Summary

of

‘Plastic Parts from ELVS’

Study

conducted by

Ramboll Deutschland GmbH

Commissioned by

ACEA, PlasticsEurope, BKV GmbH

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Background information

According to the European Commission, end-of-life vehicles (ELV) generate between 7 and 8 million tonnes of waste per year in the European Union. The so-called "ELV Directive" on ELVs aims at making the dismantling and recycling of ELVs more environmentally friendly and sets clear quantified targets for reuse, recycling, and recovery of the ELVs and their components.

The Commission's actual evaluation of the directive will, among other topics, assess the directive´s contribution to solving issues addressed by wider EU policies on Circular Economy (EU circular economy package) and plastics in particular. The specific topics of the roadmap for revising the ELV Directive regarding plastics include: dismantling of plastic parts, material-specific recycling rates, and quotas for recycled content. However, the share of the contribution to plastic recycling from the ELV sector depends on geographic factors such as the availability of national shredder installations and post-shredder treatment, the demand for spare parts for old vehicles, and other national conditions.

Against this background, the aim of this study was to investigate possibilities and limitations (ecological evaluation) of the recycling of plastics from ELVs.

Objective

This study aims to present a European overview about the status quo of dismantling and disposal of plastic parts from ELVs. Therefore, it was to identify usual disposal routes of ELVs including plastic flows and treatment via consideration of different ways of managing plastics from ELVs (dismantling, shredding, post-shredding technologies).

Further, an ecological evaluation of dismantling and post-shredding was proceeded to evaluate the existing habits of ELV treatment and how suitable those treatments are to fulfil the recycling targets of the ELV-Directive.

Methodology

For this study five European Member States (MS) were selected for the analysis: Germany, Netherlands, Poland, UK and France.

The study consists two parts. The first section is regarding the plastic flow and plastic treatment from ELVs in the mentioned MS. The second section displays the ecological classification of dismantling and post-shredder-technologies (PST) of plastic parts from ELVs.

Regarding the disposal of ELVs including plastic flows and treatment as well as ecological evaluation, a targeted desk-based literature review was carried out and statistical data was analysed. The data were examined on European level premised on Eurostat and on national lever with several national sources. Based on the availability and comparability of data for the five MS, the year 2014 was selected as reference year, as it presented the newest available data for all five MS during the data collection phase. Moreover, a questionnaire for stakeholder of the ELV-field was prepared based on the first literature search and the identified information needs and was used to close specific data gaps.

The ecological evaluation for dismantling is based on analysation and classification of ten life cycle assessment (LCA) studies. The ecological evaluation for PST was carried out by analysing and classifying five life cycle assessment studies. Those 15 studies were qualified by scoring accordance to LCA criteria, ranging from 0 (=no accordance with given LCA quality criterion) to 4 (= full accordance with given LCA quality criterion).

These polymers are considered in the further context by the term "plastic/plastic share":

- Polypropylene (PP);
- Polyurethane (PU) foam;
- Polyamide (PA);
- Polyethylene (PE-HD, -MD);
- Styrene co-polymers (ABS, ASA, SAN);
- Other types of plastics;

Tyres are explicitly excluded from the plastic parts.

Results of the section: Current plastics treatment and material flows during disposal of ELVs

The ELV Directive (2000/53/EC) frames the general treatment routes of ELVs, which has to be implemented on national level, what is fulfilled in all five analysed MS; In general, the recycling of ELVs consists of three distinct and subsequent processes: depollution and dismantling; shredding and PST, possibly including advanced PST.

The characteristics and composition of ELVs in the selected MS vary depending on the average age, weight and plastic share of ELVs.

Facilities, capacities and the treatment routes of plastics from ELVs are country-specific and depth and quality of disclosed information differs between the selected countries.

Furthermore, ELV treatment practices may be classified into manual pre-treatment (depolluting and dismantling of selected parts) process technologies (e.g. shredding and PST).
The actual adoption and combination of manual treatment steps and process technologies depends on a range of factors, e.g.:

- levels and distribution of wages;
- demand and prices for used spare parts;
- used recycling technology (e.g. advanced PST);
- scrap prices;
- disposal/waste treatment fees;
- alternative recycling structures (distribution channels for secondary raw materials);
- legal framework conditions.

