Research Report on the Sorting Trial

Turku University of Applied Sciences

Source Separation Demonstration of Vehicle-Derived Plastics

Reforming Vehicle Recycling in the Sustainability Transition – A Low-Carbon Circular Economy Vehicle Dismantling Line Project

ABSTRACT

Turku University of Applied Sciences

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April 2026.

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- Reforming Vehicle Recycling in the Sustainability Transition – A Low-Carbon Circular Economy Vehicle Dismantling Line Project

This study evaluated the feasibility of source separation of vehicle-derived plastics through a practical dismantling trial. A 2004 Citroën C3 was used as the test vehicle, from which all plastic materials assessed as recyclable were dismantled. The plastics were sorted according to material markings and weighed by material fraction. Non-recyclable elastomers, PUR foams and thermosetting plastics (in accordance with Article 6(1) of the EU Regulation) were excluded from weighing.

A total of 53.7 kg of plastic was recovered from the vehicle, corresponding to approximately 5.5% of the vehicle mass. The largest material fractions were polyethylene (PE, 26.44 kg), talc- or mineral-filled polypropylene (PP-TD/MTD, 9.88 kg), and polypropylene (PP, 8.7 kg). Material markings were found on almost all components, but their location and wear created challenges.

The trial demonstrated that source separation is technically feasible but labour-intensive: five people required several hours to dismantle and sort the plastics from a single small vehicle and to further disassemble components (particularly the dashboard and air-conditioning unit) and locate material markings. Economic viability is therefore limited if dismantling is carried out solely for plastic recycling purposes.

Based on the trial, the most cost-effective approach would be to focus sorting efforts on the largest and most easily removable plastic components, such as bumpers, door panels and other large plastic interior trim components. This would also align with the recycling requirements of the forthcoming EU Regulation, according to which the recycling rate for plastics originating from end-of-life vehicles must increase to 30%.

Overall, it was found that source separation of plastics from end-of-life vehicles can be implemented as part of normal depollution and spare parts dismantling operations but is unlikely to be economically viable as a standalone activity

without model-specific dismantling instructions, advanced identification tools or a more efficient recycling market.

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1 Introduction

The amount of plastics used in vehicles has increased significantly over recent decades due to lightweighting solutions, safety requirements and the development of functional features. At the same time, plastic streams generated from end-of-life vehicles in Europe continue to be directed primarily to energy recovery or landfill, even though plastics represent a substantial and potentially recoverable material resource in end-of-life vehicles. This situation is inconsistent with the EU’s circular economy objectives and the forthcoming Regulation on end-of-life vehicles, which introduces significant recycling and closed-loop requirements for plastics originating from end-of-life vehicles.

The forthcoming EU Regulation on End-of-Life Vehicles requires an increasing proportion of vehicle plastic components to be recovered through material recycling and, specifically, increases the required share of recycled plastics originating from end-of-life vehicles. This will fundamentally change depollution and dismantling operations for end-of-life vehicles, which have traditionally focused on metals and the reuse of spare parts. With regard to plastics, the key question is to what extent and under what conditions plastics can be separated into sufficiently pure and economically viable material streams already at the dismantling stage.

In this context, source separation refers to the separation of plastic materials during vehicle dismantling directly on the basis of their material composition before shredding. The advantage of the method is, in principle, improved material purity compared with post-shredding sorting solutions, whereas its limitations are typically labour intensity and dependence on component accessibility, material markings and the availability of dismantling instructions. As a result, the practical feasibility of source separation and its role as part of future vehicle dismantling lines remain insufficiently documented.

The objective of this study is to evaluate the practical feasibility of source separation of vehicle-derived plastics through an end-of-life vehicle dismantling trial. The assessment focuses in particular on (1) the quantity and material fractions of recovered plastics, (2) the workload involved in dismantling and sorting activities and the identified practical challenges, and (3) the conditions under which source separation could function as part of a future low-carbon circular economy vehicle dismantling line.

When reading this report, it should be noted that the vehicle could not be lifted from the workshop floor onto a vehicle lift because the lift was occupied at the time. As a result, some plastic components, such as the fuel tank, could not be removed.

The study was conducted as a practical dismantling demonstration as part of the Reforming Vehicle Recycling in the Sustainability Transition – A Low-Carbon Circular Economy Vehicle Dismantling Line Project. The work provides experimental evidence and applied knowledge particularly for dismantling operators, development projects and public authorities preparing for stricter plastic recycling requirements for end-of-life vehicles and the reorganization of dismantling processes.

2 Demonstration Plan

2.1 Basic Information

Date: 30 March 2026

Location: Peltola Unit, Turku Vocational Institute.

Vehicle: Citroën C3 1.4, Registration Date: 6 September 2004, VIN: VF7FCKFVB27086799, Registered Mass: 1,080 kg, Measured Mass: 970 kg.

Participants: Patrik Lindström, Vesa Törmäkangas, Sampo Hiltunen, Niko Reunanen, Rami Wahlsten, Mikael Juhala.

