only one type approval service provider (but not the authority) explained that they visit ATFs occasionally to see how dismantling is performed and check how this compares with the data provided during type approval, however vehicles investigated were stated not to be the same as those for which the company had supported OEMs in the process of type approval. Here too, it could be relevant to consider how it can be ensured that recyclability reported during type approval sufficiently reflects the recyclability that can be achieved at EoL.

Overall, the 3R Directive does not distinguish between treatment technologies, aside from the differentiation into pre-treated, dismantled, metal separation and non-metallic residue treated

[413] https://www.dw.com/en/bmw-sets-its-sights-on-innovative-carbon-fiber-future-with-i3-electric-car/a-17095180

[414] https://www.marklines.com/en/report_all/rep1419_201506

[415] Stellantis (2022): "There is larger importance in design considerations given to the use phase of vehicles, especially weight (to save on energy consumption); if the energy mix becomes 'greener', it might be that other aspects than use-phase would gain importance."

fractions. As explained above, if a treatment type falls under the definition of recycling[416], it will be counted towards achieving the reuse and recycling target. There is no prioritisation of technologies that achieve higher recycling qualities or that reduce the losses of certain materials.

Finally, 3R Directive does not contain any reference to the prevention of waste. Prevention was said (Stellantis 2022) to be part of design but not really measurable during 3R type approval (how to measure a material not used). It was also explained (VW/Porsche 2022) that 'longevity, durability, reparability and light weight facilitate the prevention of waste'. Stakeholders asked in this respect were generally of the opinion that it was not the objective of 3R Directive to address waste prevention. However, in the waste hierarchy and Circular Economy, there is a clear preference for prevention (and reuse) measures over recycling.

7.4.4.2 Conclusions

Is the 3R Directive effective in ensuring that vehicles put on the market enable the reuse of their components and parts to the highest potential?

Though the 3R Directive makes a reference to reuse through the requirement to show how the 3R targets are to be met, based on the information above, it is concluded that the 3R Directive is not effective in facilitating reuse per se. The method of calculation set out through the reference to ISO 22628: 2002 refers to specification of components that can be dismantled and reused, but it does not require manufacturers to address reuse separately in their 3R Type approval applications. It can be understood that manufacturers rarely refer in their calculation to components that can be reused as it is not possible to assume what components will be dismantled and reused in practice at EoL. The effectiveness of the 3R Directive can be assumed to decrease even more should the ELVD introduce additional obligations on reuse, if they are not taken up under the 3R Directive as well.

Is the 3R Directive effective in ensuring that vehicles put on the market enable the recycling of their components and parts to the highest potential? AND Would the 3R Directive remain effective in ensuring that vehicles put on the market comply with ELVD if requirements would be added to make certain waste management treatments obligatory, e.g. certain post-shredder technologies?

Though the 3R type approval process requires manufacturers to specify recycled amounts separately, it does not require a differentiation between qualities of recycling (high quality vs. downcycling). It also does not require taking recycling inefficiencies into account. Insofar it cannot be considered effective in facilitating recycling of components and material parts to their highest recycling potential. Whether it would be effective in its current form in ensuring compliance of a vehicle with possible waste management obligatory treatment technologies will depend on how such technologies for high-quality recycling would be distinguished from recycling technologies with output of lesser quality in the accounting of recyclability. The effectiveness of the 3R Directive can be assumed to decrease even more should the ELVD introduce additional obligations on recycling (e.g., material specific recycling targets or requirements on shredder and/or PST performance standards), if they are not taken up under the 3R Directive as well.

[416] Linked to the ELVD definition under Article 2(7): "'recycling' means the reprocessing in a production process of the waste materials for the original purpose or for other purposes but excluding energy recovery. Energy recovery means the use of combustible waste as a means to generate energy through direct incineration with or without other waste but with recovery of the heat".

Is the 3R Directive effective in ensuring that vehicles put on the market are composed of materials that can be recycled to a sufficient degree?

The 3R Directive does not sufficiently differentiate between non-recyclable and recyclable materials as long as technologies are available at the laboratory stage and above. De facto this allows vehicles making use of high volumes of non-recyclable to be placed on the market in some cases, like CFRP which is increasingly used in vehicles to reduce their weight and for which there are currently lacking recycling capacities for vehicles in the EU. With the trend towards lightweight materials, this could affect the achievability of the 3R targets and should be addressed more effectively in the Directive to avoid this consequence. It also needs to be said, however, that an increase in use of a non-recyclable material in the vehicle fleet could be sufficient in some cases for recycling capacities to develop over time, having a positive effect of the 3R effectiveness in this respect over time. Here too, should any requirements be introduced in relation to non-recyclables (e.g., obligatory dismantling) it would be beneficial for them to be addressed under 3R Directive so as to at least ensure that the use and localisation of such materials is communicated to waste operators to ensure compliance with possible treatment requirements.

Is the 3R Directive effective in ensuring that vehicles put on the market can fulfil the ELVD 3R targets at present or in case their ambition is increased in the future?

Considering the points raised above, there is already concern as to the achievability of the 3R targets due to the increase in use of lightweight materials and other trends. Should the ELVD increase the ambition level of targets (e.g., increase of the reuse and recycling target, change in the reporting on fulfilment or in the operations considered as recycling or introduction of material specific recycling targets), it can be assumed that the current practice would lose its effectivity in terms of preventing market entry to vehicles that cannot achieve the 3R targets and future related requirements. This is particularly the case as the current practice of checking compliance with the reuse and recycling target does not e.g., take account of recycling inefficiencies.

7.4.5 Information collected through the 3R Directive processes

The questions addressed in this section are:

- Is the 3R Directive effective in ensuring that ATFs have enough information on vehicles put on the market to allow their waste management in compliance with the ELVD 3R targets?

7.4.5.1 Analysis

The question is whether information collected as part of the 3R Type approval could be used as a basis for increasing data accessibility to waste operators on component parts and materials as well as if and how they could be dismantled to promote recycling. Another option is that such information could feed into an EPR mechanism to allow concluding from the dismantlability of vehicles to the necessity of financing certain waste treatment operations.

Generally, information is provided in the two steps of the 3R type approval, this is i) the preliminary assessment, and ii) the type approval as such. Requirements as to what data must be provided, is listed in 3R Directive Annex I (Requirements), Annex II (Information Document for EC vehicle type approval), and IV (Preliminary Assessment). There is no identifiable consistency in the information requirements referred to in Articles specifically, e.g. Art 4(2) refers to hazardous substances, or in the Annexes only.

On the total list of information that a manufacturer compiles for the 3R Type approval, the following information would be useful and relevant to dismantlers and ATFs:

- **Strategy for dismantling, reuse, recycling and recovery.** This strategy and the IDIS document are not directly interlinked (Stellantis 2022). Some OEMs do not have the same document at all, however, among the answers from OEMs, there was one (anonymous) saying that they provide to IDIS an adapted version of the strategy prepared to comply with 3RD Art 6(3).
- **ISO 22628:2002 Annex A data presentation table.** Not for all calculation steps of the ISO standard, but at least in some places, manufacturers indicate the components they expect to be dismantled, i.e., adding to the sum of dismantled parts. On the other hand, though a vehicle may in theory comply with the calculation standard, the lack of information on dismantling methods may affect what components can be removed prior to shredding in practice and thus how much will be reused or recycled at a higher level (quality and/or amount).
- **The recyclability and recoverability rate.** The rates are currently assumed to be met by the MS (see Figure 2-4 in main report), but this could change if the definition of recycling changes to exclude backfilling or other forms of downcycling or if targets ambition increases.
- **Plastic coded parts and parts containing hazardous substances.** As mentioned earlier, these two requirements are being checked in the preliminary assessment, thus, not per vehicle type, but only whether manufacturers handle data properly and completely over the value chain. This does not necessarily facilitate communication of information to the waste management sector (though more inherent when plastic coding standards are applied).
- **3R Directive Annex II information** on the general construction characteristics of the vehicle, on the power plant, transmission, and bodywork.

In the process, all this data is provided to the technical service providers and the MS competent authorities. For some OEMs, the information is adapted, and for some OEMs, additional information is compiled for the communication to the ATFs. Industry voluntarily uses the IDIS platform for this.

In terms of who should be targeted with measures or benefit from certain provisions, it should be noted that so far ATFs are not part of the stakeholders dealing with or profiting from the 3R Directive's requirements. In the current version of 3R Directive, manufacturers are targeted to provide the data to the Type approval Authorities.

7.4.5.2 Conclusions

Is the 3R Directive effective in ensuring that ATFs have enough information on vehicles placed on the market to allow their waste management in compliance with the ELVD 3R targets?

In its current version, it is not the objective of the 3R Directive to collect information and to provide it to ATFs with a view to facilitating the 3Rs. Although data has been collected that might be of interest to ATFs, a more detailed comparison between IDIS data and 3R type approval data should be made to see whether the information collected through 3R type approval might offer any additional benefits to ATFs, who should be asked for their opinion.

7.4.6 Alignment of the 3R Directive with the ISO 22628:2002

The questions addressed in this section are:

- Is the use of the ISO 22628: 2002 in the 3R type approval process effective in ensuring that type approved vehicles put on the market comply with the ELV provisions?
- Is the use of the ISO 22628: 2002 in the 3R type approval process effective in achieving the objectives of the 3R Directive?

7.4.6.1 Analysis

When the evaluation question refers to “ELV provisions” or “objectives of the 3R Directive” in the same sentence with the ISO 22628:2002, this specifically relates to ELVD Art. 7 in relation to the vehicles being ‘re-usable and/or recyclable to a minimum of 85 % by weight per vehicle and […] re-usable and/or recoverable to a minimum of 95 % by weight per vehicle’, and to the 3R Directive as the means to ensure the targets are met. Looking at the wording of the targets, ELVD refers to a reusable and/or recyclable and, secondly to a reusable and/or recoverable target. This is a different wording compared to the final outcome of calculations according to ISO 22628:2002 which is a “recyclability rate” and “recoverability rate”. However, these differences in “framing”, also in relation to reuse, are not perceived to result in any problems in the implementation, except for reuse not playing a role in the ISO calculations, as admitted by stakeholders. From the formulation it is clear that this can only be a hypothetical recyclability and recoverability, since the various masses of materials included in the calculation are ‘considered recyclable for the purpose of the calculation’. As explained earlier, recyclability is a yes or no decision in the ISO standard, while in practice, it can be assumed that some of the component parts dismantled during depollution are considered hazardous waste and thus are not being recycled. Hence, the rates calculated through the ISO norm do not represent the final shares of what is effectively recycled. But, from how the ELVD requirement is formulated, and given that no further discrepancy between the wordings of Art. 7 of ELVD, 3R Directive and ISO 22628 could be identified, it is concluded that the standard ensures that vehicles POM comply with the current provisions and objectives.

However, another point was identified, where coherence between ISO standard and EU legislation (ELVD & 3R Directive) was not ensured: In relation to the assessment of dismantled component parts to be considered reusable or recyclable, (a) accessibility, fastening and dismantling technology shall be assessed in relation to the dismantlability, (b) safety and environmental hazards shall be assessed in relation to reuse, and (c) material composition and proven recycling technology shall be assessed in relation to recyclability (requested in step 2 in the ISO calculation). Participants of interviews were asked how the classification of component parts into reusable parts and recyclable parts is done. VW/Porsche (2022) answered that “the reusability of vehicle components is usually possible for all components unless they are explicitly excluded by law, or they are wearing parts. Which vehicle components are actually reused depends on the requirements over the life of a vehicle. This cannot be foreseen by the vehicle manufacturer.” This suggests that the assessment of dismantled components to be considered reusable or recyclable according to the three criteria mentioned is of no particular importance for manufacturers in the compilation of the 3R type approval. It is unclear which of the requirements of the 3R Directive refers to or even covers this “ISO-step2-assessment”, for example ‘accessibility’ and the fastening techniques is something that is not part of the 3R Directive. Requirements that could possibly cover this assessment could be Annex I, point 2 specifying that the data calculated through the ISO 22628:2002 shall be accompanied by a list of dismantled components with respect to the dismantling stage and the process the manufacturer recommends for the treatment, and Annex I, point 8, that the type approval authority shall double check the calculation and the accompanied list against the dismantling strategy provided in the preliminary assessment. If one of these two points were included to cover the assessment, the connection can only be assumed. In the case of Annex I, point 2, the 'dismantling stage' referred to therein could be interpreted as the information on the accessibility, and the 'process recommended for treatment' could be interpreted as the information on the proven recycling technology. Then one could argue that the material composition is provided via IDIS, however, especially in the first two cases, references are only vague and in addition, there is no direct mentioning of fastening technologies which is a relevant information for dismantling. Furthermore, as explained above, as there is no reference to components for which reuse is to be promoted (through provision of such data), type approval submissions can differ significantly in the number and type of components specific for possible dismantling.

An additional aspect is noted in relation to the criteria for choosing the reference/ worst-case vehicle. Looking at the examples for the trim level and optional equipment provided in Annex I of the 3R Directive, it is assumed that the way the ISO is designed, it might not make a big (or rather no) difference in the recyclability rate whether you take a vehicle with a radio or a leather upholstery (two of the examples provided for trim level and optional equipment). Also, in terms of coherence, and if to look at the aggregated and hypothetical nature of the ISO's calculation method, it can be concluded that the ISO calculation will not necessarily make apparent variances between slightly different versions of a vehicle type, when data which is used to calculate the recyclability rate is only inserted in the calculation in a very aggregated way.

7.4.6.2 Conclusions

Is the use of the ISO 22628: 2002 in the 3R Type approval process effective in ensuring that type approved vehicles put on the market comply with the ELV provisions? AND Is the use of the ISO 22628: 2002 in the 3R Type approval process effective in achieving the objectives of the 3R Directive?

Yes, ISO 22628 is effective in calculating the targets set out in ELVD Art. 7 and, to the extent that it is intrinsic to such a methodology, it can also support the objectives of 3R Directive. However, discrepancies are expected in the different levels of aggregation: Small optional equipment, for example, plays a role in the selection of the reference vehicle, while the ISO methodology will not be able to display the differences of a vehicle type with this optional equipment being added or not. A second discrepancy was identified in relation to the assessment whether to consider a component reusable or recyclable. The method also does not allow taking account of recycling inefficiencies in terms of the 3R targets and this could lead to increase ineffectiveness in the future, should the ambition of the targets or related recycling requirements rise.