After shredding following categories apply generally: Shredder Light Fraction (SLF), Non-ferrous materials (aluminium, copper, zinc, lead, etc.) from shredding, Shredder Heavy Fraction (SHF) and other materials arising from shredding for plastic residues.

Overall, Shredder outputs vary between both countries and individual shredder facilities based on the applied technologies.

PST is applied in all countries to separate metallic fractions. Information on advanced PST facilities focusing on plastic recovery is only available to a certain extent. PST based on advanced separation technologies (such as optical sorting, electrostatic charging, magnetic and eddy current separation, aerodynamic separation, screening or sieving or drum separation), is currently available and enables the separation of different plastic fractions and contaminants. Data on the contribution of shredders and advanced PST to plastic recovery are available for France, the Netherlands and partially for Germany. Specific information on waste management options of plastic from advanced PST was only available for France and the Netherlands. However, in-depth information is often lacking and there is no general definition e.g. of the terms Shredder Heavy Fraction and Shredder Light Fraction which makes it difficult to compare the activities of PST of the selected MS.

The growing importance of advanced PST is recognised within individual MS such as the Netherlands and existing technologies are continuously further developed. Further innovations would be desirable in order to tackle practical issues like contamination or quality aspects.

The average age, weight and plastic share of ELV as well as the facilities, capacities and treatment routes for ELVs of all five MS is summarised in the following fact sheets:

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Germany

General

Number of ELVs collected		Average Age of ELVs (years)		Average weight of ELVs (kg)		Assumed plastic share of ELVs (%)
2014	2017	2014	2017	2014	2017	contemporary
512,163[2]	-1.1%[2]	14-15[3]	+21.4%[3]	981[3]	+6.7%[3]	15[1]

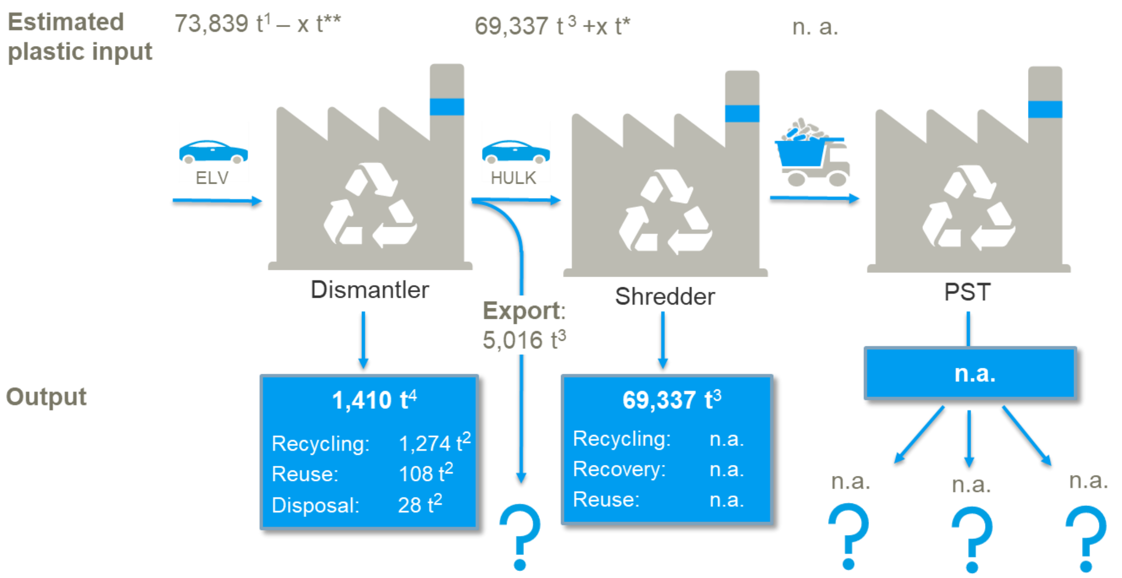
Legend: [1] Literature; [2]Eurostat; [3]National Statistics/Data;

Facilities and capacities and treatment routes for ELVs (data for 2014)

	Number of plants	Capacity [ELV/ year]	Capacity currently utilized [t/a or ELV/ year]
Dismantler	1,211[3]	n.a.	n.a.
Shredder	50[3]	n.a.	n.a.
PST	n.a.	n.a.	n.a.