2.2 Demonstration Objectives

- Remove all recoverable plastic materials from the vehicle.
- Sort plastics according to material markings.
- Measure the total quantity of each fraction.
- Evaluate the feasibility of source separation.
- Document dismantling, sorting, challenges and observations affecting the design of the future vehicle dismantling line.

2.3 Required Equipment

2.3.1 Dismantling Tools

- Screwdrivers, socket set and other standard workshop hand tools (no open spark generation).
- Reciprocating saw and cordless screwdriver/drill.
- Fastener removal tools.
- Side cutters, utility knife.
- Personal protective equipment (cut-resistant gloves, safety glasses, safety footwear, coveralls).

2.3.2 Sorting and Weighing

- Sorting bags and containers.
- Scales + weighing container for smaller material fractions.
- Labelling tape and marker.
- Documentation forms for sample containers and samples, camera.

3 Demonstration Protocol

3.1 Preparation and Documentation

- Remove all non-original contents from the vehicle.
- Weigh the vehicle before dismantling.
- Photograph the exterior and interior of the vehicle.
- Record vehicle details in the protocol.
- List large homogeneous plastic components.

3.2 Dismantling Work

- Remove components in the following order:
- Interior trim.
- Dashboard plastics.
- Bumpers and engine bay plastics (technical plastic components (PA6-based)).
- Wheel arch liners and air guides.
- Underbody plastics.
- Record the following information for each component:
- Component name.
- Material marking.
- Challenges (corroded fasteners, hidden clips, damage, component “homogeneity”, etc.).

3.3 Sorting

- Place each component into the appropriate material fraction.
- Multi-material components → separate category.
- Components without material markings → separate category.
- Special Notes:
    - PPTxx in separate categories (talc-filled polypropylene, xx = percentage of talc).
    - PA6GFxx in a separate category (glass fibre-reinforced polyamide, xx = percentage of glass fibre).

3.4 Weighing

- Weigh each plastic category separately.
- Record the weights in the table.
- Calculate the total quantity of plastic.
- Calculate the percentage of vehicle mass.

4 Demonstration Outcomes

Source separation is feasible but is unlikely to be economically viable due to labour costs if dismantling is carried out solely for plastic recovery. The dismantling of a small passenger car required several hours of work by five people. The process would be accelerated by detailed model-specific dismantling instructions.

Prior to the sorting experiment, efforts were made to obtain access rights to the IDIS system (International Dismantling Information System), but without success. The system would provide up-to-date instructions for the treatment of end-of-life vehicles using model-specific information from more than 70 vehicle manufacturers, including information on the plastic grades of plastic components. Prior to the trial, the test group was granted access to review the system using a personal license belonging to one of the project stakeholders, but the organization responsible for managing the system did not agree to provide access rights to Turku University of Applied Sciences. Consequently, the system could not be utilized for the sorting trial.

Source separation of prohibited and/or permitted POP compounds and other hazardous substances was found to be impossible based solely on visual inspection of plastic markings and plastic materials. At a minimum, dismantling would have required information held by vehicle manufacturers regarding the composition of plastic materials and the locations of potential hazardous substances. Field analyzers are, however, available on the market, such as XRF (X-ray fluorescence) instruments, which could be used to verify bromine content during dismantling and to direct low-bromine components towards plastic recycling. (Guide for the Management of POP Waste 2024, 93)

A total of 53.7 kg of plastic material was dismantled and sorted from the vehicle. This corresponds to approximately 5.5% of the measured vehicle mass. PUR foams, thermosetting plastics and elastomers excluded from recycling were not weighed; however, based on visual assessment, the total quantity of recyclable plastics was several times greater than that of non-recyclable materials. Of the sorted plastics considered suitable for recycling, the proposed 30% recycling target would be achieved with approximately 16 kg of recyclable material. In the case of the test vehicle, this could be achieved through the recovery of the bumpers and the large plastic components of the doors and interior trim. In this vehicle, the fuel tank was a large plastic component that could likely be recycled as material, but its removal was not possible because the vehicle lift in the dismantling workshop was unavailable. Removing the fuel tank while the tires remain in contact with the floor is, in practice, impossible.

Figures 1–8 present the vehicle dismantled during the demonstration and images from different stages of the dismantling work.

Figure 1. Citroën C3, the vehicle used in the sorting trial.

Considerable time was spent searching for suitable tools and, in particular, locating plastic material markings. Some components required substantially more time to remove than others, with the dashboard being a notable example. Even in a small and relatively inexpensive vehicle, dismantling and sorting required several hours of work by five dismantlers, making it reasonable to assume that the process would take longer for larger, more modern and more premium vehicle models.

Figure 2. Weighing of PE plastics; large components were weighed separately, while smaller components were weighed in bags.

Figure 3. PE-MD plastic grade is used extensively in trim components. The MD marking may refer either to medium density or to mineral-filled polyethylene.