7.4.7 Alignment and coherence with the UN ECE Regulation 133

The questions addressed in this section are:

- Is the 3R Directive coherent with the UN ECE Regulation 133?

7.4.7.1 Analysis

In fact, the evaluation question asks whether or not it is ensured that vehicles placed on the market after a UN ECE Regulation 133 type approval also comply with the relevant provisions that are required for vehicles that are type approved on the basis of the 3R Directive and vice versa. Similarities and differences between the 3R Directive and UN ECE 133 were shown earlier (chapter 7.2.4). To summarise, deviating aspects are the criteria for the selection of the worst-case vehicle (see table above) and, under UN ECE in the specific type approval, according to which manufacturers shall additionally declare compliance with hazardous substances and plastic coding. This, however, only applies to the preliminary assessment in case of the 3R Directive. Another aspect is, that the definition of recovery in the UN ECE 133 differs from that included in the 3R Directive and ELVD. The latter refers to a list of recovery processes agreed under the Waste Framework Directive. Hence, the definition in ELVD is more detailed than the UN ECE definition. However, it was neither mentioned by stakeholders nor were there any other indications that pointed out or concluded that this discrepancy between the definitions was problematic. As the 3R Directive (2005) has mainly been the source for the UN ECE Document published in 2014, and given that there are only slight differences that are not substantial to the objectives and main provisions, it is assumed that the 3R Directive is generally coherent with the UN ECE Regulation 133.

A stakeholder reported that his company was generally applying for type approvals under the UN regulation. Against this background, VW/Porsche (2022) stated that ‘If Europe would change 3R type approval, also UN R 133 has to be amended’. Stakeholders also addressed the importance of this coherence in the workshop, explaining that it also made the process more efficient for OEMs, i.e., as they did not need to perform the type approval process multiple parts for the same vehicle type in different regions. It is thus very important to not lose sight of the fact that stakeholders currently use both legislations for the same purposes/interchangeably and alternatively.

7.4.7.2 Conclusions

Is the 3R Directive coherent with the UN ECE Regulation 133?

Yes, the comparison of the 3R Directive and the UN ECE Regulation 133 (chapter 7.2.4) showed and stakeholders confirmed that both legislations are considered identical in terms of the ambition level, except for minor differences explained above.

7.5 Summary of the results

Five points are identified to work effectively in the 3R Directive: These are (1) the intention of the regulation (in the current wording), (2) the comprehensive scope (looking at the 3R Directive individually), (3) ensuring market compliance with hazardous substance and plastic coding provisions, (4) effectiveness of ISO 22628 in calculating the targets set out in ELVD Art. 7, and (5) the interchangeably of the 3R Directive and the UN ECE legislation.

Four aspects of ineffectiveness were identified:

- Comparing the scope of the ELVD and the scope of the 3R Directive, it was identified that they are neither aligned nor dynamically linked in relation to M1 and N1 multi-stage built vehicles and vehicles produced in small series (if not special-purpose vehicles). ELVD requirements apply to these vehicles, but compliance is not checked during type approval processes (because of an exclusion from scope of the 3R Directive).

- The 3R Directive is neither effective in ensuring that vehicles POM are more circular, nor in facilitating reuse per se. It is also not considered effective in facilitating recycling of components and material parts to their highest recycling potential.
- The 3R Directive does not sufficiently differentiate between non-recyclable and recyclable materials as long as technologies are available at the laboratory stage (Technology Readiness Level 4) and above, creating a concern as to the achievability of 3R targets in the future.
- Because it is not the objective of the 3R Directive to collect information and to provide it to ATFs, the 3R Directive is not effective in ensuring that ATFs have enough information.

On the basis of the list of inefficiencies, it is suggested that, even if ELVD was not amended, the aspect of promotion of reuse and recycling of material parts to their highest recycling potential should be included. Furthermore, a differentiation should be made between non-recyclable and recyclable materials. These amendments should be made to cover current inefficiencies.

In the context of the current revision of the ELV legislation it is important that account will be taken of the following additional inefficiencies if the ELVD, and the 3R Directive is not:

- If the 3R Directive cannot be used as a means to further implement additional requirements in relation to measures to support design for circularity, the regulator shall lose its mechanism to check compliance of design requirements supporting the ELV treatment.
- If scopes will still not be aligned between the two legislations, the existing discrepancies that exist today will increase in the future: If, for example, multi-stage built vehicles continue to be excluded from the 3R Directive but will be in scope of ELVD in terms of design requirements (haz. subst., plastic coding) or 3R targets applying to them, then, the compliance with certain ELVD requirements will not be ensured for a considerable number of vehicles, as the compliance cannot be checked through 3R type approval.
- Should the ELVD increase the ambition level of 3R targets, it is assumed that the 3R Directive would lose its effectivity in terms of preventing market entry to vehicles that cannot achieve the 3R targets. This could also be the case should additional provisions on recycling qualities and standards be introduced.

At various moments of this targeted evaluation, the question arose as to merging the ELVD and the 3R type approval directive. Should merging be considered, the following was identified as issues to keep notice of:

- Future regulation will require (dynamic) references to the general type approval legislation (Regulation 2018/858), assuming that the regulator continuously intends to use the process of type approval to ensure compliance with vehicle design requirements prior to their being put on the market.
- The legislation will have one scope only - it is recommended to regulate exemptions for specific vehicle categories in relation to a single or multiple provisions rather than putting exemptions generally upfront. An example for the proposed way of regulation is the Art. 3(4) of the ELVD which exempts special-purpose vehicles from the provisions of Art. 7 (of ELVD).
- It is very important to not lose sight of the fact that currently, stakeholders use 3R Directive and UN ECE 133 legislations alternatively for the same purposes/interchangeably. Consequences of a merging for this interchangeability should be considered.
- As long as the cross-references are kept or revised according to different legislations, articles and annexes, it is expected that hazardous substance prohibitions and plastic coding will remain effective.

As outlined earlier (Table 7-1), possible measures will be integrated in the policy options under the main study of the ELV Impact Assessment. The following measures have been identified to address the earlier mentioned inefficiencies:

- Under the Problem Area of "circularity"
  - Measures to achieve specific objective 2.1: Improve design and production of vehicles to support reuse and recycling
    - 2.1.d) Provisions for improving the relation between the 3R Type approval process and ELV waste management performance. (chapter 2.1.5.1.4)
    - 2.1.e) Option for OEMs to submit life cycle data as part of the 3R type approval process to justify the use of materials where recycling is not yet established (chapter 2.1.5.1.5)
    - 2.1.f) Obligatory reporting requirements on the use of materials that affect dismantling and recyclability to facilitate identification of incompatible practices (chapter 2.1.5.1.7)
    - 2.1.h) Obligatory due diligence for materials used in vehicles (chapter 2.1.5.1.9)
    - The manufacture of vehicles and vehicle components makes use of numerous materials of both primary and secondary nature. Some of these are sourced from countries (outside the EU) where the local governing conditions and/or the level of performance of mining and processing facilities may not ensure the provision of human rights, the health of workers and/or of nearby residents, or the prevention of adverse impacts on the environment. Where the manufacture of vehicles has a high dependency on material sourcing from such countries, this can contribute to adverse impacts on society and on human health and the environmental. To prevent such impacts, vehicle manufacturers could be required to perform due diligence when sourcing materials to produce vehicles and their components from high- risk countries. This can be related either to primary materials that are sourced from conflict-affected or high-risk areas or to secondary materials sourced from countries that do not ensure a minimum level of environmental performance and/or of minimum social working conditions.

At horizontal level, in relation to the sourcing of minerals from conflict-affected or high-risk areas, Regulation 2017/821/EU lays down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from such areas. The sourcing of e.g., tin, tungsten, tantalum, niobium and gold minerals and metals for vehicle manufacture would be addressed through this Regulation, making an ELV obligation redundant.

In some cases, there may be other materials used in vehicles sourced from countries that do not ensure that the sourcing and processing of such materials is environmentally and socially sound. For such cases, due diligence obligations could be included in the Directive, similar to those currently proposed for the new regulatory framework for batteries. This would include a provision, laying down obligations for OEMs to perform due diligence on the supply of certain materials (primary and secondary), and to declare on the risk of occurrence of adverse impacts and on strategies for their mitigation. Declarations on such actions, including third party verification would need to be made available to authorities as part of the type-approval process and for MS inspections. A list of materials (e.g., REE) for which this is to be obligatory would be included in the future legislation for vehicles, also specifying thresholds for each material as to the amount of use contained in a vehicle above which the obligation would comply. The annex would be updated continuously, in relation to the thresholds and if necessary, also as to the materials specified therein.

There is also a need to consider the requirements set out in the Corporate Sustainability Due Diligence Directive. The CSDD is a horizontal legislation that focusses more generally on the *behaviour* of companies and addresses the entire value chain for all goods and services. It will implement the due diligence requirements of the proposed Batteries regulation by introducing a *value chain* due diligence related to raw materials (and goods and services) that are *not* covered in the Batteries Regulation. Both build on the OECD due diligence guidance, making implementation coherent.

Expected outcome: It is currently not clear which materials could be addressed through a due diligence obligation to be included in the future ELV legislation. Materials addressed under other legislation (or in focus of future sectoral legislation such as the Batteries Regulation) are not used in large amounts in vehicles.

In parallel, the European Commission has published a tender to review the functioning of Regulation 2017/821/EU, which towards 2026 could both lead to adaptations in future due diligence requirements as well as in the materials for which such requirements are necessary.

    -
    - 2.1.i) Set out an obligation for OEMS to provide additional information on composition of cars (chapter 0)
    - But not: 2.1.c) Obligation for OEMs to develop and implement a circularity strategy for increasing the circularity of vehicles. This measure is regarded in addition to 3R Directive “strategy for dismantling, reuse, recycling and recovery”, see the full description in chapter 2.1.5.1.3.
- Measures to achieve specific objective 2.2: Ensure elimination of hazardous substances in vehicles
- 2.2.a): Restriction of substances in vehicles

This measure deals with defining the means to generate specific limitations/restrictions on substances used in vehicles. The expected mechanism should be able to deal with the existing restrictions of the four heavy metals as well as with the exemption mechanism. At the same time, it should cover the restriction of additional substances.

The objective of this measure is to provide legal certainty about the currently restricted substances and their exemption, and the procedure for future substance restrictions and the exemptions mechanism.

Furthermore, it should allow to restrict further substances in vehicles. This is relevant against the background that there is a general increase in the use of plastics, for example, due to its advantages for vehicles in terms of weight reduction. However, the use of plastics also raises concern as to the presence of hazardous chemical additives in such materials and with regard to the question as to how far this can pose technical difficulties for their recovery. Concerns on additives also apply to other materials such as rubber or textiles, though possibly used in lower amounts in these materials. This suggests that there may be a need to regulate the presence of additional hazardous substances that are used in vehicles, aside from the four heavy metals currently prohibited, e.g., certain flame retardants, plasticisers or surface-active agents such as PFAS.

Three variants of this measure can be distinguished, these shall be treated as policy options. Thus, the detailed description of the measures can be found in the description of the policy options in chapter 3.1.4.8.2. For this measure, three alternative policy options are:

POLICY OPTION 1A – RESTRICTIONS AND EXEMPTIONS UNDER REACH

POLICY OPTION 1B – RESTRICTIONS AND EXEMPTIONS UNDER REVIEWED ELVD

POLICY OPTION 1C – HYBRID APPROACH

2.2.b: Improved communication on hazardous substances in the automotive value chain

This measure addresses the communication needs at the end of life of vehicles on the hazardous substances to allow improved reuse and recycling by sorting (out). An improvement in the communication on hazardous substances in the automotive value chain would also contribute to the elimination of hazardous substances in material fractions generated by the ELV waste management sector. There are information systems in place covering the details on material composition, however, the missing element is the availability of the information at waste treatment facilities on the one hand side, and the information for dismantling on the other side. Thus, there is a need for additional dismantling information for recyclers in addition to the current information provided by SCIP or GADSL in IMDS.

This proposed measure is to introduce an obligation – to be added to the ELVD – that the information on the content of substances with hazardous classifications or substances under assessment for classification needs to be documented along the value chain. Should a need for depollution arise, the information on the content of hazardous substances would need to be made available to treatment facilities in a way that the information is linked to

single parts/components,

the location of the parts/components in the vehicle combined with dismantling information and

to safe use instructions for dismantling and recycling processes.

This communication would enable the dismantling prior to shredder, combined with subsequent decisions on whether to sort out components or materials, from the material flow, for disposal due to their content of hazardous substances (as is the case for parts containing the POP decaBDE) or to sort out such components or materials to allow their diversion to specific treatment that allows controlling the content of hazardous substances (e.g., separating aluminium wrought and cast alloys) or eliminating it from the general material stream.

The improved communication could be envisaged according to three possible information schemes:

Via the SCIP database as a centralised European Database: The SCIP database was recently established to collect information from companies on the contents of Substances of very High Concern of the REACH Candidate list in articles supplied to the EU market. These notification requirements under the SCIP database for SVHC comprise a current obligation and can be considered as the baseline.
In order to serve as a measure on improved communication, the SCIP database would need further development and adaptations.

Via an industry-driven system, e.g., based on GADSL/IMDS: The Global Automotive Declarable Substance List (GADSL) was developed to facilitate communication and exchange of information regarding the use of certain substances in automotive products throughout the supply chain. The list only covers substances that are expected to be present in a material or part that remains in a vehicle at the point of sale. The GADSL specifies not only substances that are prohibited, but also substances that are under assessment and could potentially be regulated in the future. In this sense, the GADSL covers substances beyond those, for which the use is to be notified to the SCIP database.

In order to serve as a measure on improved communication, the GADSL/IMDS would also need further development and adaptations.

Via a Digital Product Passport (DPP), which is most likely based on a decentralised IT architecture, as defined in the Proposal for a Regulation establishing a framework for setting Ecodesign requirements for Sustainable Products (ESPR). The information requirement on substances of concern is depicted in the text box below. The information might be made available via different manners. Due to the complex composition of vehicles, a DPP or an access to the information via the VIN number on a website or an application seems to be the most appropriate form of communication. However, a concrete development is still underway and so far not in place.

Proposal for a Regulation establishing a framework for setting Ecodesign requirements for Sustainable Products (ESPR):

Article 7 Information requirements

[…]

5. The information requirements referred to in paragraph 1 shall enable the tracking of all substances of concern throughout the life cycle of products, unless such tracking is already enabled by another delegated act adopted pursuant to Article 4 covering the products concerned, and shall include at least the following:

(a) the name of the substances of concern present in the product;

(b) the location of the substances of concern within the product;

(c) the concentration, maximum concentration or concentration range of the substances of concern, at the level of the product, its main components, or spare parts;

(d) relevant instructions for the safe use of the product;

(e) information relevant for disassembly.