Legend: [1] Literature; [2]Eurostat; [3]National Statistics/Data;

Typical treatment routes for plastic parts (data for 2014)



[1]Calculations based on Eurostat and average plastic share and assumptions based on literature
[2]Calculations based Eurostat data and assumption on plastic share in waste category
[3]Calculations based on national data and assumption on remaining plastic share
*including further input e.g. stock, import, ...
**Total plastic waste generated - possible reserves are not accounted for

Country specifics

-

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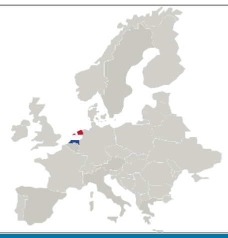
Netherlands



General

Number of ELVs collected		Average Age of ELVs (years)		Average weight of ELVs (kg)		Assumed plastic share of ELVs (%)
2014	2017	2014	2017	2014	2017	Contemporary
188,487[2]	+5.8%[2]	n.a.	18.1[3]	1,041[2,]	-0.6%[2]	15[1]

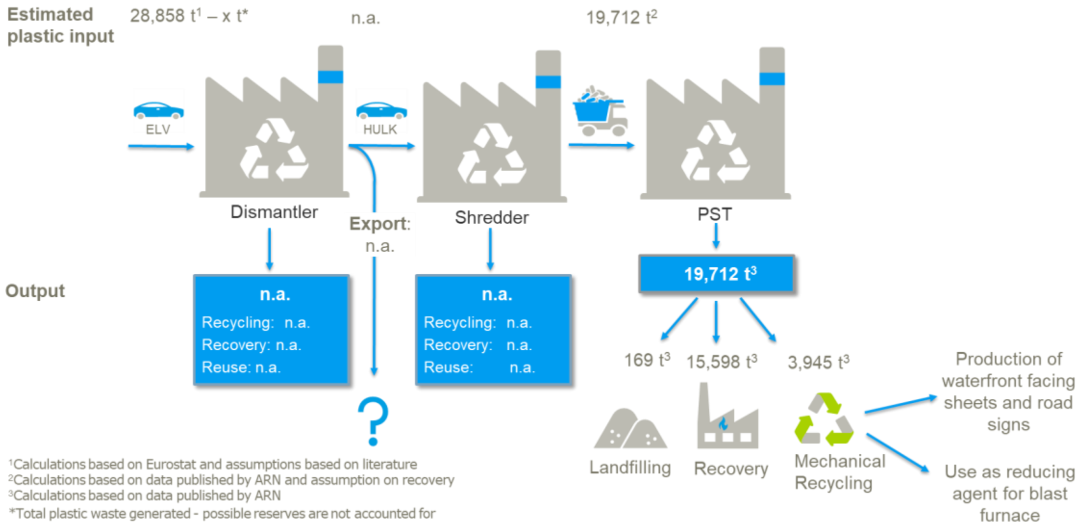
Legend: [1]Literature; [2]Eurostat; [3]National Statistics/Data; [4]Caluclation; [5]Stakeholder contribution

Facilities and capacities and treatment routes for ELVs (data for 2017)

	Number of plants	Capacity [ELV/ year]	Capacity currently utilized [t/a or ELV/ year]
Dismantler	450 – 580[5]	300,000 ELV/year[5]	230,000 ELV/year[5]
Shredder	6 – 11[5]	n.a.	n.a.
PST	1[5]	42,000 t/a[5]	42,000 t/a[5]

Legend: [1]Literature; [2]Eurostat; [3]National Statistics/Data; [4]Caluclation; [5]Stakeholder contribution

Typical treatment routes for plastic parts (data for 2014)



Country specifics

Large discrepancies between data reported to Eurostat and data provided by ARN.

Data provided by ARN represents the majority of the ELV processing market in the Netherlands, but not its entirety (around 90 % of the ELVs processed)

Only one dedicated PST facility located in Tiel is operated by ARN.