Figure 4. PP-TD and PP-MD components are also found beneath the dashboard. In this case, TD and MD most likely refer to talc-filled and mineral-filled grades.

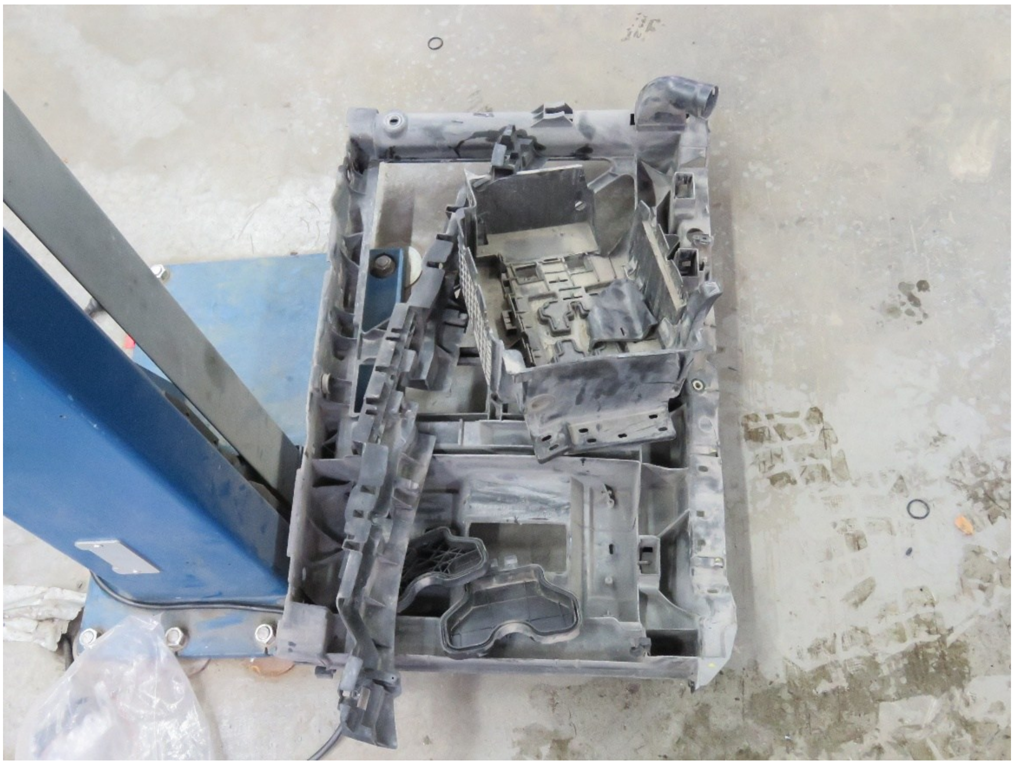

Figure 5. PP-GF plastic grade (glass fiber-reinforced polypropylene) is used, among other applications, in the radiator support and other plastic components in the engine compartment.

Figure 6. PC and ABS plastic components.

Figure 7. Elastomers and foamed polymers excluded from recycling, as well as multi-material components containing them.

Figure 8. The vehicle was dismantled to remove all recyclable plastic material.

Metal elements were removed from all plastic components extracted from the vehicle, including metal inserts, reinforcements, screws and other fasteners. Screws and fasteners could be removed relatively easily using a cordless drill. Plastic components were not removed intact, as this was not considered necessary; therefore, in certain cases, it was faster simply to break the plastic fasteners. The dashboard was clearly identified as the most complex and time-consuming plastic-containing component to dismantle. Removing the dashboard alone required the dismantling of numerous additional components before access to its fasteners could be obtained. These included, among others, the A-pillar trim panels, center console, radio, glove compartment and dashboard side panels. In addition, the steering column mounting brackets had to be loosened in order to release the steering wheel assembly attached to the dashboard.

The removal of the dashboard and dismantling of its plastic material were justified for several reasons: in terms of mass, the dashboard is one of the largest plastic components alongside the bumpers; pyrotechnic devices, i.e. airbags, were removed in accordance with Annex 7, Part B, point 1a of the European Council (2025) proposal; infotainment system components in accordance with Annex 7, Part C, point 10; main wiring harnesses in accordance with Annex 7, Part C, point 12; printed circuit boards in accordance with point 17b; and the remaining metal components. Based on material markings, the plastic components of the dashboard were found to consist mainly of PP-MD and PP-GF plastic grades (mineral- or glass fiber-reinforced polypropylene). (European Council 2025, 172–174)

Figures 9–12 present the dismantling of different vehicle components to expose plastic materials.