  - Measures to achieve specific objective 2.3: Increase the re-use and remanufacturing rates of parts and components contained in cars
    - 2.3.f) Set up a separate (monitoring) target for re-use/preparing for re-use/remanufacturing (chapter 2.1.5.3.6)
- Under the Problem Area of "scope"
  - Measures to achieve objective 1: Ensure a comprehensive coverage of the sustainable production and dismantling of all relevant vehicles by the ELV Directive
    - Obligation to give a CoD to the last owner of the vehicle

In combination with the obligation to treat vehicles in ATFs, this measure shall ask that a certificate of destruction (CoD) is given to the last owner of the vehicle (by the ATF), which would be necessary for deregistration. At a minimum, through this measure the same provisions shall be established for vehicles not yet in scope of ELVD as for M1 and N1 vehicles today.

Among the measures to address the problem of missing vehicles (in relation to objective 3.1) the OBLIGATIONS FOR DISMANTLERS /RECYCLERS TO CHECK AND REPORT ON ELVS/CODS is under consideration(see details under section 2.2.5.1.5). Dependent on the preferred option in relation to this measure (amongst others) it is still to be decided whether the new obligation to check and report ELVs on the number of CoDs shall apply to the waste operators dealing with new vehicles.

The provision shall be formulated so as not to create obstacles for the reuse market.

Vehicle specifics: not vehicle specific.

Expected Outcome: This measure facilitates Member States to identify the extent of problems associated with missing vehicles. It is considered a contribution to closing the lack of knowledge hindering authorities in fact-based decision making.

Affected Stakeholders: Vehicle owners, ATFs/dismantlers

- 3R TA provisions (chapter 2.4.5.1.6) in relation with targets for Reuse & Recycling (chapters 2.4.5.1.9)

Sources for this section:

- VW /Porsche (2022) Interview
- Mitic, S and Blagojevic, I (2018) Mobility & Vehicle Mechanics, Vol. 44, No. 3, (2018), pp 13-25
- ELV IA Main Study Interviews
- https://www.dw.com/en/bmw-sets-its-sights-on-innovative-carbon-fiber-future-with-i3-electric-car/a-17095180
- https://www.marklines.com/en/report_all/rep1419_201506
- Relevant legislation
  - ELV Directive
  - 3R Directive
  - Regulation 2018/858
  - Directive 70/156/EEC
  - ISO 22628:2002
  - UN ECE 133

Please note that other stakeholders interviewed requested that information stays confidential and that their answers shall not be cited.

ANNEX III: STAKEHOLDER CONSULTATION (SYNOPSIS REPORT)

8. Consultation Strategy

Within the preparation of the impact assessment, the consultation of stakeholders aims at capturing the views and ideas of relevant stakeholders, allowing them to provide relevant and robust information and data for assessing possible options for a new regulatory framework on ELVs, incl. the 3R type approval. The following synopsis report was prepared following the better regulation guidelines (Tool 55). It outlines the different steps and consultation activities which were conducted to feed into the assessment.

8.1 Consultation objectives

The objective is to ensure that stakeholders' views are sought on all key impact assessment aspects. The aim is to collect information from stakeholders in relation to the various problems and the measures proposed for achieving the objectives defined for each problem and their likely impacts. This information will complement information and data gathered through other sources (e.g., literature review, existing policy and position papers, Eurostat data and other statistical data sources, etc.). All inputs (data, information, etc.) from the consultation shall be incorporated into the impact assessment at appropriate points, i.e., information provided by stakeholders shall support the analysis of the problems, identification of options that could answer the objectives and their analysis.

8.2 Stakeholders consulted

Relevant stakeholders were grouped as follows:

- **Industry associations** (automotive industry (OEMs) for different vehicle types including material and component suppliers, dismantlers (ATFs), shredders, recyclers; including small and medium enterprises). The experience and knowledge of the industry located at the different life cycle stages is very important to assess the impact of the alternative policy options because the measures tailored to a specific life cycle stage have interlinkages with other life cycle stages. Industrial operators constitute a well-structured sector. There are several organisations at EU level that cover individual steps of the material and component supply, production, and different end-of-life management steps. These organisations and their members (individual companies) are able to convey the different interests and views of their members and to provide important input (e.g., market developments and other data and information) for the assessment.
- **Environmental protection organisations, general public, consumers**. The contribution of environmental NGOs is of high interest to link the particular case of ELVs with broader considerations of circular economy, resource efficiency, transboundary shipment of (hazardous) wastes, pollution, i.e., environmental conditions of end-of-life management etc. End-users and consumers directly experience the impact of certain measures in their day-to-day life (e.g., amendments in vehicle registration processes, e.g., temporary deregistration or repairability, spare part availability and costs of repair). Of particular interest is the fact that their views go beyond purely technical considerations.
- **MS public administration**. This group consists of government experts from all Member States, particularly environmental agencies, national EPR organisations, the registration and/or type approval authorities, market surveillance bodies. The experience of national administrations related to certain measures and options is highly specific and could be relevant. National administrations were consulted through a survey and/or through the participation in the meeting for Member States' representatives.

- **Other stakeholders,** e.g., academia, think tanks, etc., who may have a good knowledge and an interest in alternative options and their analysis and assessment were consulted on specific issues. Specifically, representatives from the United Nations Economic Commission for Europe (UNECE) and the United Nations Environment Programme (UNEP) were consulted on the impacts of European ELV framework revision in relation to international agreements. Another stakeholder group consulted in the group of other stakeholders is that of vehicle insurance companies playing an important role at a vehicle's end-of-life in the case of accidents.

Lists of stakeholders to be consulted for the impact assessment study in each of the consultation activities were provided to the European Commission (EC), aiming at a balanced representation of the stakeholder groups and the different stakeholders representing various sectors and areas. The list covered EU-wide associations and individual companies; different sectors from e.g., manufactures to environmental NGOs. An overview of stakeholders that participated in each consultation activity is provided in the sub-sections of the summary of the stakeholder consultation below.

8.3 Consultation methodology

For the consultation with various stakeholders, different tools were applied. The table below (6-28 next page) summarises the individual consultation methods and provides an overview of the overall consultation strategy.

In comparison to the initial consultation strategy, the elements of consultation of MS as well as the follow-up consultation after the workshop were included as additional consultations. It was found that some MS have experiences with legislation addressing problems targeted in the review of the ELVD, and questions arising on information provided by stakeholders required additional contacting to clarify their contributions. Furthermore, the consultation activities in relation to the study to develop and assess options to review Directive 2005/64/EC (3R Directive) and integration of the results into the impact assessment of the ELV Directive are summarized within this synopsis.

Please note that contributions received in the context of the public consultations published on the "Have Your Say" web portal cannot be regarded as the official position of the Commission and its services and thus do not bind the Commission. Furthermore, the contributions cannot be considered as a representative sample of the EU population.

8.4 Summary of stakeholder consultations process

All consultation activities are summarized in the following.

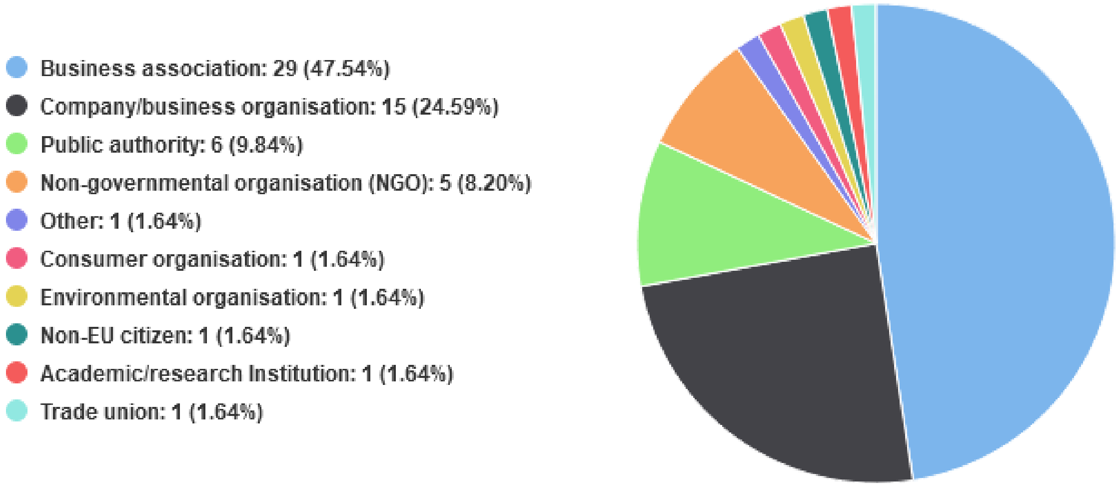
For some of the documentations of the stakeholder activities, no general publication is intended. However, the European Commission was provided with those documentations of stakeholder consultation activities not presented in this Annex, if not indicated differently by consulted organisations, i.e. where information was not disclosed.

8.4.1 Feedback on the inception impact assessment

An inception impact assessment setting the pathway for the revision of the ELVD was published on ec.europa.eu[417] and open for public feedback between 22 October 2020 and 19 November 2020. The feedback received stemmed from 61 entries. 47 of the participants submitted an additional document along with their contribution. Submitted documents and entries on the feedback website were looked at and attributed to the different topics of the revision.

[417] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

Figure 8-1 Affiliation of stakeholders (n=61) participating in the public feedback on the inception IA



Source: *https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en (access 16.06.2022)*

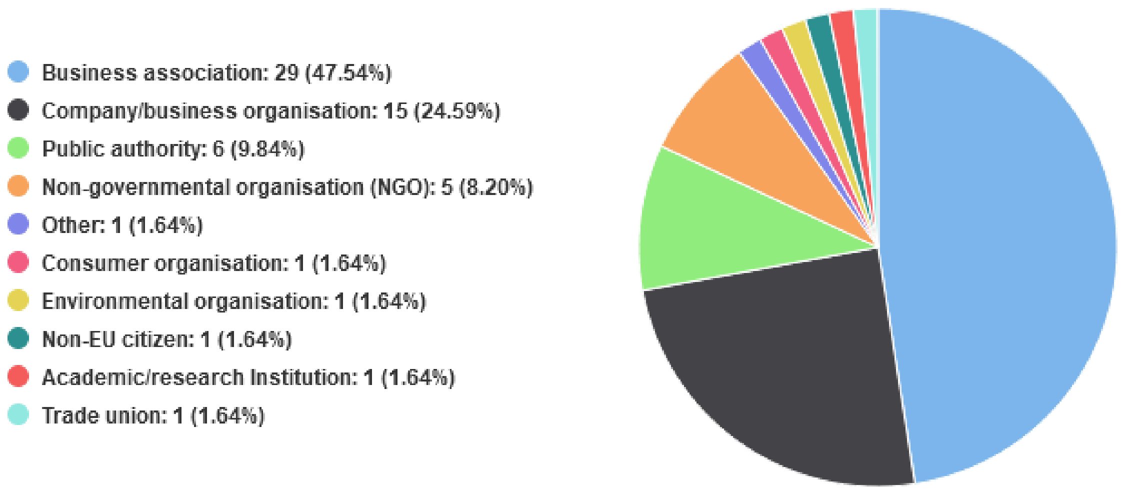
provides input as to the various aspects referred to in the different contributions.

Table 8-1 Overview of different methods of the project's consultation strategy

What	Public feedback[418]	Online public consultation (OPC)	Targeted consultation	Stakeholder workshop	Consultation of Member States	Follow up consultation activities after the workshops
How	No specific format of feedback required, additional written contributions possible	Online Questionnaire Survey with the possibility to provide additional written contributions	Web conference interviews	2-day online meeting	Ad-hoc survey and 1-day meeting	Written feedback on the content presented in the workshop and written exchange
Why	To explain the approach and invite them to contribute	To validate/obtain data and information and to gain opinions on more detailed/specific aspects	To validate/obtain data and information and to gain opinions on more detailed/specific aspects	To discuss specific aspects, validate findings, gather additional evidence	To inform MS on measures and policy options, to discuss specific aspects, gather additional evidence and experiences from MS	To gather evidence that was requested in the workshop, to ask clarification questions on feedback, opinion and information provi-ded, to request additional data
Who	All stakeholders	Specific stakeholder groups	Selected key stake-holders from specific stakeholder groups	Specific stakeholder groups	Representatives / Experts of MS authorities	Targeted stakeholders
How data / information was used in the impact assessment	Information used to structure the OPC questionnaire, to provide an initial overview of interested stakeholders	Identification of opinions of specific stakeholder groups; participating stakeholders were invited to the stakeholder work-shop; for stakeholders invited to the targeted consultation, identify topics to which the study team expected the interviewed stakeholder to contribute	Validate assumptions, understand the situation of selected key stakeholders, information used for identification of measures and policy options for reviewing the ELV Directive, information used for the impact analysis of measures.	Information used for revising the measures and policy options for reviewing the ELV Directive, information used for the impact analysis of measures.	Learn from experiences of MS-specific legislation already addressing problems targeted in the review of the ELVD and with regards to the measures proposed on EU level	Used for the impact analysis of measures

[418] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

Figure 8-1 Affiliation of stakeholders (n=61) participating in the public feedback on the inception IA



Source: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en (access 16.06.2022)

Table 8-2 Number of contributions referring to the topics of review

Topics of the review	No. of contributions referring to the topic
Missing vehicles	47
Illegal exports	37
Reporting vehicle fleet	24
Reporting reuse – recycling	21
Definition recycling	12
Separate reuse target	33
Material specific material targets	31
Data accessibility	27
Design for circularity	24
Recycled target contents	27
EPR system	22
ELVD scope	14
Coherence – substances	11
Coherence – definitions	12

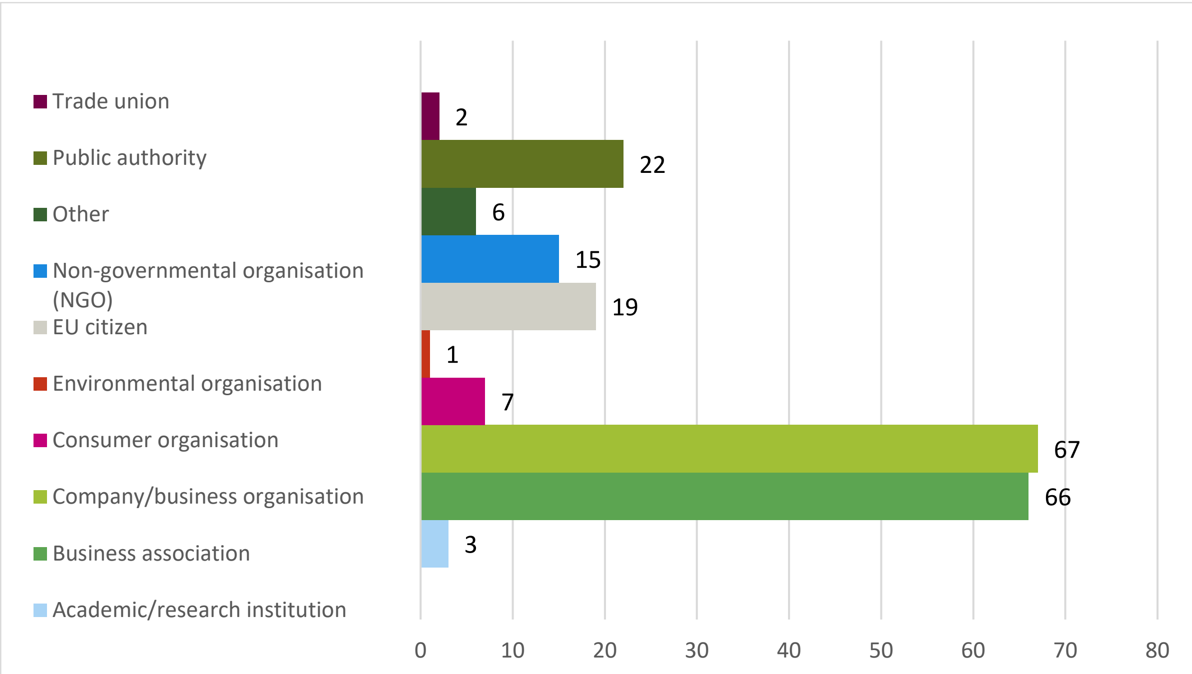
The feedback can be found on https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/feedback_en.