Poland

General

Number of ELVs collected		Average Age of ELVs (years)		Average weight of ELVs (kg)		Assumed plastic share of ELVs (%)
2014	2017	2014	2018	2014	2017	contemporary
454,737[1]	+9%[1]	18.7[2]	+7%[2]	1,016[1]	+3.6%[1]	13[3]

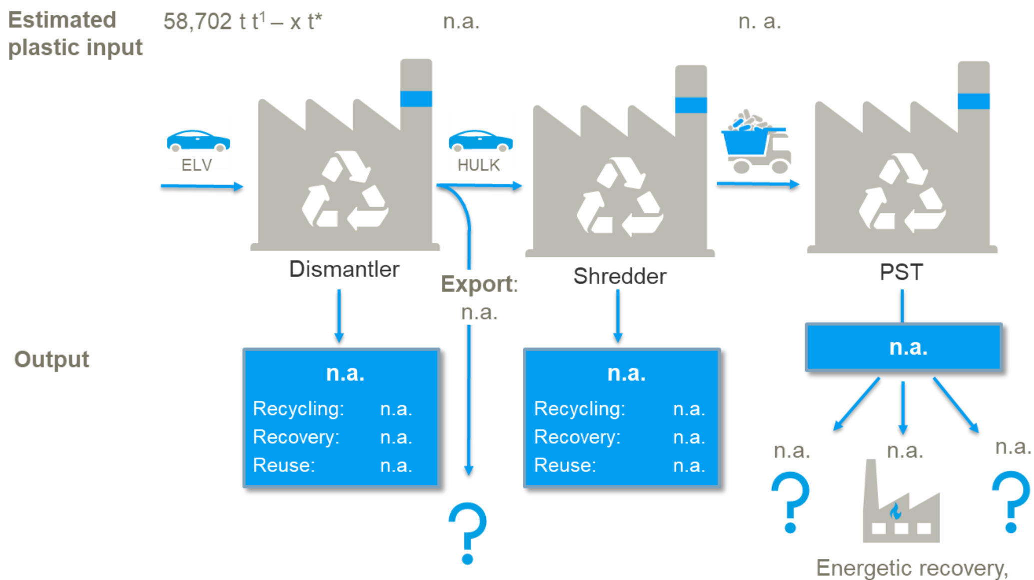
Legend: [1]Eurostat; [2]National Statistics/Data; [3]Average based on literature; [4]Stakeholder contribution;

Facilities and capacities and treatment routes for ELVs

	Number of plants	Capacity [ELV/ year]	Capacity currently utilized [t/a or ELV/ year]
Dismantler	819[2] / 1,044[4]	n.a.	n.a.
Shredder	6	n.a.	n.a.
PST	n.a.	n.a.	n.a.

Legend: [1]Eurostat; [2]National Statistics/Data; [3]Average based on literature; [4]Stakeholder contribution;

Typical treatment routes for plastic parts (data for 2014)



[1]Calculations based on Eurostat and assumptions based on literature
*Total plastic waste generated - possible reserves are not accounted for

Country specifics

Large discrepancies between data reported to Eurostat and nationally published data.
Generally low data availability.

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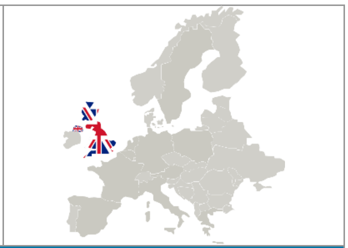
UK



General

Number of ELVs collected		Average Age of ELVs (years)		Average weight of ELVs (kg)		Assumed plastic share of ELVs (%)
2014	2017	2014	2017	2014	2016	contemporary
1,106,846[2]	+25.6%[2]	13.6[1]	+4.4%[1]	971[2]	+16.4%[1, 2]	12[1]