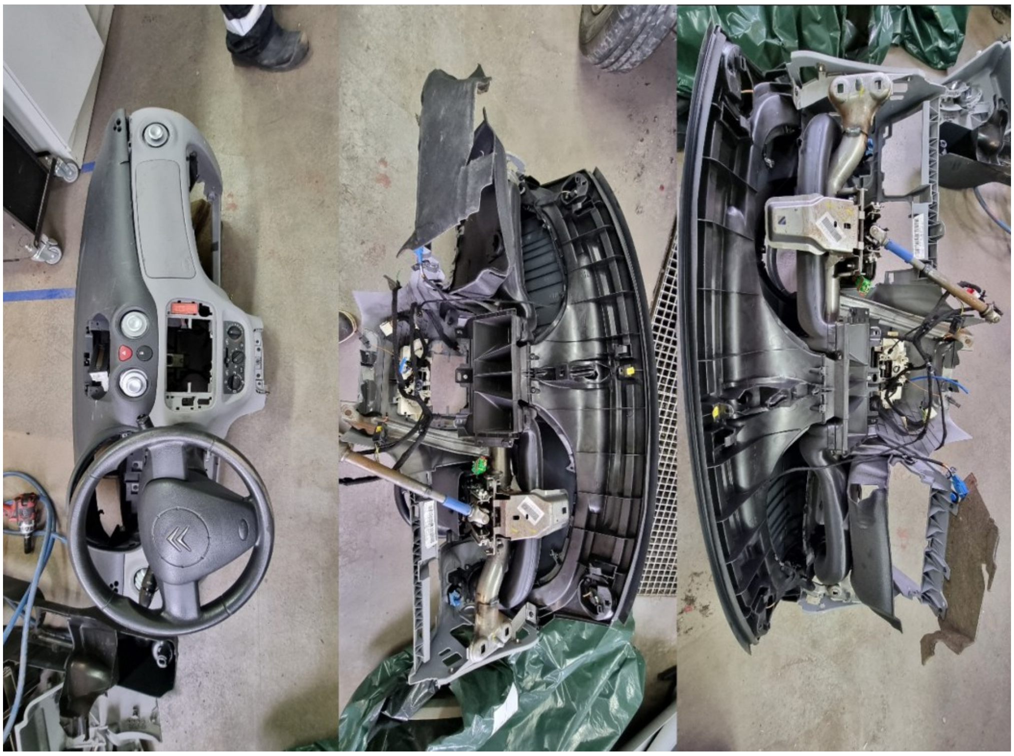

Figure 9. The dashboard consists of multiple components and contains significant quantities of WEEE fractions and steel fractions.

In addition to the dashboard, the air conditioning unit was identified as another clearly complex component, as shown in Figure 10 below.

Figure 10. Air conditioning unit.

Figure 11. Disassembled air conditioning unit.

Dismantling complex components solely for plastic recovery is unlikely to be economically viable due to the time required. The dismantling of the air conditioning unit was justified by the recovery of high-quality recyclable materials. In this case, these included copper cables and aluminium. Based on material markings, the plastic material in the air conditioning unit was identified as a PP-MD grade.

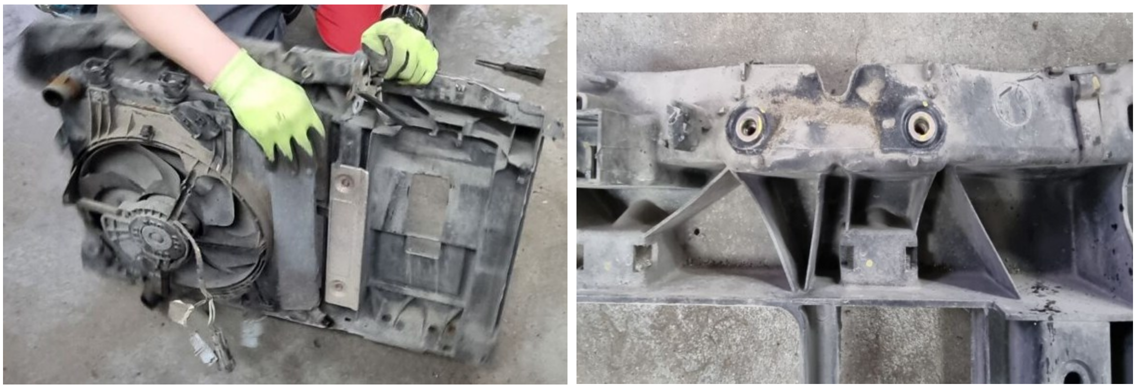

Figure 12. Radiator.

The radiator located at the front of the vehicle was the third most time-consuming component to dismantle in order to recover plastic material, after the dashboard and the air conditioning unit. The radiator’s metal fasteners had oxidized and become tightly seized and were partially embedded in the plastic, while the rubber-like radiator hoses, which are not suitable for plastic recycling, were also difficult to remove. The quantity of copper cable was low, and the electric fan motor was small in size. The plastic material of the radiator was identified as a PP-GF plastic grade.

4.1 Plastic Markings

Plastic markings were found on all plastic components in the vehicle except for two. The components without markings were the rear bumper trim strip and the rear windscreen wiper arm. The rear bumper trim strip differed from the corresponding front bumper component specifically because of the absence of this marking, whereas plastic markings were found on every component of the front bumper. Locating plastic markings on the components proved challenging, as the markings were not positioned consistently and could be located anywhere on the components. In addition, plastic components located on the exterior of the vehicle had become dirty and worn during use, requiring dirt to be removed in order to locate the markings. Furthermore, due to wear, some markings were difficult to identify (Figures 13 and 14).