8.4.2 Open Public Consultation

The stakeholder consultation was held between 20 July 2021 and 26 November 2021 as a public EU stakeholder consultation. It targeted all citizens and organisations. The EC sent invitations to participate to various parties, including stakeholders identified for this purpose by the consultants. The consultation was launched on the EU public consultation platform and was publicly available throughout the consultation duration. The consultation took place in the form of an online survey and enabled two forms of input: (a) through a stakeholder survey (a shorter questionnaire targeting input from "interested citizens with only a general interest in the area of end-of-life vehicles", 10 questions in total; and a longer questionnaire targeting input from individuals with "specific knowledge and/or interest about end-of-life vehicles", 43 questions in total; and (b) additionally, stakeholders were given the option to provide written input, e.g., position papers and evidence/data.

In total, 208 participants took part in the survey during the consultation period, see their affiliation to stakeholder groups in **Figure** 8-2. Of all the organisations that provided input, replies to the questionnaire were received from two organisations, each from two representatives.[419]

Figure 8-2 Answer to the question "I am giving my contribution as: …" (multiple options)



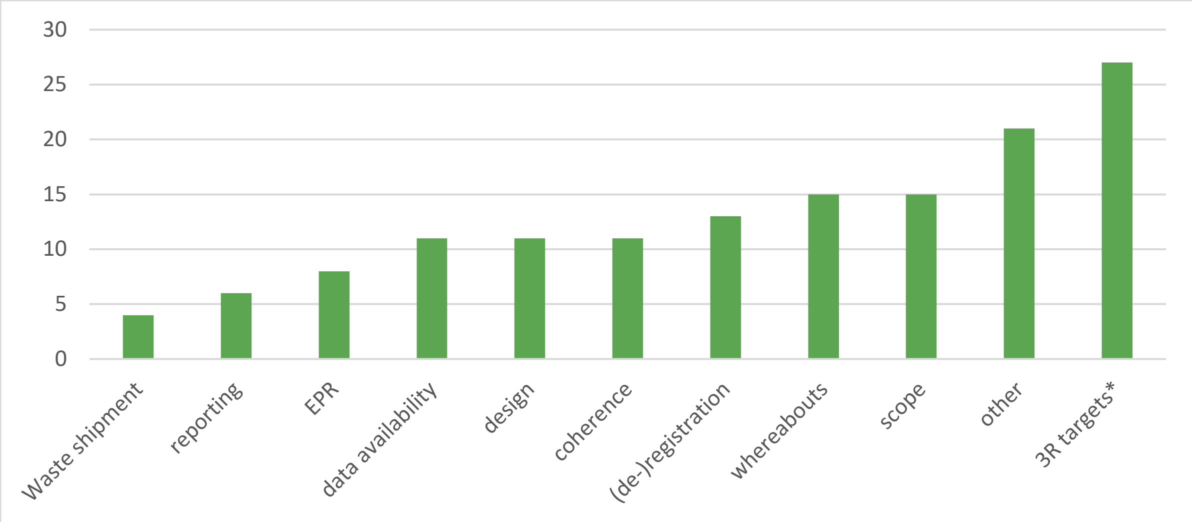
A total of 57 stakeholders submitted written contributions in addition to the answers to the consultation survey questions[420]. The contributions were first screened to identify the main issues that they addressed. The following figure shows how many of the written contributions

[419] Ministry of the Environment of the Czech Republic, and Galloo (a company from the dismantling and recycling sector incl. shredder and PST operators).

[420] One stakeholder submitted 2 times answers to the consultation adding two different written contributions.

referred to a number of specific issues that were also referred to in the OPC survey and give a first indication as to the aspects addressed by stakeholders in this format.

Figure 8-3 Key words of main aspects discussed in the written contribution (n=58)



Notes: (*) including recycled content target
The category 'other' includes: Handling of hazardous components/waste (n=2); (Recycling of) EV (n=6); Remanufacturing; Annex I of the EU Directive 2000/53/EC; batteries in electric cars, carbon footprint requirement; role of insurances; ATFs: More controls over ATFs, illegal ATFs are more cheaper, but without environmental standards (n=3); ASR (Automotive Shredder Residue); batteries are way more heavy than in the ELVD stated; Removal of tyres, batteries etc.
Source: own compilation

The obtained answers to the questions were processed via Microsoft Excel, written input was summarized per topic. Find a summary of the results in section 8.5. The complete evaluation of answers to the open public consultation is among the material that was provided to the European Commission.

Identical answers to the OPC were received from

- VFSE Automotiv WG (organisation size: micro), EuPC Automotive Division (micro), PlasFuelSys (micro), PLASTIC OMNIUM - CLEAN ENERGY SYSTEMS DIVISION (large)
- Two different individuals of the Ministry of the Environment of the Czech Republic
- DEMONTA Trade SE (organisation size: medium) and Czech Association of Circular Economy (large)

8.4.3 Targeted stakeholder consultation

A targeted consultation (interviews) was held starting in November 2021. The phase was split into two rounds of interviews:

- The **main study interviews** held in the period from 03 November to 03 December 2021. In this round, the consultants conducted 20 interviews, see the list of interviewed organisations in Table 8-3. One additionally invited stakeholder (ANEC BEUC) did not participate due to the questions being too technical for the stakeholder group they represent. The group of stakeholders that participated in the main study interviews consisted of automotive manufacturers for cars, trucks, vans, buses, and motorcycles (n=3), suppliers of materials and (second-hand) components (n=6), stakeholders involved in the EoL management (n=7), and individual other stakeholders including a PRO, a registration and international authority each, a stakeholder representing insurance companies, and environmental NGOs.

- **Interviews held in relation to the 3R Type Approval Directive** in the period from 17 December 2021 to 07 February 2022. The invited group of stakeholders consisted of automotive manufacturers (n=5), type approval technical services (n=3), type approval authority/ market surveillance (n=2), international authorities and one stakeholder conducting dismantling trials. Inputs were obtained from 8 out of 12 invited stakeholders (a few per written contribution only), see Table 8-4.

The consultation phase was organised as follows: The interviews were distributed internally according to the focus of the respective associations or stakeholders and the work focus of the experts. The interviewees were initially contacted indicating the goal and scope of the study. When no answer was received, reminders were sent. Date and time for the interview were agreed on and consultants provided a web conference tool. An interview guideline was sent to the stakeholders in advance of the meeting. Due to the extent of the main study questionnaire, it was accompanied by an indication of the sections to which the study team expected the interviewed stakeholder to contribute (see Table 1-1). Other sections were included for transparency, and the interviewees could also contribute to the questions therein. Often, answers were received with specification of topics of interest for the stakeholders. In some cases, stakeholders responded to topics additional to those planned for the interview (not displayed in Table 1-1). Only in some cases, the whole questionnaire was subject of the interview. Protocols of results were prepared after the interview and sent for approval to the respective interview partner. Together with the approval, consultants asked for the permission to cite answers given in the interview in the study report. If rejected, information was not included in the report.

Table 8-3 Stakeholders invited to main study interviews, and indication of the sections to which the study team expected the interviewed stakeholder to contribute

Scope	Hazardous substances	Design 4 circularity	Coherence (3RD)	Recycling definition	Reuse target	Material recycling targets	Data accessibility	EPR	Missing vehicles	Illegal export	Reporting: vehicle fleet	Repoorting: reuse recycling
x	x	x	x		x	x	x	x	(x)	(x)	x	
x	(x)	(x)	(x)	(x)	(x)	(x)	(x)	(x)			(x)	(x)
	x	x	x		x	x	x	x			x	
x	x	x	(x)				x					
	x*	x*		x		x*	x	x				
	x*	x*		x		x*	x	x				
(x)	x	x	(x)		x		x	(x)				
x	x*	x*	(x)	x	x	x*	x	x				x
		x*	(x)	x		x*		x				x
	x*	x*	x	(x)		x*	x	x				x
(x)		x	(x)		x	x	x	x*				x
(x)		x	(x)	x	x	x	x	x*				x
(x)		x	(x)		x	x	x	x				x
x		(x)	(x)	x	x	x	x	x				x
(x)									x	x	x	

	x		x						x	x	x	
					x			*x*	*(x)*	*(x)*		
x	x	x			x	x		x	x	x		
x		x			x		(x)					
	(x)	x	(x)	x		x	x	x				x

Table 8-4 Stakeholders invited to interviews held in relation to the 3R Type Approval Directive

#	Organisation name	Input provided	Details of contact
1	United Nations Economic Commission for Europe (UNECE)	Yes	Aspects of 3R type approval covered under the interview in the ELVD IA main study
2	Kraftfahrtbundesamt (Germany)	No	Contacted but did not respond
3	Ministère de la Transition écologique France	Yes	Interview held on 27.12.21
4	European Automobile Manufacturers' Association (ACEA)	Yes	Written input provided on 07.02.22
5	BMW (manufacturer)	No	No answer to various attempts to schedule an interview (contacted 10.12.21, reminder sent on 27.1. and 10.02.22)
6	VW (manufacturer)	Yes	Interview held on 14.01.22, with Porsche
7	Porsche (manufacturer)	Yes	Interview held on 14.01.22, with VW
8	Stellantis (manufacturer)	Yes	Interview held on 17.12.21
9	TÜV Nord (Type approval technical service)	No	Scheduled interview was cancelled by TÜV Nord, alternative contact details were sent without a response when requesting to reschedule the interview
10	IDIADA (Type approval technical service)	No	Written input promised, questionnaire sent and response requested by mid-January, reminders sent on 27.1. and 10.2.22. No answer obtained.
11	Tech4You (operators of IDIS; dismantling trials)	Yes	Interview held on 07.02.22
12	UTAC (Type approval technical service)	Yes	UTAC provided additions to the Ministère de la Transition écologique, France

See the positions of stakeholders mentioned in chapter 8.5.

Approved interview documentations were gathered and distributed within the study team in order to use input of all interviews for developing the measures in further detail and assessing related impacts. The input from the targeted consultation has been taken into consideration for the preparation of initial results and the development of initial measures that were presented at the sectoral stakeholder meetings as well as the MS meeting (see sections below).

Though in most cases stakeholders gave their consent to cite information provided through the interviews, confirmed interview documentation is not intended for publication itself. The documentations are among the material that was provided to the European Commission.

8.4.4 Survey in relation to 3R Directive

A 3R-Directive-specific survey was conducted with stakeholders on this subject in proximity to interviews (see section before). The survey was developed similarly to the interview questionnaires for consulting three different stakeholder groups: OEMs, technical services, and type approval authorities. For all three groups, questions on the link to the ELVD, on the process of type approval and on possible future amendments were identical, a stakeholder group-specific set of questions was added to each one. The questionnaire was agreed on and is available to the European Commission.

The survey was distributed to OEMs through requesting the association ACEA to send the survey questionnaire to its members. The European Commission assisted in sending the questionnaire to type approval authorities. The survey was also forwarded to type approval technical services that had been initially identified but not interviewed.

Four Member States participated (3 provided the filled-out survey, 1 provided short input per email), and one OEM send a confidential contribution. Additional information was received from three more organisations/stakeholder groups

- one position paper (from ACEA),
- one interview in the main study was used to get specific information on the 3R Directive (UN ECE/UNEP), and
- one e-mail with additional explanatory information was received, in relation to the information provided in one of the specific interviews (from MS representatives from France).

In the round of written feedback in April 2022 (follow-up after the workshop in March 2022), a further written contribution from Germany was received.

Based on the indication of a lot of stakeholders, most of the information cannot be cited in this report as information has been provided on a confidential basis or interview documentations have not been confirmed by interviewees.

The positions of stakeholders are summarised in chapter 8.5.6.

8.4.5 Stakeholder Workshop on 23/24. March 2022

In cooperation with the Commission, the contractor prepared the stakeholder workshop and the Member States meeting (see the chapter on “consultation of MS” below). All meetings were organised as web conferences which were hosted by the consultants. In cooperation with the EC, the consultants prepared the agenda and an invitation letter, and the EC invited participants. Stakeholder contacts from the targeted consultation were provided by the consultants. Further selection of invitees was done by the European Commission, e.g., participants of the open public consultation. Associations were invited, but, in comparison to the targeted consultation, more individual companies were present. The contractor prepared material to inform participants on the contents of the meeting which were send around to invited stakeholders beforehand. At the meeting, the contractor gave an input (presentation) on the current situation in relation to the problems, the measures under consideration, initial results, and topics for discussion.