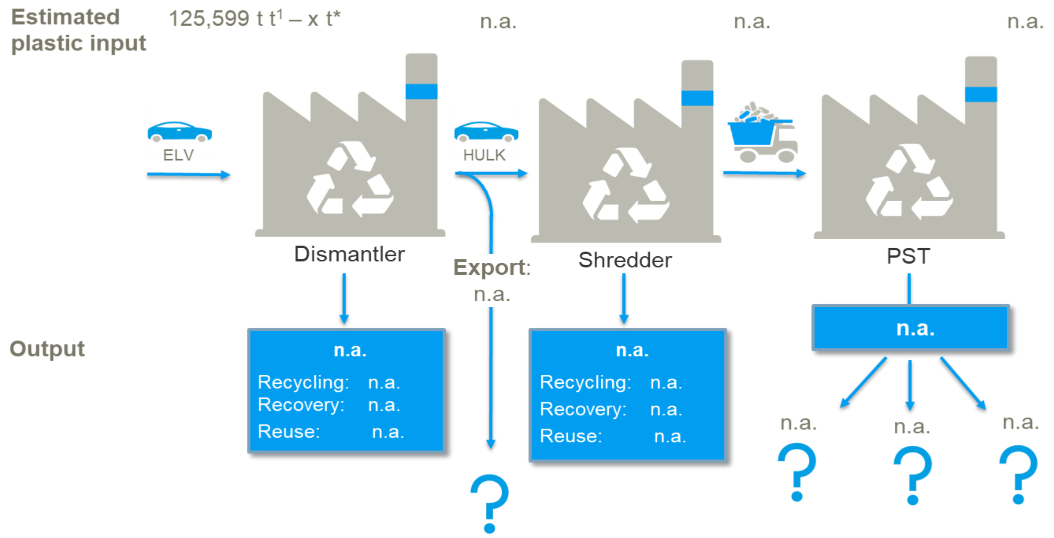
Legend: [1]Literature; [2]Eurostat

Facilities and capacities and treatment routes for ELVs

	Number of plants	Capacity [ELV/ year]	Capacity currently utilized [t/a or ELV/ year]
Dismantler	2,031[3*] (2018)	n.a.	n.a.
Shredder	45[4**] (2013)	n.a.	n.a.
PST	No specification. Included in shredder facilities to varying degrees. [4]	n.a.	n.a.

Legend: [1]Literature; [2]Eurostat; [3]National Statistics/Data; [4]Information form relevant Associations; [*]Information for 2018; [**]Information published in 2013

Typical treatment routes for plastic parts (data for 2014)



[1]Calculations based on Eurostat and assumptions based on literature
*Total plastic waste generated - possible reserves are not accounted for

Country specifics

Generally low data availability.

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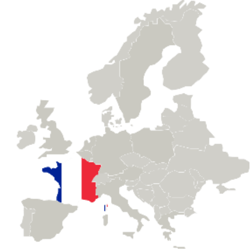
France



General

Number of ELVs collected		Average Age of ELVs (years)		Average weight of ELVs (kg)		Assumed plastic share of ELVs (%)
2014	2017	2014	2017	2014	2017	contemporary
1,084,766[1]	+4.9%[1]	17.5[2]	+5.7%[2]	1,028.1[2]	+4.3%[2]	11,5[2]

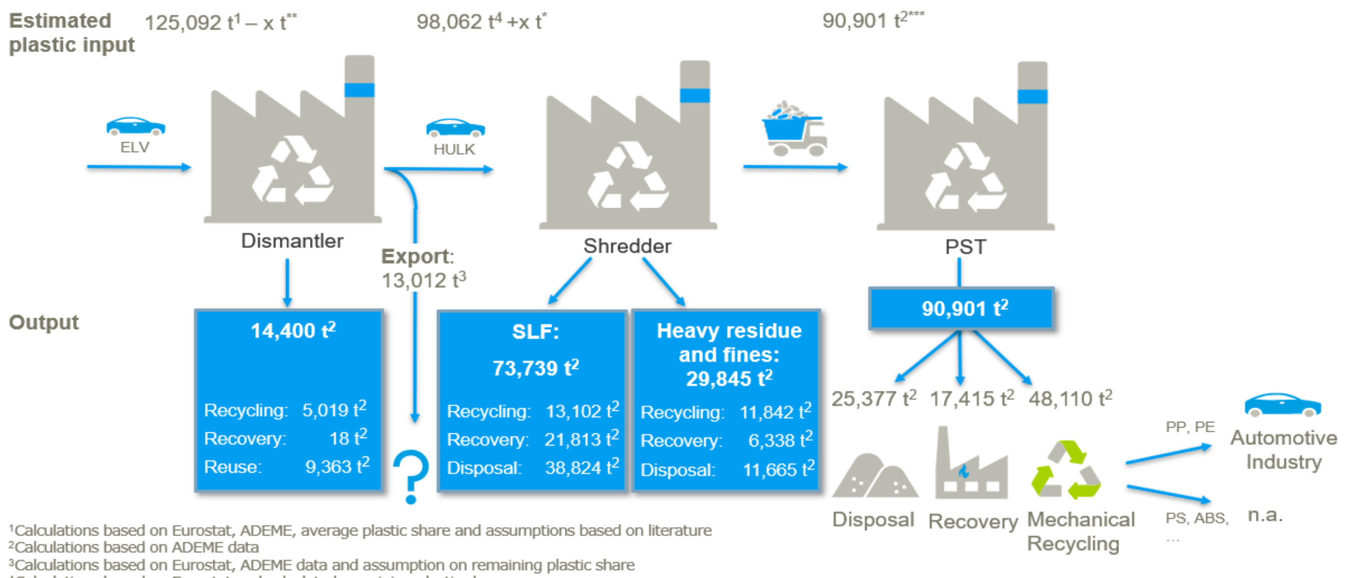
Legend: [1] Eurostat, [2]National Statistics/Data,