Figure 13. Locating the plastic marking on the rear bumper.

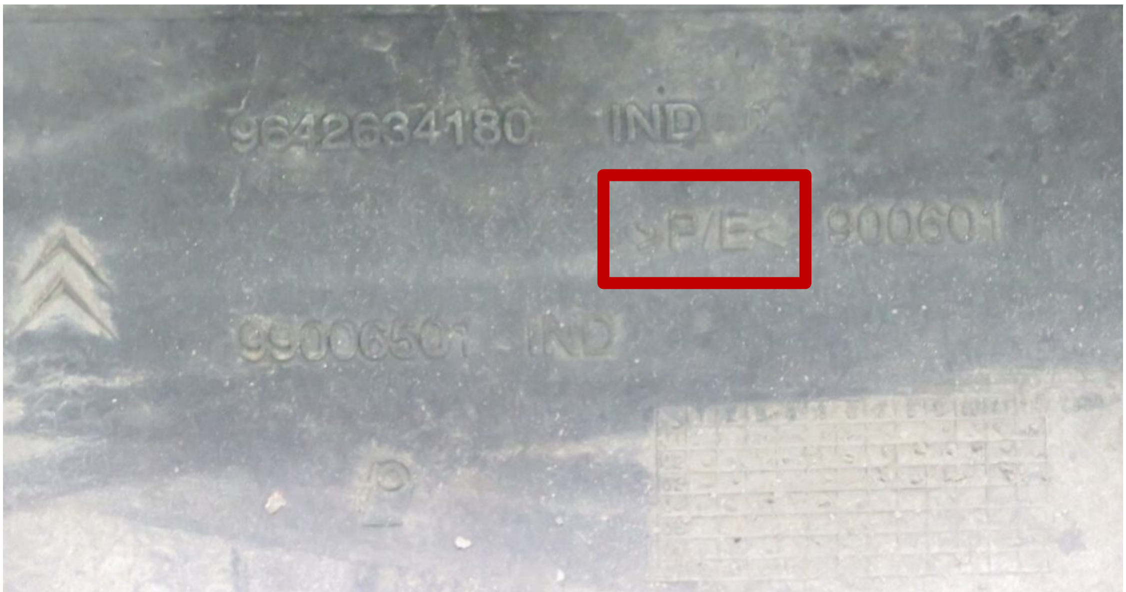

Figure 14. Rear bumper plastic marking P/E.

No seized fasteners or screws were encountered during this demonstration apart from the end fasteners of the front bumper; however, because the main focus was on materials and material markings, the end fasteners were loosened using a pry bar.

4.2 Results of the Weighing

Table 1 presents a list compiled by Muoviteollisuus ry (2016) of plastic grades typically used in vehicles and the components in which they are used.

Taulukko 1. Autoissa käytettävät muovilaadut (Muoviteollisuus Ry 2016).

Lyhenne	Muovin nimi	Käytetty
ABS	akryylinitriilibutadieeni-styreeni	laitekotelot, pölykapselit
ASA	akryylinitrilistyreeni	ulkoiset laitesuojat ja maskit
EPDM	eteeni-propeeni-dieeni-eltomeeri	tiivisteet, värinävaimentimet, hihnat
PA	polyamidi	imusarjat, kotelot, kytkimet, matot, kiinnikkeet, turvavyöt
PC	polykarbonaatti	valot, ikkunat, sähkökomponentit, spoilerit
PE-HD	suuritiheyksinen polyeteeni	lokasuojat, nestesäiliöt
PE-LD	pienitiheyksinen polyeteeni	nestesäiliöiden korkit
PE-LLD	lineaarinen pienitiheyksinen polyeteeni	kaapelien ja johtosarjojen päälliset
PMMA	Polymetyylimetakrylaatti, kestomuovi	takavalot, heijastimet
PP	polypropeeni, kestomuovi	puskurit, kojelaudan ja istuinten osat
PUR	polyuretaani	pehmusteet, sisustusmateriaalit, liimaukset
PVC	polyvinyylikloridi	eristeet, turvatyynyt, teippaukset, korroosionestopinnoitteet
SAN	lasinkirkas akryylinitriili-styreeni	kuten ABS ja ASA

Table 1. Plastic grades used in vehicles (Muoviteollisuus ry 2016).