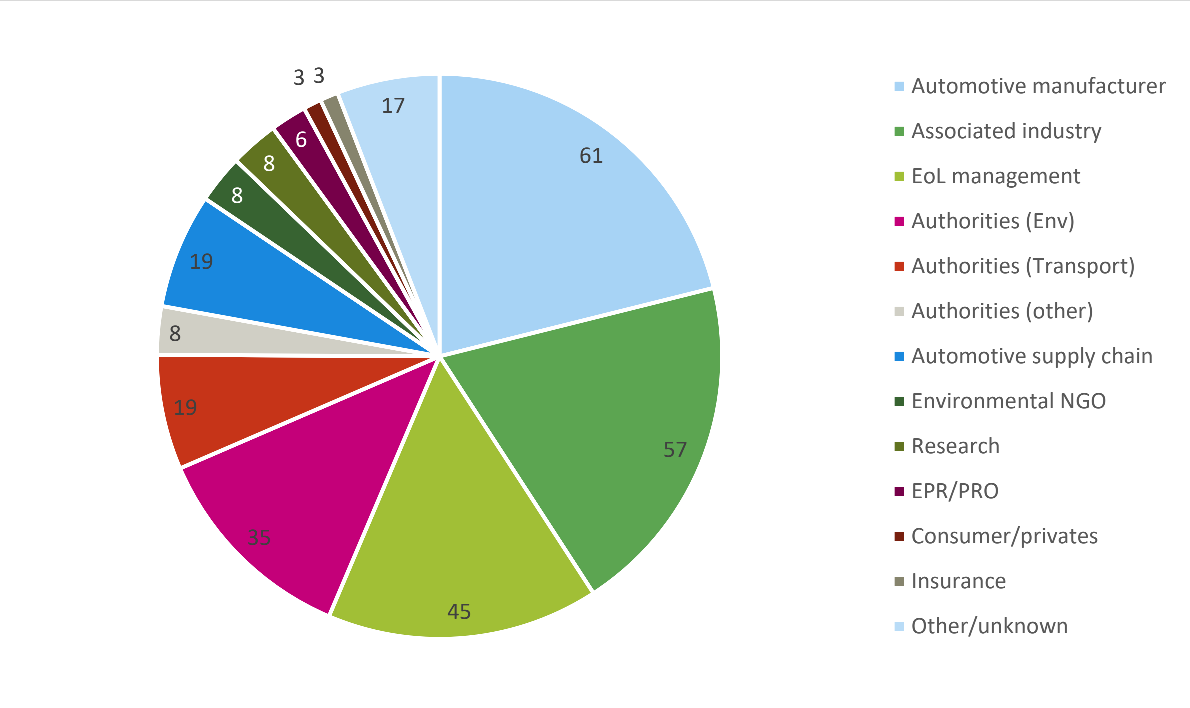
The meetings were structured according to the topics. The agenda is provided below. Meetings were facilitated by the consultant’s team members; minutes were prepared of each meeting.

Table 8-5 Agenda of the stakeholder workshop

Day 1 - THU 23.03.2022			Day 2 – FRI 24.03.2022		
9:00-9:15	EC: Welcome	Presentation	9:00-9:15	EC: Welcome	
9:15-10:45	Current situation + measures for **Design/Reuse + Remanufacturing/Recycling**	Presentation by the consultants, clarification questions	9:15-10:45	Current situation + measures + analysis + first results for **Recycled content** - JRC	Presentation, clarification questions + Discussion

11:00 -12:00	Analysis method + first results for **Design/Reuse + Remanufacturing/Recycling**	Presentation by the consultants, clarification questions	11:00 -13:00	Current situation + measures + analysis + first results and discussion for **Missing vehicles + illegal exports**	Presentation, clarification questions + Discussion
12:00-13:00	Discussion on **Design/Reuse + Remanufacturing/Recycling**	Discussion	14:00 -15:45	Current situation + measures + analysis + first results and discussion for **Scope**	Presentation, clarification questions + Discussion
14:00 -15:30	Pre-conditions for Design/ Reuse + Remanufacturing/ Recycling: **EPR + Access to Information** (current situation + measures + analysis + first results)	Presentation Discussion	16:00-16:30	Wrap up for each objective	Presentation
15:45-16:45	**Due diligence; Hazardous substances; NdFeB magnets**.	Presentation Discussion	16:30-17:00	Outlook - EC	Presentation
16:45-17:15	Overarching aspects				

Figure 8-4 Overview of composition of stakeholder registered* for the workshop (n=289)



Note: The category of "automotive manufacturers" includes manufacturers of all types of vehicles, incl. motorcycles, vehicles accessible to disabled people, caravanning industry, to name some. / The category of "associated industry" includes, among others, all (secondary) raw material-related industry stakeholders. / (*) The numbers relate to the registrations for the workshop. Due to changing audience during and last minute requests before the workshop, it was not possible to analyse the composition of stakeholders in relation to their actual participation.
Source: Own compilation

Possibilities of participation in the meeting:

- To gather input from a larger audience of stakeholders, and additional interaction tool (app called *Slido*) was used during the workshop to survey the views of the participants on certain aspects. Slido questions were answered by participants in the course of the presentations of the consultants or in the days following the workshop.
- For oral contributions, stakeholders could write in the chat the essence of their comment and wait to be requested to speak.
- After the workshop, all participants had two weeks to submit additional information and data to substantiate their views (see section 8.4.7)

A summary of discussed aspects per topic can be found in the summary of key positions of stakeholders in section 8.5.

For each of the topics, the consultants took into account aspects that were discussed in the meetings, and where (updates of) data was provided, e.g., in relation to the material composition of L-type approved vehicles, these were feed into the calculation of impacts for the final report.

The parts of the documentation of the stakeholder workshop not intended for publication and provided solely to the EC include:

- Participants list;
- Minutes of the meeting;
- Documentation of the chat of the online meeting; and
- Slido results.

8.4.6 Consultation of Member States

The consultation of MS consisted of two elements:

a) Adhoc survey

A questionnaire for Member State Experts was prepared covering the four topics:

- Management of Shredder Light Fraction (SLF) and Shredder Heavy Fraction (SHF),
- Fees or taxes to support recycling of ELVs,
- Enhanced Producer Responsibility (EPR) System,
- Waste management of other types of vehicles.

The questionnaire was sent out to the MS in February with most MS sending answers prior to the workshop, and a few (2-3) sent afterwards . Answers to the questionnaire were provided by 15 MS, namely Lithuania, Belgium, Ireland, Estonia, Slovakia, Greece, Malta, Finland, Croatia, Spain, France, Czech Republic, the Netherlands, Sweden, and Germany. Additional documents were received from Belgium only.

As for the processing of the data, it is to be said that no statistical evaluation of responses was made, but responses are exemplarily summarized for two of the four topics as follows. Where information from the survey is used in the main report, it is referenced, and all questionnaires are available to the EC.

Management of Shredder Light Fraction (SLF) and Shredder Heavy Fraction (SHF). In 6 MS, the disposal of untreated SLF/SHF in landfills is prohibited. 4 MS prohibit the disposal in landfills of fractions from post shredder treatment (PST). 4 MS (in case of BE only Flanders) allow to consider untreated SLF for the purpose of road construction, within which 3 consider it as recycling. Selected detailed responses showed that some countries defined certain criteria for acceptance of waste at the landfill that have to be fulfilled (e.g., POP content in the residues or that the residues intended to landfill cannot be recycled of incinerated anymore). BE (Flanders) allows the disposal in landfills of fractions from PST, however the costs for disposal are higher than the costs for recycling or thermal treatment. Some countries admitted that due to a disposal ban in their countries the recycling rates of ELVs increased.

Waste management of other types of vehicles. In ES, FR, CZ, BE (Flanders), and LT the waste management of **motorcycles** is governed by specific national legislation? This is not the case in SK, EL, MT, FI, HR, NL, DE, SE, and IE. In ES, CZ, BE (Flanders), and LT waste management of **trucks** is governed by specific national legislation. This is not the case in SK, EL, MT, FI, HR, FR, NL, DE, SE, IE. Of those that do not have specific national legislation, several countries (HR, FI, EL, NL, DE) indicated that the treatment of motorcycles and trucks is ensured and/or environmental permits for facilities are requested through general waste legislation. Additional information on waste management of other types of vehicles was provided by 4 MS (LT, BE, CZ, DE).

b) Member State Workshop on 31. March 2022

In cooperation with the Commission, the contractor prepared a Member State Representatives workshop in addition to the stakeholder workshop (see above). The meeting was organised as web conferences which was hosted by the consultants. In cooperation with the EC, the consultants prepared the agenda and an invitation letter, and the EC invited participants. The same material as for the stakeholder workshop was distributed among MS representatives to inform participants on the contents of the meeting beforehand, also, representatives of the MS were invited to participate in the stakeholder workshop. Thus, assuming that MS representatives could inform themselves in the stakeholder workshop as well as with the provided information, at the meeting, the contractor gave a very short additional input (presentation) the problems, the measures under consideration, and topics for discussion.

The meeting was structured according to the topics. Additional three presentations were held by Member State representatives from France, Belgium, and the Netherlands. The agenda is provided in Table 8-6. Meetings were facilitated by the consultant's team members; minutes were prepared and provided to the European Commission.

Table 8-6 Agenda of Workshop with Member State Representatives

9:00-9:30	EC Welcome Mattia Pellegrini (DG ENV), Mark Nicklas (DG GROW), Jade Vetters (DG GROW)
09:30-09:55	French EPR Scheme Project for ELVs FR Ministry of Ecology, Sustainable Development and Energy: Bruno Miraval
09:55-12:30	Objective 2: Circularity: Short presentations by the consultants, clarification questions and discussion-Moderation by Gael de Rotalier Point 2.1 -Design, Oeko: Yifaat Baron Point 2.1.g: -Recycled content targets for plastic, JRC: Thibault Maury Point 2.2 -Reuse, Oeko: Izabela Kosińska-Terrade Point 2.3 -Recycling, Oeko: Izabela Kosińska-Terrade Point 2.4 -Transparency and fair distribution of costs, Mehlhart Consulting: Georg Mehlhart Point 2.5 -Hazardous Substances, Oeko: Katja Moch
13:30-14:30	Objective 1: Scope: Short presentation by the consultants, clarification questions and discussion (Oeko: Clara Löw)-Moderation by Jaco Huisman
14:30-15:50	Objective 3: Missing vehicles: Short presentation by the consultants, clarification questions and discussion -Moderation by Jaco Huisman Point 3.1 -Vehicle tracking; Mehlhart Consulting: Georg Mehlhart Point 3.2 -Illegal dismantling and illegal exports, Mehlhart Consulting: Georg Mehlhart Point 3.3 -Criteria to prevent export of ELVs. Short presentation by the consultants, clarification questions and discussion, Mehlhart Consulting: Georg Mehlhart
	The Netherlands approach on exchange of information on vehicle registration with the example of EUCARIS, NL Vehicle Authority: Idske Dijkstra
	How Missing ELVs are addressed in Belgium (Flanders) through defined recognition criteria, BE The Public Waste Agency of Flanders (OVAM): Lies Verlinden
15:50-16:00	Outlook-EC

Table 8-7 Overview of composition of Member State representatives registered* for the workshop

Austria	2	Ireland	4
Belgium	4	Italy	6
Bulgaria	2	Latvia	2
CROATIA	2	Lithuania	2
Czech Republic	3	Luxembourg	3
Cyprus	0	Malta	2
Denmark	2	Netherlands	6
España	1	Poland	1
Estonia	4	Portugal	0
Finland	5	Romania	2
France	4	Slovakia	3
Greece	0	Slovenia	1
Germany	9	Sweden	4
Hungary	2		

(*) The number relate to the registrations for the workshop. Due to changing audience and last minute changes during the workshop, it was not possible to analyse the composition o stakeholders in relation to their actual participation.

8.4.7 Follow-up after the workshop and ad-hoc consultation

Discussions during the stakeholder workshop left open several questions and stakeholders were asked to provide information on certain topics at the end of each meeting. A list of associations and stakeholder groups that submitted additional input after the sectoral meetings is given below.

List of stakeholders sending input after the workshop (n=39)

- ACEA/HDVs
- ADA
- Ademe
- BASF
- BMW
- CLEPA
- Copper Alliance
- Derichebourg Environment
- ECOEURO
- ECOS
- EEB
- EGARA
- Estonia (MS)
- ETRMA
- EuRIC
- EUROBAT
- EU Aluminium
- FEDEREC
- FEAD
- FNA
- FNADE
- Galloo
- German UBA (MS DE)
- German BMUV (MS DE)
- Glass4Europe
- Holger Luehn
- INDRA
- JRC
- Milan Lauko
- Mobilians
- OVAM (MS BE)
- PGM
- PRE
- Plastics Europe
- POCES
- Renault
- RWD (MS NL)
- Sweden (MS SE)
- TERRA
- Thomas Gardin

plus one stakeholders that wished to remain anonymous.

In addition to other consultation stages, several stakeholders were consulted individually in terms of specific aspects of interest for the consultants. A list of individually consulted stakeholders and the topic on relation to which they were contacted is provided below. The information provided was used for the impact analysis of measures and policy options.

Table 8-8 Ad-hoc consultation of specific stakeholders

Stakeholders contacted ad-hoc	Contacted Person	Contacted in relation to specific topic/s
ADEME	Eric Lecointre	Material composition of L-type approved vehicles
German UBA	Regina Kohlmeyer	Calculation of end-of-life trucks based on the Eurostat stock data Exchange about an UBA report in publication: Impacts of illegal end-of-life vehicle recycling. Identify the environmental, economic and business impacts of the unrecognized dismantling of end-of-life vehicles and the illegal transfer of end-of-life vehicles and derive measures to address potential impacts.
EURIC / Galloo	Olivier Francois	Exchange of documents related to the STAKEHOLDER WORKING GROUP ON THE REVISION OF 2015 REUSE/ RECOVERY/RECYCLING TARGETS MINUTES FROM THE PLENARY MEETING OF 17 OCTOBER 2005 on the targets and alternative approaches.
EGARA	Henk-Jan Nix	Regards existence and characteristics of EPR schemes across EU Regarding post-shredder technologies across the EU
EUROFER	Lubor Kalafus	Copper impurities in steel
UNEP	Francois Cuenot	About an international initiative to define and develop an internationally unified method for carbon life cycle analysis (LCA)
EU Aluminium	Benedetta Nucci Patrik Ragnarsson Christian Leroy	About the average weight of aluminium bumper carrier frame for the purpose to calculate the GWP for different bumpers.
MS representatives of Spain, France, Czech Republic, Belgium/Flanders, Lithuania, Italy	Fernando J. Burgaz Moreno, Bruno Miraval, Katerina Dostalova, Lies Verlinden, Kauzonas Mindaugas, Letteria Adella	About MS specific legislation for waste management of motorcycles and/or trucks, e.g., on evaluations on changes in the material flows of waste powered-two-wheelers / motorcycles or waste trucks and/or assessments of the ecological, economic and/or social impacts of this regulation at national level

8.5 Key positions of stakeholders on specific topics

8.5.1 Circularity

Design for circularity

Statistical OPC

On the question if there should be an obligation on vehicle manufactureres to improve circularity characteristics of a vehicle during the design phase, all groups of stakeholders agreed in over 50% to this question. Support was the lowest (51 %) in the category of the automotive manufacturers, where almost 25% did not support this option. The highest support was registered by environmental NGOs (100%), waste management operators (93%) and public authorities (86%).