Facilities and capacities and treatment routes for ELVs (data for 2017)

	Number of plants	Capacity [ELV/ year]	Capacity currently utilized [t/a or ELV/ year]
Dismantler	1,706 [2,3]	1,500,000 – 2,000,000[3]	1,100,000 – 1,600,000 t/a[3]
Shredder	57[2,3]	2,000,000[3]	995,330 – 1,600,000 t/a[3]
PST	9 for Fines, 12 for SLF 12 for NF mix[3]	n.a.	n.a.

Legend: [1] Eurostat, [2]National Statistics/Data, [3]Stakeholder contribution

Typical treatment routes for plastic parts (data for 2014)



[1]Calculations based on Eurostat, ADEME, average plastic share and assumptions based on literature
[2]Calculations based on ADEME data
[3]Calculations based on Eurostat, ADEME data and assumption on remaining plastic share
[4]Calculations based on Eurostat and calculated remaining plastic share
*including further input e.g. stock, import, ...
**Total plastic waste generated - possible reserves are not accounted for
***Plastic entering PST is assumed to already be partially included in the shredder output fractions

Country specifics

Discrepancies between data reported to Eurostat and nationally published data.

Results of the section: Analysis of prospective treatment options for plastic parts from ELVs (ecological evaluation)

Ecological evaluation

Out of 32 founded studies, concerning LCAs of ELVs treatment and plastics, 15 studies were identified as relevant for this study and were analysed. Ten studies for the ecological evaluation of dismantling plastic parts from ELVs and five for the ecological evaluation of the treatment of plastic shredder residues, PST.

The ten analysed LCA-studies for the ecological evaluation of dismantling large plastic parts from ELVs and the five LCA-studies about the treatment of plastic parts by PTS are ranked based on their LCA quality score results (table 1 and 2). The higher the score for the LCA quality criteria, the better the research approach matches the settings of this study and the more information is provided on the modelled system. Additionally, the traffic light system states whether or not the dismantling of plastic parts and (advanced) PST treatment of plastic parts are considered environmentally beneficial in terms of reducing the impact on the assessed impact categories with focus on Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Abiotic Resource Depletion (ADP) and Ozone Depletion Potential (OPD), as applicable.

In general, dismantling can reduce environmental impacts (e.g. in terms of potential climate change impacts) due to a presumably higher share of materials going into recycling rather than combustion with energy recovery. However, there is no clear indication for or against a profound ecological advantage concerning the dismantling of plastic parts. Therefore, dismantling is not a generally preferable option and not suitable as a stand-alone solution.

Table 1: Overview and evaluation of the literature findings (dismantling)

Reference	LCA quality score[1]	Is dismantling of plastic parts environmentally beneficial?
Krinke et al. (2005)	3,6	• - dismantling is less environmentally beneficial than PST
Nürrenbach et al. (2003)	3,4	• - environmental benefits from recycling cannot be generalised
Fonseca et al. (2013)	3,3	• - environmental benefits are seen in dismantling
Jenseit et al. (2003)	3,1	• - environmental benefits are seen in dismantling of only large plastic parts
Belboom et al. (2016)	2,9	• - environmental benefits of dismantling of large plastic parts are insignificant
Gradin et al. (2013)	2,9	• - environmental benefits are significant for CO_2-eq. emissions
Schmid et al. (2016)	2,7	• - dismantling of large plastic parts is considered best scenario but dismantling alone does not achieve ELV-target
Duval & McLean (2007)	2,0	• - there are environmental benefits from dismantling
Chen et al. (2019)	1,8	• - there are environmental net benefits in five impact categories
Schlotter (2011)	1,1	• - market deregulation is better

[1] Unweighted average of all results from LCA quality criteria

The focus at the LCA-studies about PTS is to point out the environmental performance of shredding scenarios that include, considering mainly benefits or burdens in terms of the impact categories GWP, ADP, AP, EP and OPD.