Abbreviation	Plastic Name	Typical Applications
ABS	acrylonitrile-butadiene-styrene	equipment housings, wheel covers
ASA	acrylonitrile styrene acrylate	external protective covers and grilles
EPDM	ethylene-propylene-diene elastomer	seals, vibration dampers, belts
PA	polyamide	intake manifolds, housings, switches, carpets, fasteners, seat belts
PC	polycarbonate	lights, windows, electrical components, spoilers
PE-HD	high-density polyethylene	fenders, fluid reservoirs
PE-LD	low-density polyethylene	caps for fluid reservoirs
PE-LLD	linear low-density polyethylene	cable and wiring harness sheathing
PMMA	polymethyl methacrylate, thermoplastic	rear lights, reflectors
PP	polypropylene, thermoplastic	bumpers, dashboard and seat components
PUR	polyurethane	padding, interior materials, adhesives
PVC	polyvinyl chloride	insulation, airbags, tapes, anti-corrosion coatings
SAN	transparent acrylonitrile styrene	similar applications to ABS and ASA

Table 2 presents the weighing results for the sorted plastic components.

Table 2. Results of the Weighing.

Plastic Grade	Weight (kg)	Number of Components	Observations
PP	8.7	11	-
PP-TD, PP-MTD	9.88	27	Talc-filled, separated into its own material fraction.
PP-GF	3.96	5	Glass fiber-reinforced, separated into its own material fraction.
PU	-	-	-
PE	26.44	38	Bumpers and door panels were the largest components.
PET	-	-	-
PVC	-	-	-
PC, ABS, SAN, ASA, PMMA	3.28	36	Potentially compatible for blending, collected together. ABS plastic was the most common material.
PA (nylon)	0.34	4	Smallest components.
PA6GFxx	1.14	7	Glass fiber-reinforced PA6, separated into its own material fraction.
No marking.	-	2	Differently colored plastic trim strip on the rear bumper and a rear wiper component.

4.3 Conclusions from the Demonstration

Based on the results of the sorting trial, it can be concluded that source separation should potentially be focused on the largest plastic components by mass, such as bumpers, door panels and other large plastic components, where separate dismantling requirements would be minimized. Dismantling vehicles solely to recover plastic material is unlikely to be economically viable; therefore, plastic recovery should preferably be carried out alongside other dismantling activities. That is, when parts/components are removed from the vehicle for reuse and/or when the vehicle undergoes depollution in accordance with legislative requirements. The compatibility of different plastic blends may be overly complex information for vehicle dismantlers without additional training and clear guidance. Most likely, the key consideration will be which plastic grades generate market demand; therefore, authorized treatment facilities should cooperate with plastic recyclers and vehicle manufacturers. From the perspective of plastic recycling, the following are likely to be important:

- Plastic components should be sorted according to material markings into a limited number of the most common grades, such as PP, PE and ABS.
- Compatibility between different blends should be defined.
- Plastic components should be materially homogeneous.
- Metals, rubber and PUR foams should be removed.
- Plastic components may be broken to accelerate dismantling.

4.4 What Is Recommended for the ERDF Vehicle Dismantling Line 2.0 Project?

Clear dismantling instructions and advance familiarization with the vehicle model would provide clear benefits during dismantling. The process would be faster, as less time would be spent locating screws and determining bolt sizes.

Based on the demonstration, source separation is feasible but, with a high degree of probability, not economically viable as a comprehensive approach to plastic removal. Based on the observations, source separation of plastics could be considered economically viable if carried out as part of other vehicle dismantling activities, where parts/components are removed for reuse and/or remanufacturing. The forthcoming Regulation on end-of-life vehicles requires authorized treatment facilities to remove parts/components intact from end-of-life vehicles for reuse and materials for recycling. Consequently, plastic components will in any case be removed from end-of-life vehicles, and this could contribute towards meeting the 30% plastic recycling requirement.

Dismantling, sorting and documenting the plastics from a single simple vehicle required several hours of work by five workers, and a large proportion of the working time was spent searching for the correct tools, identifying plastic materials, and weighing and documenting the sorted components rather than dismantling the vehicle itself.

A large proportion of the plastic components were relatively easy to access, but certain small components were difficult to reach or required the prior removal of other components. Because the vehicle lift in the dismantling workshop was occupied, access beneath the vehicle was not possible. However, in this vehicle model, this only affected the removal of the fenders. The front fenders were easier to remove, but at the rear, the wheels first had to be removed in order to gain access to the wheel arch liner fasteners. Based on the collected data, it can be concluded that most of the recovered mass originates from large components, such as bumpers and trim components in the doors, dashboard and rear section. From the perspective of the vehicle dismantling line, the most efficient approach could be to remove the doors, bumpers, dashboard and large interior trim components from the vehicle. The doors may, where appropriate, be sold onwards as complete assemblies or dismantled into components outside the dismantling line. Interior trim components must be removed if recovery of the wiring harness is intended. Removing small individual components is slow, and their contribution to total mass is not significant.

5 Background Research

5.1 Guide for the Management of POP Waste 2024

Plastic components known to contain POP compounds should be removed from end-of-life vehicles before shredding. Separation is not necessary if all plastic is directed to energy recovery. Separation should be targeted at vehicles manufactured before 2020, as the use of deca-BDE was prohibited in 2019. Plastics containing bromine can be identified using an XRF analyzer. (Guide for the Management of POP Waste 2024, 93)

The low-bromine fraction may enable separation of polymers suitable for recycling:

- Polypropylene (PP)
- Polyethylene (PE)
- Acrylonitrile-butadiene-styrene (ABS)
- Polystyrene (PS). (Guide for the Management of POP Waste 2024, 93)

5.2 Proposal (2025) for a Regulation of the European Parliament and of the Council on circularity requirements for vehicle design and on the management of end-of-life vehicles, including its annexes.