For more details please refer to "Analysis of open public consultations" (Oeko-Institut e. V. 2022).

Written OPC

Ten contributions mention the topic of (eco-)design specifically. One of the focus topics is the design for dismantlability which various stakeholders would like to see promoted through the new regulation (VEOLIA, EEB, Federec, INDRA, FNADE) whereas others have objections such as:

'life cycle approach more efficient to promote circularity than imposing design requirements' (Volvo);

'dismantling provisions must not impair the essential targets of safety, comfort, environmental performance such as fuel/electricity consumption, costs etc' (Plastics Europe); and

'solutions on eco-design therefore should not be solely based on manual separation/sorting' (EuRIC) stating that PST sorting should be taken into account.

Design for circularity could be supported by sensor-based technology (ECI) and free knowledge sharing and discussion between recyclers and manufacturers (EuRIC, FNADE; see also under 'data availability').

Eco-Design is mentioned in combination with the 3R Type Approval Directive by EuRIC in terms of merging ELVD and 3RD; and by Federec and INDRA with regards to 'practicability checks' of recyclability under the 3R Type approval. Volvo suggests that 'ELVD should focus instead on requiring OEMs to have a strategy to cover the 3 Rs', which is already part of the provisions of Art. 6 of 3R Type Approval Directive.

Another focus is on the means of eco-design to phase out hazardous substances mentioned by VEOLIA. Other stakeholders mentioned hazardous substances under the topics of 'data availability', in combination with recycled content targets or with regards to 'coherence'.

Individual aspects include ethical sourcing as part of material decisions in eco-design (ECI), less different polymers ('there are currently 39 different 1types of basic plastics and polymers used to make an automobile', and a proposal from FEAD to limit the use of non-recyclable materials based on The Plastics Industry Trade Association, 2016).

It should be noted that in their contributions some stakeholders consider recycled content targets as part of the 3R targets, and some connect the recycled content targets with the topic of (eco-) design.

Interviews

Regarding non-recyclable materials, the vehicle manufacturing sector generally pointed out the benefit of using such materials for light weighting due to the benefits during the use phase in terms of emissions reduction. Stakeholders representing the waste phase referred to the obstacle that large amounts of such materials raise for achieving targets but were against their prohibitions, explaining that this would affect innovation, whereas proven materials would increase in use and at some point suffice to develop manufacturing (with less beneficia ones being used shortly and then abandoned).

ATFs referred to the phenomenon of locking components with digital keys (e.g., window wiper motor, injector, inverter, mirror, window motor, navigation, etc.) as a problem, explaining that it is an obstacle for reuse as a component removed without the key will not be reusable. The information does not have to be free, but the price should not be prohibitive for reuse practices of ATFs. This is understood to particularly affect establishments that work with multiple vehicle models and brands and that do not have contract with specific OEMs. Vehicle manufacturers on the other side claim that the locks are of importance for the safety of vehicles, anti-theft and provision of the data could disclose proprietary. It is not clear what type of data would be at risk. Components that are interchangeable between models and brands were also raised as a type of component where OEMs are reluctant to provide data (e.g., when the same supplier provides multiple vehicles models and brands with the same component) an where this can have an effect on the ability to reuse parts.

As for IDIS, ATFs said that it contained a lot of information but that the level of detail is not always sufficient to support dismantling. Information is not available through IDIS for parts with reuse potential (the objective of IDIS is to support quick dismantling – ensuring that the component remains functional is not always in line with this objective). Though OEMs say that such data can be accessed under the RMI (Repair and maintenance information systems of the OEMs – each is individual to a certain OEM) ATFs complain about the cost of such data. Here too, the information does not have to be free, but the price should be fair to encourage dismantling for reuse.

Some stakeholders state that the 3R Directive calculation is too theoretical, recommending requiring OEMs to also specify how certain parts can be dismantled. The calculation should also reflect the ease or difficulty of recycling a part depending on whether it is a mono-material of not.

Workshop

During the workshop the issue of compliance of automotive manufacturers with diverse regulations was brought up (ACEA). Thus, new regulations should consider the other compliance demands, in particular for passenger safety and environmental protections. Vehicles typically comply the existing regulations on the day that they are brought to the market. The changes in regulations that happen during the vehicle lifetime can be covered by post-shredder technologies.

The idea to combine the ELV aspects from the ELV Directive and the 3R Directive into a single regulation was also encouraged (ECOS). Additionally, it was proposed to bring the EU ELV legislation to the level of the United Nations when looking at lifecycle provisions (UNECE).

Definitions

Statistical OPC

Most stakeholders (56%) agreed or agreed strongly that the ELV definition for **recycling** should be aligned to that of the WFD as this would support a higher level of material recovery. Aside from the automotive producers that were mainly neutral, the majority in all stakeholder categories supported an alignment. Only 3% disagreed with this statement, however there was also a large share of stakeholders that were neutral (40 individuals) or that did not have an opinion (31 individuals) making for a total of 40% together with those that did not specify an answer (13 individuals).

Status of parts to be recycled/**remanufactured** must be clearly distinguished from waste and benefit from same conditions as spare parts. EU should establish a harmonized definition of waste and non-waste for reuse/remanufacturing purpose.

Written OPC

Coherence with the WFD is referred to in a general way (WEEE AUDITS; CRM Alliance) or by pointing out specific needs, e.g., to exclude backfilling from the definition of recycling (FNADE) or the need for harmonized definitions of waste and recycling in order to prevent distortions of competition due to different national implementation (FORS). Also, consistency with the landfill directive is mentioned (Plastics Europe). Definition of when a car becomes an ELV was also raised (Febelauto) also in the context of vehicles export (FEDEREC), where it should be required to present a valid technical control certificate to authorize their export.

Interviews

It is generally agreed that the definition of **recycling** should be aligned with the WFD to exclude backfilling. Many stakeholders do not expect that this will change the achievability of the 3R targets as backfilling operations are not so common and does not cover all downcycling operations. This is particularly understood to be relevant for glass, which is mainly considered recycled through the post-shredder mineral fraction.

The need to align the definition of **reuse** with the WFD was raised in relation to the later reference to ”preparing for reuse”. Changes to the definition could affect what is considered waste and what is considered a product and need to look into how they work with the definition of ”end-of-waste” to ensure that obstacles are not created for shipments of used or remanufactured parts. A definition for **remanufactured** components should also be introduced to strengthen how such parts are perceived in comparison to reused ones and to ensure that remanufacturing practices fulfil minimum requirements.

A few stakeholders raised the need to define ELVs as compared to **second hand** vehicle so that the differences between these two categories is clearer and easier to enforce for customs to prevent illegal exports.

Workshop

As shared by a car manufacturer representative (Renault), the current legal definition of a new product does not allow inclusion of **remanufactured parts**. This means that a new vehicle currently, in legal terms, may not contain remanufactured elements; the entire vehicle must be made new, though perhaps using recycled materials. This legal issue is not specific to vehicles. However, from a technical perspective, remanufactured vehicle parts are certified as equivalent in functionality and reliability/safety/etc. to new parts and could therefore be acceptable for use in new vehicles. This legal limitation restricts the sale of remanufactured vehicle parts to the repairs market. Also, there is anyway a limited feedstock of remanufactured parts because the long vehicular lifetime means that the current ELVs do not offer many parts for remanufacture. Additionally, the term and definitions of remanufactured parts should be included in the 3R Type-approval Directive.

A definition of differentiating between **pre- and post-consumer** plastics would be helpful as well as applicable definitions of ‘open-loop’, ‘closed-loop’, etc.

In Belgium, each total technical loss means the vehicle is an **ELV**, regardless of the price of repair in the home country or elsewhere. However, total economic loss is not considered in the definition of an ELV; such vehicles may be exported from Belgium as damaged vehicles without any special conditions.

Separate Reuse target

Statistical OPC

46% of the participants either agreed or strongly agreed with the implementation of a reuse target separately from the recycled target. This included all environmental NGOs, most waste operators (53% of the category) and most public authorities (68% of the category). 22% disagreed or disagreed strongly with this option, with the automotive manufacturing sector most often providing these answers (51% of the category).

On the question on which measures would contribute to increase the reuse of vehicles parts, the most common answers were: obligation for repair shops to offer customers used spare parts as an alternative to new ones, obligation for ATFs to remove certain parts of ELVs before shredding to help increase reuse, obligation for car manufacturers to enable (e.g. the ATFs) unlocking parts so that they can be reused and dismantle, and obligation for car manufacturers to provide the dismantling centres (ATFs) information about which parts can be used as identical parts in other models of the manufacturer or even other brands.

Written OPC

When asked to explain their views, the more common views in support of a separate reuse target were that reuse is higher up in the EU waste hierarchy than recycling, also supporting circularity. Others explained that before a part is recycled it could be reused. Specific targets were explained to allow monitoring reuse, in relation to the "quantity of pieces reintroduced in the market" (an indicator of eco-design, and percentage of reuse and repairability) and as an indicator of the "efficiency of treatment operations of the authorized centres".

Of those that disagreed with such measures it was explained that reuse was mainly economically motivated (if no one needs a particular spare part it's better to recycle). Though reuse was stated to be important, as reuse is market driven it was questioned if targets would increase the amount of reuse. It was also said that vehicles that are recycled are often too old (20 years) for re-use of parts as well as mentioning that this was also the case for vehicles after a crash. Though reuse is said to be practiced commonly by ATFs, one stakeholder explained that it may not be reported to "avoid reporting taxable income in the ATFs".

Additionally, separate reuse target worsening quality and safety risks witnessed in the informal refurbished vehicles market. Reuse and recycling should be considered as on par equivalents if separate targets for each were to be created.

Interviews

Regarding reuse, many stakeholders spoke against the idea of separate targets for reuse and recycling, explaining that fulfilment of the one may have negative effects on the other. Obligatory dismantling to promote the reuse of parts was explained to create significant costs while not esurient the level of reuse would actually increase. ATFs explained that they need flexibility to look at the demand on the market and respond through deciding what components to reuse and which ones not to. This was due to fluctuations in the demand for reused components but also in the quality of components of some models. The example was given (EGARA) of the engine, where some models may have frequent malfunctions, in which case ATFs would avoid their reuse as a minimum guarantee could not be ensured. In some models, malfunctions are very rare, so that dismantling for reuse would result in the engine being stored for years, also creating large costs. Rather ATFs explain that measures should be considered that increase the demand for reused parts, with ATFs than following suit to ensure sufficient supply.

Workshops

Participants commented that decisions concerning remanufacturing are of high relevance in a circular economy, with such processes being essential for encouraging recycling. However, it is not recommendable to strictly consider reuse targets for aspects that may not have market options; ELV parts should not be required to be removed before shredding where there is no market for reselling such parts. It could be useful to consider environmental issues, market forces and overall demand in the recommendation.

A target for reuse/ remanufacturing of parts could potentially be helpful. However, it is necessary to consider the traceability of parts to know which ones would at all be suitable for reuse (as opposed to remanufacturing). It can be noted that the age of a used part may be much younger than the vehicle in which it is found. Safety should in particular be considered, especially for parts relating to vehicle safety (Romania).

Material specific recycling targets

Statistical OPC

The most common answer to this question (31 participants or 15%) supported that the establishment of material-specific recycling targets would increase the separate recycling of materials addressed by targets, their quality and revenues from sale of such materials while also increasing the costs of recycling. 12 % (24 participants) answered that this would increase separate recycling and secondary material quality while also increasing costs. The same share of participants estimate that such targets would only increase the recycling costs. From 47 respondents in the automotive manufacturing sector, 72% (34 individuals) stated that this would increase costs, while 51% (24 individuals) state that it would increase separate recycling of materials. An increase in separate recycling was supported by all environmental NGOs, 85% (5 individuals) of which also supported that it would increase the quality of recycled materials. Public authorities supported the four options similar, with between 15 and 11 individuals (68-50%) indicating the various options. Waste management most often indicated that this measure would support separate recycling of materials (71%) but also increase the costs (60%).

The vast majority (64%) of stakeholders agreed that material-specific recycling targets have an impact on innovation. This was the most common answer in all stakeholder categories with most categories showing 60-70% agreement. Only 8% were against this, while the rest did not have an opinion (23%) or did not answer (5%).

The most common answer to this question was either no answer (79 individuals or 38%) or that material specific recycling targets would lead to an increase in high quality recycling, in innovative recycling opportunities and processes and in innovative eco-design of products (59 individuals or 28%). The distribution of answers was quite similar among stakeholder categories.

Written OPC

When asked to provide detail on answers, one stakeholder stated that “Targets for the entire vehicle proved to be effective. Splitting the target into different material-specific ones should be done only for improving the quality of recycling and the effectiveness of the directive. They should not be legally binding”. Against the measure it was said that ”some materials are recoverable but without any outlet / market”.

Materials mentioned in the context of specific material recycling were the Platinum Group Metals (PGMs). For glass and plastics, it was mentioned that the costs of recycling are higher than revenues while for electronic components it was assumed that revenues were possible. In some cases, it was stated that this would allow a greater separation of certain materials prior to shredding, like plastics.

Stakeholders provided also further details on the question on ”how material-specific recycling targets would impact innovation” and introduced negative (e.g. documentation/monitoring will be impossible: volume flows in tonnes range, versus quantities in milligram range to be documented; limits the use new materials, e.g., non-recyclables like carbon fibre composite, until a viable solutions has been developed and implemented in Europe) as well as positive sides (e.g.: increase of development of post-shredding technologies as well as processing technologies of secondary raw materials, increase use of secondary raw materials).