Table 1: Overview and evaluation of the literature findings

Reference	LCA quality criteria	Is Shredding with PST environmentally advantageous?
Krinke et al. (2005)	3,6	• - PST has slightly better reduction potentials than dismantling
Rinaldi et al. (2015)	2,7	• - PST has potential to reduce environmental impact
Ciacci et al. (2010)	2,4	• - improved, overall environmental performance achieved in scenarios with PST
Soo et al. (2017)	2,4	• - environmental benefits from plastic recycling are insignificant for one whole ELV; relevance of PST for environmental impact will increase
Passarini et al. (2012)	2,1	• - benefits depend on energy mix; the higher the plastic content the more important is separation and recycling through PST

PST is considered necessary for the compliance with the targets of the ELV-directive, particularly with the increasing plastic content of ELVs. Therefore, cost efficient combinations of dismantling of large plastic parts and advanced PST procedures should be implemented.

Conclusion

Current plastics treatment and material flows during disposal of ELVs

The conducted research on an MS level has uncovered inconsistencies between reported data at European (Eurostat) and national levels (national reports and data from other organisations). These discrepancies are, in part, due to different approaches and definitions of the shredder output fractions. In addition, annually cumulated and averaged data may be a poor representation of evidently heterogenic treatment situations within and between countries (e.g. differing output fractions depending on PST applied). This hinders the comparability of country data at European level to a certain extent. The chosen MS data on plastic treatment as far as available from ELVs was compiled and the data for each country within the scope of this study is presented in factsheets.

The responses of relevant stakeholders indicate that dismantling of specific large plastic components for retaining material might, in theory, be technically possible. However, several feasibility barriers were reported. Increased market prices for plastic materials were put forward during the stakeholder consultation as a necessity to improve the dismantling of plastic components.

Initial core process of further treatment after dismantling is the shredding of the decontaminated ELV with the goal to make different materials (different metals, plastics, minerals) separately accessible. PST based on advanced separation technologies (such as optical sorting, electrostatic charging, magnetic and eddy current separation, aerodynamic separation, screening or sieving or drum separation), is currently available and enables the separation of different plastic fractions and contaminants.

According to the stakeholder consultation, advanced PST is in place in Germany, France, and the Netherlands, and their importance for environmentally suitable waste treatment has been recognized. However, material recycling of plastics from ELVs is still limited. A nationwide or EU wide application of advanced PST, focusing not only on recovery of metals but also of plastics, could contribute to achieving higher plastic recycling from ELVs.

Ecological evaluation

From the selected publications it can be concluded, that dismantling of large plastic parts is not a generally preferable treatment option but largely depends on the underlying assumptions and data used for the reviewed LCAs. In fact, potential environmental advantages depend on the geographical context, the infrastructure, the energy mix, transport logistics and efficiency levels of the local treatment facilities.

The conducted literature review provides an ecological evaluation of advanced PST and is based on five relevant LCA studies which investigated respective ELV treatment pathways. Moreover, an attribution of environmental effects to either the recycling of plastics, metals or other materials is mostly not performed in the reviewed studies. Hence, environmental benefits from PST are mainly attributed to the separation of metals. The contribution of plastics to the environmental impact is not the dominating factor. In general, nevertheless, the results show environmental advantages for the utilisation of plastics from advanced PST when compared to alternative scenarios without PST and those with manual dismantling. Ultimately, advanced PST is considered relevant as additional treatment option for reaching ambitious recycling levels, especially when the proportion of plastics in end-of-life vehicles is to increase in the future.

Considering the findings of the ecological evaluation, neither of the two distinct treatment options is considered to be exclusively superior. Country specific combinations of treatment methods can offset the respective advantages and disadvantages and probably achieve the greatest overall reduction potential However, the data availability, not only for life-cycle inventories (LCI) and full life-cycle assessment (LCA) studies, remains an issue and should be improved, i.e. reporting by MS and specific LCI data.

The full study can be ordered against a fee of 500 EUR plus VAT on the BKV GmbH website (only available in English):

https://www.bkv-gmbh.de/en/info-zone/studies.html.

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