Summary of Article 6: Minimum Recycled Content Requirements for Vehicles

Article 6 establishes progressively stricter minimum requirements for recycled content in vehicle plastic components. The regulation requires an increasing proportion of recycled plastic produced from post-consumer plastic waste.

This so-called blending obligation for plastics increases gradually and, ultimately, 120 months after the Regulation enters into force, at least 25 weight percent of the plastic content in new vehicles must consist of recycled plastic produced from post-consumer plastic waste, of which 25% must originate from closed-loop recycled material derived from end-of-life vehicles. In addition to the blending obligation, a specific recycling target of 30% will be established for plastics originating from end-of-life vehicles.

Excluded from the calculation are elastomers, all thermosetting plastics based on polyurethane foam except those used as cushioning and insulation materials, and plastics containing persistent organic pollutants (POP substances) above the threshold values defined in Regulation (EU) 2019/1021.

The Article therefore reinforces the EU objective of increasing the mechanical and closed-loop recycling of vehicle plastics and ensuring that a significant proportion of recycled plastic originates specifically from end-of-life vehicles, thereby improving material recovery and reducing the need for virgin plastics. (European Council 2025, 44, 73–74.)

5.3 Handling of End-of-Life Vehicles and Plastics (CIRCUS WP1, RISE)

This preliminary study forms part of the CIRCUS project, which aims to increase the reuse of plastic components and promote circularity in the automotive industry. The study mapped the handling of plastics from end-of-life vehicles (ELVs) in Sweden and Europe, identified plastic materials and components with the highest recycling potential, and evaluated the impacts of the proposed new EU ELV Regulation.

Sweden recycles approximately 160,000 vehicles annually, generating an estimated 24.6 kilotons of plastic. Most of this plastic still ends up as energy waste after shredding, as the cleaning and separation of plastic fractions are considered challenging. Reuse of spare parts, however, already functions very efficiently. Market conditions and insurance company requirements drive dismantling operators to remove all saleable parts, which has increased demand for used parts by 30% in recent years. Material recycling of plastics is not yet implemented in Sweden; however, several operators in Europe, including Axion, Galloo, MBA Polymers and MOCOM, recycle ELV plastics for industrial applications.

The forthcoming ELV Regulation introduces ambitious requirements: new vehicles must contain 25% recycled plastic, of which 25% must consist of closed-loop recycled material originating from ELVs. This represents a substantial increase in the use of PCR plastic and requires new collection and sorting solutions. According to the study, the current plastic stream in Sweden is insufficient to meet the required quantity of recycled plastic, which may result in a need to import recycled materials.

Volvo and Polestar identified PP-based plastics (PP, PP-EPDM, PP-talc), PC/ABS and ABS as materials with particularly high recycling potential. These plastics are common, structurally suitable for mechanical recycling, and supported by the automotive industry’s increasing requirements. The study also proposed priority components: bumpers, side skirt extensions, wheel arch liners, pillar panels and PC/ABS components, which will be investigated further in work packages WP2–WP4.

The study concludes that the Swedish spare parts market already performs well from a circular economy perspective, but material recycling of ELV plastics requires significant development together with new business models, technical solutions and harmonized EU-level regulation. The ambitious recycling targets can only be achieved if dismantling, sorting and recycling infrastructure develop substantially.

5.4 Recycling Disassembled Automotive Plastic Components for New Vehicle Components

This study examines the suitability of mechanically recycled plastic components from end-of-life vehicles (ELVs) as raw materials for new vehicle components. Approximately 80% of ELV plastics in the United States still end up in landfill, despite the increasing quantity of plastic used in vehicles. The objective of the study was to generate measured data on the properties of recycled plastics and evaluate their realistic reuse potential.

The study analyzed four common automotive plastics: polypropylene (PP), talc-filled PP grades (PP-T10 and PP-T20), and mineral- and glass-fiber-reinforced polyamide (PA6 + GF7 + MF13). The components were collected from ELVs, cleaned, granulated and injection molded into test specimens. Particle size, density, thermal analysis, FTIR, mechanical and HDT measurements were performed, and the results were compared with corresponding virgin materials.

According to the results, PP showed the greatest reduction in mechanical performance, with stiffness and tensile strength decreasing by 15–50%. In contrast, filler-reinforced PP grades and glass- and mineral-filled PA6 retained more than 90% of their original stiffness, strength and heat-resistance properties. Small changes were observed in crystallinity and density, but the heat deflection temperature (HDT) remained almost unchanged across all material groups. Variation in material composition between older vehicles and current virgin materials proved to be a significant factor influencing the results.