Interviews

When asked about the option of introducing separate material targets for reuse, many stake-holders explained that it was difficult to comment on the targets proposed as whether a specific value was achievable depended on how the targets were measured (EUROMETAUX). If recycling is to be measured based on the actual material that is included in the composition of a specific vehicle or based on a theoretical value would make a big difference. Whether reporting is on the total inputs of a materials, the amount sent by operators for recycling or the amount that is actually recycled affects the achievability of a target. Also, for some materials like aluminium, there are big differences in the total content between models. Luxury cars will have higher amounts but are also more often exported, so that an average value may be difficult to fulfil. For steel it was explained that 90% is already achieved. The rate could be increased, however every marginal increase from this level will also increase the costs significantly. On tyres, views were raised that the market is still very much developing in terms of recycling options. Some outlets could be considered to increase the total recycling, but have low acceptability with MS (e.g., rubber turf for playgrounds and sport fields):

Workshop

Material-specific recycling targets should be seen as an addition to the common targets, which are applicable for different actors at different legislative levels. The MS mainly report data from dismantlers, shredders and ATFs, data which is collected from different points in the recycling process. Ultimately, the recycling quota of the MS is reported, not dismantling rates. (Swedish EPA).

Recycled content targets

For key positions of stakeholders on a recycled content target content for plastic please refer to the respective report by the EC Joint Research Center.

Statistical OPC

There was one question on other materials (other than plastic) for which a recycled content target should be considered in the OPC. Though a few materials were mentioned in this respect by about a third of stakeholders (e.g., aluminium, glass mentioned, REE but also PGMs and steel), a larger share of stakeholders (45%) did not provide input, indicating the answers ”none”, ”no opinion” or just skipping the question altogether.

Interviews

Regarding recycled content for other materials, for most metals it was explained that recycling was already quite high, and that a recycled content target would not change this much but rather create competition between (high quality) uses, which will not result in resource savings. Recycled content targets should only be considered where there is a market failure. Positive views were raised for plastics and in some cases for glass and tyres, where high quality recycling is low and where SRM is less common for use in vehicles

Data accessibility

Statistical OPC

In the OPC, when stakeholders were asked to specify what kind of information producers should provide free of charge to ATF, a large number of stakeholders (41%) specified all of the available options, namely, information on:

- where dismantled components can be reused (which vehicle or brands, models and types).
- how to correctly remove parts with digital components and how to appropriately prepare them for reuse/ installation.
- the duration / effort for obligatory depollution
- the duration / effort for dismantling components for reuse

There was furthermore strong agreement (over 70%) that manufacturers should provide such information in a fair and non-discriminatory manner and at reasonable prices (if any) to all ATFs. Stakeholders were also asked to indicate whether vehicle manufacturers should be obliged to provide information on the content of certain substance groups to support plastic recycling. Here there was a diversity of answers, with a third having no opinion, but also with large support for information obligations on flame retardants (66%), plasticisers (49%) and stabilisers (46%).

Written OPC

Stakeholders emphasised the importance of access to information on vehicle contents for dismantling and safe treatment of vehicles. Though some stakeholders stressed the need for data at model level, in some cases mentioning IDIS. The option to develop a Digital Product Passport was also mentioned as well as the option to use a RFID or a QR code.

Interviews

ATFs raise the difficulties that they experience with the availability of various data types. IDIS was said to include a lot of information however stakeholders of this sector complain that the level of data is not homogenous for all models and makes and that the amount of data on how to dismantle specific parts is not always sufficient to support the process. Availability to data on components that are locked with a digital key is problematic. Though data is understood to be made available by OEMs for a cost, ATFs explain that there is no harmonised system and rather that ATFs need to register for multiple systems, each with separate costs. For facilities dismantling vehicles of multiple brands (and also for repair shops) this makes the use of such data prohibitive as the costs paid for access will depend on how often a system is accessed. Access to data on the contents of hazardous substances may be available through the SCIP data base, but this is not practical to support removal of relevant parts during dismantling. Data is not available as to the contents of hazardous substance at the level of the specific component in a specific model (except data on mercury in components that need to be removed or lead in Pb-acid batteries. This is a problem for example for substances that are prohibited by the POPs Regulation (e.g., DecaBDE) resulting in the need to send plastics with a risk of containing such materials to incineration as the level of content cannot be determined during dismantling for each material part separately.

Workshop

The concern was raised that if the method for making data available to ATFs is in the form of a digital product passport (DPP), that this would probably not all the 250 million vehicles on the road that will take several decades to be treated. Either ATFs would not have data for these or IDIS will have to continue working even if it is not any more the solution and no new information is introduced. Also, in relation to the option of a DPP, it was mentioned that a single system would need to be developed, rather than having multiple DPP for the vehicle.

8.5.2 Hazardous substances

Statistical OPC

The OPC had two questions on hazardous substances:

The first on whether the revised ELV Directive should ban hazardous substances in vehicles, taking into account that restrictions on hazardous substances are also specified in other pieces of EU legislation (notably REACH). 66 of the responding stakeholders (32%) were of the view that all substances in vehicles should be regulated in the future under chemicals regulation. The same amount indicated that substances prohibited under ELV should remain there, but that future prohibitions should be addressed under chemical legislation. In practice this would mean that for future prohibitions, 64% of stakeholders would prefer regulation under chemical legislation than under ELV. Only 20% (41 individuals) were of the opinion that substances in vehicles should continue to be regulated under ELV. For waste management operators, public authorities, environmental NGOs and dealers and repair shopped the distribution between these answers was similar. Automotive producers had a stronger tendency to support the options where chemical legislation would be used for future prohibitions as opposed to the ELV Directive. The situation was similar for citizens and their organisations and “others”. Only 6% had no opinion or did not provide an answer.

To the second question, which, if any, additional criteria for evaluating exemptions from the list of substance prohibitions are necessary to allow a more differentiated assessment, the answers were quite variable. This is however also due to the fact that 7 different criteria were proposed as possible answers aside from “none” and “other”. Most combinations were indicated 1-2 times, in some cases having support of 6-9 stakeholders. The most common answers were to indicate all criteria (46 individuals or 22%), none (30 individuals or 14%), no answer (28 individuals or 13%) and the “Criterion on comparison of the use of the restricted substance with that of available substitutes in terms of environmental and health impacts (15 individuals or 7%). All other combinations received less support.

Asked to provide additional detail, stakeholders stated that:

- No exemption to the list of substance prohibitions in the ELVD, except for limited transition, if needed. Substances meeting the criteria for CLP & SVHC under REACH should be banned. The ELVD should allow for additional chemicals to be banned,
- The prohibitions and Annex II of ELVD needs to be aligned with other EU legislations (REACH, RoHS, Batteries) concerning hazardous substances (3 stakeholders),

- impossible to give a "single" answer to this incredibly complicated question: as for flame retardant: you prefer the vehicle burn, or the people are exposed to a possible endocrine disruptor chemical? the answer is not technical, it is political (courage)

Other criteria mentioned:

- CO2 footprint assessment (2 stakeholders),
- To check whether the use of the substance creates a risk impossible to manage or prevents recycling,
- Full life cycle consideration for the existing substance & substitute (2 stakeholders),
- Balanced approach for chemicals management, climate aspects and circularity (2 stakeholders),
- Technical and economic feasibility (2 stakeholders).

Interviews

Many stakeholders when asked about the options of having all prohibitions under one legislation (ELV or REACH), did not really consider this option. Though certain stakeholders prefer REACH for (further) substance restrictions (material suppliers and recyclers), they explain that they would rather leave the exemptions for the four heavy metals under ELV as the review mechanism is already established. Vehicle manufacturers were the only ones that clearly favoured the alternative of having all restrictions under ELV. Though some general statements were made as to costs of the exemption process or the environmental benefit that accrued so far from the prohibition of the 4 heavy metals, these were not quantified or e.g. explained in relation to how costs break down in to specific activities.

Written OPC

with regards to the prohibition of hazardous substances, coherence with REACH and CLP are mentioned in support of less hazardous substances (Anonymous, FNADE, Swedish Government), reminding to the current obligation for reporting in the SCIP database to assist recyclers with understanding if SVHCs are present or not is also relevant here. (FNADE; Plastics Europe), for the assessment of hazardous substances, uses and exposure as established for the risk assessment under REACH should be considered (Plastics Europe). Some stakeholder raised very singular aspects.

Workshop

The discussion on the hazardous substances part was surprisingly vivid.

Some participants stressed in the chat that they prefer REACH as central legislation for substance restrictions because REACH became a robust legal instrument and that this horizontal legislation should be referred to in all product legislation that restrict the use of substances due to risks. Also the coherence issue was noted to avoid different interpretations of legislative text or different content of definitions.

On the other hand it was argued that so far REACH restriction is however barely covers chemicals in products as until now this only appears for textiles and PAH in rubber. A participant from NGOs claimed that substances that meet the criteria for SVHC under REACH and meet the CLP criteria should be prohibited in the new ELV Regulation for supporting a toxic-free environment policy purpose. Other participants however reminded that the "hazard" approach does not sufficiently support “a true circular economy” as contaminants might always remain in materials that are however embedded in the solid material and no health problem occurs. For this reason, the participant reminded to the risk approach, with exposure scenarios, which, in the case of a vehicle is relatively easy to define.

Besides, various participants reminded the difficulty of the time span until vehicles reach their end-of-life that makes the information on chemicals difficult ("How should the recycler and the automotive manufacturer know if they can use the material in a new car?" – "If you start now a digital product passport etc. the result will (perhaps) be visible/useful in 20years.") To solve this problem it was proposed to define specific exemptions not only for spare parts but also for recycling material. Participants argued that though this would not be in line with the aim of a non-toxic environment of CSS, there is a risk that material will not be recycled because of legal risk or additional burden, which makes the circular business unprofitable.

8.5.3 Collection / Missing vehicles

Statistical OPC

That a charge applicable to the owner during periods of temporary de-registration would help ensure that owners follow their obligation to report any change of ownership or export to the authority was strongly supported by environmental NGOs, waste operators and public authorities. Only 11% were against this measure, mostly represented by consumers and their organisations who would also be the most negatively affected by such a measure. A vast majority agreed that better traceability should be established between the EU Member States' registration systems on a legal status of a vehicle until its final deregistration. Including a roadworthiness test as a condition was considered by the largest number of stakeholders as an appropriate measure to overcome the problem of 'illegal exports' of ELVs and of exports of ELVS as used vehicles. Compliance with certain environmental criteria was the second most favoured, followed by conditions on maximum age or on maximum mileage. Among 14 different options for reducing the number of missing vehicles, over half of the participants (52%) indicated a combination of at least 6 of the various options which shows the high support for the implementation of additional measures to reduce the problems related with missing vehicles. A total of 46 participants (22%) did not provide an answer, 17 of which were from the automotive producing sector.

Results of a stakeholder consultation held in the course of the study on the ELVs of unknown whereabouts (Mehlhart et al. 2017) can provide additional insights as to the pros and cons of the various options. Due to former public consultations on the aspect of vehicles of unknown whereabouts, exported vehicles and collection, this OPC did not put a strong focus on this topic, but only asked the questions summarized above. To display a comprehensive stakeholder feedback on the topic, the OPC results from a study in 2016 can be found in the following box:

Excurse: Open Public Consultation in 2016
The `Public consultation on potential measures to improve the implementation of certain aspects of Directive on end-of-life vehicles, with emphasis on vehicles of unknown whereabouts´ was open for twelve weeks from 29 June to 21 September 2016.
The objective of this public consultation was to receive the views of stakeholders concerned with the topics of the consultation.
The online survey covers 6 topics below:
1. Keeping track of vehicles within the EU (intra EU trade);
2. Methods to achieve more complete reporting on extra EU export and ways to distinguish between exporting ELVs vs. used vehicle;
3. Enforcement techniques to reduce illegal dismantling of ELVs at dealers and repair shops (garages) and actions to improve ATF compliance;
4. Public awareness and incentives for ELV tracking and environmental risks;
5. Aspects to improve coverage and data quality when reporting on ELVs (possible revision of the Commission Decision 2005/293/EC);
6. Persistent Organic Pollutants (POPs) and ELVs.

According to the conclusion from the OPC in 2016[421], "there is a broad and joint understanding among all stakeholders that the current procedures need further improvement to keep track of vehicles and to strengthen the requirement to issue and present a CoD. This applies for the provision of evidence on the vehicles fate during a temporary de-registration and also applies for fines to owners which do not provide statement of whereabouts for such temporary de-registered vehicles.
Most of the stakeholder support the implementation of economic incentives for instance fees or refund systems to ensure that ELVs are delivered to ATFs. Only car manufacturers and importers oppose such economic incentives.
With regard to the extra EU export of used vehicles (some of them possibly to be considered as ELV) the proposal to make Correspondents Guideline No 9 legally binding, many stakeholders oppose this proposal. Several stakeholders argue that the current version is difficult to apply and adjustments are needed before making the stipulations legally binding. Also, the approach to ban the extra EU export of used vehicles was not supported by the stakeholders. Instead, the stricter enforcement of inspections (when exporting) cooperation between IMPEL, police and customs services and the adjustment of reporting on waste shipment found strong support by all stakeholders.
With regard to the fight against illegal treatment within the EU the majority of stakeholders acknowledged the need for action in particular the need for national/ regional authorities to perform regular inspections of the sector (not only ATF and shredders but with a broader scope for garages, repair shops and spare part dealers) to identify illegal operations.
Comments expressed the concern that improved burden to ATF only might even cause adverse effects (more illegal operator) and inspections should carefully focus to support legal operating facilities.
The proposal to establish minimum requirements for such inspection activities is less supported and partly rejected by the car manufacturers and importers. Again, proposals to establish economic incentives to strengthen the legally operating sector are opposed by the car manufacturers and importers. The proposal to improve the reporting mechanism when issuing a CoD and upon arrival of an ELV at ATFs or shredder facilities was in general supported, including the establishment of electronic notifications to the registration authorities.
Supporting public awareness for the management of ELVs is considered as relevant by the stakeholders. While penalties to car owners not fulfilling their duties are supported by the vast majority of stakeholders, incentives based on funds/ deposits are again opposed by the car manufacturers and importers.
With regard to the very specific questions how to address aspects of the unknown whereabouts in the Commission Decision 2005/293/EC the number of contributing stakeholders decreased slightly however beyond 100 contributors provided their option accordingly and supported effectively all proposals with a vast majority or at least did not oppose."
All replies of the stakeholders to the manyfold questions in details can be found in the mentioned report "Assessment of the implementation of Directive 2000/53/EU on end-of-life vehicles (the ELV Directive) with emphasis on the end-of-life vehicles of unknown whereabouts[422]" published by the EC in 2017.

Written OPC

The topic was of high interest for stakeholders providing written input. Of 57 contributions, 15 contained information or opinion on vehicles of unknown whereabouts, 13 on (de-)registration, and additional 6 on reporting. Contributions on these topics were received from all stakeholder groups.

Workshop

Topics discussed at the workshop following the presentation of the consultants on the topic of missing vehicles were the

- The suitability of road-worthiness test where various stakeholders have different opinions on details of the use of such test, however, it is seen a "key question";
- ELV registration competencies, e.g., a MS representative pointed out that EU-wide information exchange (database) on CoDs accessible by the EU registration authorities would be an effective tool, industry agreed. It was clarified that EUCARIS, the data exchange mechanism for vehicle data in Europe, does already have a CoD-message in place to exchange the CoD-info across Member States. EUCARIS is used by all EU Member States, however the CoD-message is currently not being used;
- vehicles deregistration, e.g., in relation to the limitations of temporary deregistration, harmonized rules, and automotive industry requested that an automatic deletion from the registration systems after seven years for example like in some MS should not be continued
- recyclers pointed out to the responsibilities of insurance companies and

[421] Mehlhart et. al (2017)

[422] Mehlhart et. al (2017)

- total technical loss status, but also the definition of an ELV compared to used vehicles

In general, many stakeholders engaged in the debate. Many of the stakeholders participating in the debate shared perspectives and experiences from MS, e.g. from Sweden or Germany (MS representatives), the Netherlands (stakeholders engages in repair and dismantling and EPR), Belgium (representative of the EPR system) or Latvia, Poland, France etc. (recyclers). It was pointed out by industry that national systems may pass their competences and jurisdiction to the higher level. Further, a representative of the Dutch EPR said that a good cooperation between the Ministry of Environment and Ministry of Infrastructure/transportation (etc.) is key […] to be able to monitor ELVs. Another idea presented by stakeholders were 'massive citizens information about legal way to dispose your ELV' (recycler + manufacturers).

8.5.4 EPR System

Statistical OPC

In the OPC, most stakeholders agreed that in order to ensure a high quality of recycling, that it is necessary to compensate the ATFs for their dismantling efforts, which are not economically viable under the current conditions. This was mainly supported by included environmental NGOs and consumer organisations, waste management operators, public authorities, and citizens but also a fair share of automotive producers (32%). When asked in more detail, 56% of all stakeholders agreed that producers should compensate the ATFs for their dismantling efforts and for appropriate treatment and disposal of these wastes. Here, waste management operators were the most prominent in their support of this aspects.

Written OPC

A few written contributions addressed Extended Producer Responsibility aspects, some only as a simple need that has to be implemented and others with more elaboration. Several stakeholders explained the purpose of an EPR scheme to be to affect the design of products so that they result in less negative environmental impacts. Others see the EPR scheme mainly as a funding opportunity to e.g. to balance costs for dismantling in particularly when secondary materials are more expensive than virgin materials, to boost investment in high-quality PST through economic incentives. One stakeholder raised the concern that the creation of an EPR monopoly in which producers have power over where finances and ELVs end up could end up limiting the free and fair competitiveness of the current network of dismantlers and shredders.

Interviews

Waste management operator look at the establishment of an EPR positively, in particular where it is necessary to support the financing of components of materials that need to be dismantled and treated in a way that is not economical. Though EPRs is exist for some MS, a difficulty was raised that they are usually run by OEMs without involving ATFs in their management. The difficulties in managing funds for a European EPR were raised in light of the frequent exports between countries and also the different costs that waste management results in in each country that would make setting a single fee for an EPR fund at EU level tricky.

Workshop

Participants commented that there are concerns about what entity has authority over EPR schemes. A few stakeholders mentioned that funds have not shown big advantages to support the economic feasibility of ATFs and stated that the processes that ATFs should treat vehicles and then producers have to cover negative market value vehicles is the direction that the EPR should develop, with it being established in the Directive. In contrast it was mentioned that funds were effective in compensating unprofitable labour (material dismantling), allowing the dismantler to compete more effectively with the illegal sector and being less dependent on enforcement. A few stakeholders raised the aspect of the CoD and the need for more enforcement to lower illegal exports leading to less vehicles being treated in the EU. The EPR was mentioned as an option to address the problem of cars going to other continents and not just for ensuring financial feasibility of ELV treatment.

8.5.5 ELVD Scope

Statistical OPC

For almost all stakeholder categories participating in the OPC, over 50% of the individual answers were in favour of extending the Directive additional vehicles. The highest support of this option was given by environmental organisations (100%), public authorities (90.9%) and waste management stakeholders (85.7%). On the question which additional vehicles should be included into the scope of the ELV Directive, the majority was in favour of adding motorcycles and trucks with a higher preference for trucks from the waste management operators and a higher preference for motorcycles from the manufacturers.

Avoidance of environmental harms to the environment thanks to minimum requirements for end-of-life treatment, increased resource recovery and increased recyclability were the top 3 important advantages of extending the scope of the ELVD largely supported by all stakeholder categories. Individual stakeholders explained that including them in the scope would increase the supply of recycled materials and lead to better dismantling, that heavy vehicles are exported to a larger extent than cars and reuse of spare parts is not as developed. And illegal vehicle dismantling, and unfair competition take place. This should be dealt with in the legislation. One third had no opinion on disadvantages of the scope extension. The most supported individual answers were that “These other vehicles (e.g., motorcycles and trucks) have features which are different from the vehicles covered by the ELV Directive, so that the provisions of the ELV Directive are not adapted to these other vehicles” (62 individuals or 30%) and “Higher burdens for SMEs” (48 individuals or 23%). Answers were distributed relatively evenly between the various categories. The stakeholders themselves relativised their statements on disadvantages when asked to detail: Though, “motorcycles are small, so it will be a lot of work for a very small amount of materials”, and “trucks are big and require specialised facilities for dismantling”, stakeholders say that “recycling facilities are suitable for all of the ELVD scope”. “Today these vehicles [it is not clear which] are already treated in authorized facilities even if they are not covered by the scope of the Directive.” Or: “The ELV change will result in some system changes and investment costs. It however involves an investment for the future. If the demand for recycled material is successfully established, it will pay itself back.”

More than one third of the stakeholders did not have an opinion on / did not know the areas where compliance for motorcycles and/or trucks would be difficult, and 15% said there are none. About 20% support that the following measures may be difficult to comply with: Material-specific recycling targets (45 individuals or 22%), reuse target (47 individuals or 23%), and recycled content target (38 individuals or 18%).

Written OPC

Various stakeholders from the motorcycles sector contributed additional information: ACEM emphasises that the sector consists of many SMEs that have no experience with the requirements of the current ELVD. Besides the quantitative results from a survey on the numbers of recycled motorcycles in Finland, SMOTO brings forward the concern that the common reuse practices could be undermined by the perceived focus of the current ELVD on recycling rather than reuse. An anonymous stakeholder (motorbike manufacturer) proposes non-reusable parts for motorcycles in addition to those listed in Art. 8 of the 3R Type approval Directive for M1 and N1[423]. FORS (a Polish recycling association) speaks for the practice of certificates of destruction for end-of-life motorcycles. A recyclability target is preferred whereas recycled content targets and reuse targets are explicitly not recommended for motorbikes (Eurofer).

For trucks, Swedish Government considers it important to distinguish between light and heavy-duty vehicles. If trucks were included, the Czech Ministry of Environment sees “problems in their size and different composition of materials”. Generally, for new vehicles in scope, the regulation should prevent the phenomenon seen for missing vehicles, i.e., the avoidance of the EU end of life treatment requirements (Swedish Governmental Agencies).

Six contributions focus on historic cars and motorcycles. Current practice of exempting historic cars should be pursued.

Interviews

Relevant interviewees are ACEA and ACEM presenting the manufacturers of trucks and L-type approved vehicles, and ANERVI/AETRAC, EuRIC and EGARA representing the EoL stakeholders. To describe the status quo of the dismantling of lorries, the main messages in the interviews were that lorries are not just bigger cars, that depollution is in practice in some MS, that lorry recycling infrastructure is different in different MS, and that ATFs that can manage a lorry also manages trailers. As for the status quo of EoL treatment of motorcycles, it was noted that reuse is important, that L-type approved vehicles have no chassis which is relevant for the definition of what is an ELV. Then, a very small number of L-type approved vehicles are returned to recyclers, and that there is no statistics on motorcycles, e.g., no separate waste code, right now.

In relation to potential regulation covering additional vehicles, the clear message was sent that vehicles different to M1 and N1 vehicles require specific rules, e.g., that the same 3R targets could not apply, and that these vehicles potentially require different exemptions from heavy metal restrictions (or new substance restrictions).

Workshop

Views differed on exemptions for hazardous substances in additional vehicle categories. Vehicle manufacturers were in favour of a category specific Annex II, i.e., to review the application of existing Annex II bans per vehicle category. The issue was also brought up in relation to multi-stage built vehicles, incl. wheelchair accessible vehicles. There is also difficulty if more than one vehicle category applies to a vehicle.

Stakeholders broadly support that it is currently not foreseen to recommend applying the 3R Type approval Directive to multi stage built vehicles.

[423] wheel suspension (front / rear) incl. triple clamp, swing arm and all damping parts, handle bar, all kind/material of rims, sub-frame, all kind/material of fuel tank

In the workshop, various participants of all stakeholder groups commented on the presented data and/or provided additional data (on the calculation of the fleet of motorcycles and lorries, on actual fleet data from Spain and Germany,). ACEA is currently performing a study on lorry, with results expected in September 2022.

A representative from the European Environmental Bureau (Environmental NGO) stated that, if the scope of these Directives is currently being discussed, the discussion should not be limited to a scope for only on-road vehicles.

8.5.6 3R Type Approval and its relation to the ELVD

Current situation. Questions were asked to understand better the role of type-approval technical services', the type approval authorities' and the OEMs' in the process of type-approvals in general as well as the special part of the 3R type-approval in particular. Because this is more for the understanding of the current situation, the answers are not summarised here. Stakeholder statements were used in Annex II of the main report when describing the process.

Effectiveness. Type approval authorities state that the Directive generally facilitates the achievement of the 3R targets. This is also supported by OEMs. However, this is not supported with data. Stakeholders are of different opinion in relation to whether the 3R Directive facilitates "high-quality" recycling. There is no systematic monitoring or studies that compare between the targets reported in type approval declarations of OEMs for specific vehicle models and between their actual performance at end-of-life. Quantitative feedback is scattered:

- The number of 3R Type Approvals performed per MS varies largely: Some have not performed any TAs since Directive 2005/64/EC came into force (e.g., Latvia, Finland) but do report on Regular TAs for second stage of N vehicles. Some perform 3R Type approvals regularly (6-9 per annum).
- One authority estimated the costs for the process at "< 0.25 years FTE per each 3R type approval"
- Some MS collect fees for the TA and some do not – sum also depends on certificate type (0-600 €).
- 3 of 5 MS agreed that the 3R TA should cover all stages of multi-stage vehicles (2 did not answer the question)

A second cluster of question was asked around the possible future amendments of the ELVD. In general, little to no input is provided on impacts of introducing certain measures proposed to be changed in the 3R Directive. One stakeholder (stakeholder shall not be named) is of the opinion, that the scope of the 3R Directive should be extended to include additional vehicles. Reference to the preferred TRL level of recycling technologies accepted in the ISO calculation varied widely between 3-4, 6-7 and 9.

On the merge of ELVD and 3R Directive. Of the interviewed stakeholders, one is of the opinion that there is a missing link and missing references between 3R Directive and ELVD. No stakeholder clearly indicated that the stakeholder preferred a merge of 3R Directive and ELVD or that it would be meaningful, MS that perform 3R Tas were against a merge with ELV. At least, two times China was provided as an example where one legal instrument is in place, however, the European market would be more diverse according to stakeholders. Looking at the stakeholder groups that provided their input on this topic, it should be noted that the stakeholders rarely take the perspective of the end-of-life. An ACEA position paper (ACEA 2022) refers to the positions of the automotive industry in relation to the merge of 3R Directive and ELVD: ACEA "call[s] for the current legal framework to be maintained." Rather than focusing on recyclability, they would like to see their engagement in the field of emission reductions during the use phase, i.e., strategies focusing on light weight, acknowledged framing it Design for Sustainability.[424] Another argument put forward (stakeholder shall not be named) is that currently, the responsibilities are distributed, i.e., recyclers fulfil the ELVD and manufacturers fulfil 3R Directive requirements. A merge of the Directives producing a legislation with joint responsibilities could increase innovation times and create longer discussion processes.

8.5.7 List of documents available to EC in addition to the synopsis

Public feedback

- Feedback is available to the EC
- Already online available under https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-Revision-of-EU-legislation-on-end-of-life-vehicles

Online public consultation (OPC)

- Export of data from online questionnaire is available to the EC
- Stakeholders' written contributions are available to the EC
- Summary report already available under https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12633-End-of-life-vehicles-revision-of-EU-rules/public-consultation_en.

Targeted consultation (main study + 3R type approval interviews)

- Confirmed interview documentations
- Additional studies or written input sent with the interviews
- List of confidential or non-confirmed interview documentations

Stakeholder workshop

- Analysis of Slido (interactive tool) questions
- Documentation of the chat of the online meeting
- Lists of attendees (contains personal data)

Consultation of Member States

- Answers of MS to ad-hoc survey are available to the EC
- List of registrations[425] of MS expert workshop (contains personal data)
- Documentation of the chat of the online meeting

Follow up consultation activities after the workshops

- Stakeholders' written contributions sent after the workshop are available to the EC.

[424] ACEA „want to point out that, for the necessary new and innovative materials for achieving the ambitious goals of targeted carbon neutrality by 2050, there might not yet be available appropriate recycling technologies for vehicles on an industrial scale."

[425] For technical reasons, we have not downloaded a list of attendees in this case.

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

– at the following standard number: +32 22999696, or

– by email via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from: https://op.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

Open data from the EU

The EU Open Data Portal (http://data.europa.eu/euodp/en) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

Publications Office
of the European Union