The study demonstrates that correctly sorted and mechanically recycled ELV plastics—particularly filler-reinforced polypropylenes and polyamides—retain sufficient performance for the manufacture of next-generation vehicle components. This supports the feasibility of closed-loop recycling and may reduce waste generation and raw material costs. Further studies are required, including broader testing (e.g. impact toughness and flexural strength), together with quantitative assessment of environmental impacts and economic viability.

5.5 Closing the Loop on Automotive Plastics: From End-of-Life Vehicles to Circular Material Streams

The study is based on an industrial pilot carried out by the Global Impact Coalition (GIC) between 2024 and 2026, in which eight companies from the chemical and waste management sectors processed 100 end-of-life vehicles through a dismantling–shredding–sorting chain. The objective of the study was to determine whether it is technically possible to recover plastics originating from end-of-life vehicles into material streams of sufficiently high quality for use as raw materials in new vehicles.

The pilot applied a component-based approach: approximately 35 predefined components per vehicle were dismantled and grouped into 22 plastic streams according to their assumed polymer composition. The components were shredded, sorted using optical and sensor-based technologies (including the Unisort Blackeye system), and subsequently directed to evaluation for mechanical and chemical recycling. The pilot was intentionally conducted without access to vehicle manufacturers' material databases in order to reflect the actual operating conditions currently faced by dismantling facilities.

The key finding of the study is that closed-loop recycling of vehicle plastics is technically feasible but not yet economically viable. The pilot succeeded in recovering more than 50% of the plastic mass from the vehicles (approximately 8 tons from 100 vehicles), and particularly large components such as bumpers, protective panels and seats proved highly suitable for recovery.

However, material quality remained below automotive industry requirements in many cases. Multi-material structures, surface coatings, glass and mineral fillers, and various impurities reduced sorting performance and lowered the yield of usable recycled material. For example, the purity of polycarbonate fractions was too low for most automotive applications without additional processing, and in the case of polypropylene, separation of different filled and blended PP grades proved to be a critical challenge.

Economic analysis showed that dismantling and processing plastics currently costs up to 75% more per kilogram than the level required for an economically sustainable business model. Consequently, cost reduction is a key prerequisite for large-scale implementation of closed-loop recycling.

The most significant finding of the study is not an individual technical bottleneck but rather a lack of system-level coordination. A structural contradiction exists within the value chain: vehicle manufacturers define material requirements but do not control the end-of-life phase; dismantlers control material flows but lack incentives to invest in plastic recovery; and the chemical industry requires consistent feedstock, which the current system does not provide.

The study shows that, in the short term, the greatest potential lies in focusing on a limited set of high-volume and high-value components and combining mechanical and chemical recycling. In the long term, common quality and material standards, improved vehicle design from the perspective of recyclability, and new business models that distribute costs and benefits across value-chain actors will be decisive.

Overall, the study provides academically and industrially robust evidence that the recycling targets introduced through regulation are technically achievable, but their implementation requires substantial economic, organizational and institutional changes across the entire vehicle circular economy system.

6 References

Closing the loop on automotive plastics: From end-of-life vehicles to circular material streams. Global Impact Coalition Automotive Plastics Circularity Project Report. Geneva: Global Impact Coalition. Accessed 23 April 2026. https://globalimpactcoalition.com/gic-automotive-plastics-circularity-pilot-report/

European Council. 2025. Opinion on the proposal for a Regulation of the European Parliament and of the Council on circularity requirements for vehicle design and on the management of end-of-life vehicles, amending Regulations (EU) 2018/858 and 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC. Accessed 9 April 2026. https://data.consilium.europa.eu/doc/document/ST-10092-2025-INIT/fi/pdf

Lindqvist, K. & Boss, A. 2024. *Handling of end-of-life cars and the plastics: Report WP1, CIRCUS project.* RISE Research Institutes of Sweden. Accessed 9 April 2026. Report not publicly available.

Meshkat, N., Korey, M., Hubbard, A.M., Slavny, K., Anilal, A.L.S., Das, A., Kearney, L., Ozcan, S. & Vaidya, U. 2025. *Recycling Disassembled Automotive Plastic Components for New Vehicle Components: Enabling the Automotive Circular Economy*. Accessed 9 April 2026. Available at: https://www.researchgate.net/publication/395844525_Recycling_Disassembled_Automotive_Plastic_Components_for_New_Vehicle_Components_Enabling_the_Automotive_Circular_Economy

Guide for the Management of POP Waste 2024. Publications of the Ministry of the Environment 2024:24. Helsinki. Ministry of the Environment. Accessed 9 April 2026. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/165706/YM_2024_24.pdf?sequence=1&isAllowed=y

Talvensaari, K. 2017. Recycling Automotive Plastics: Bumpers as Raw Material for 3D Printing Bachelor’s Thesis (UAS). Turku: Turku University of Applied Sciences Accessed 9 April 2026. https://urn.fi/URN:NBN:fi:amk-2017061613717