

Feasibility Study on Enhancing the Circularity of Truck Cabins (CIRCAB)

Public report

Project within Circularity- FFI- autumn 2024

Author Farazee Asif, Jonny Gustafsson, Lotta Jähkel, Lars Jerpdal and Michael

Lieder

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FFI in short

FFI, Strategic Vehicle Research and Innovation, is a joint program between the state and the automotive industry running since 2009. FFI promotes and finances research and innovation to sustainable road transport.

For more information: www.ffisweden.se

List of Acronyms and Abbreviations:

Acronym	Description
DRS	Deposit Return Systems
ELV	End of Life Vehicles
EoL	End-of-Life
EPS	Expanded Polystyrene
HDPE	High-Density Polyethylene
LDPE	Low-Density Polyethylene
LLDPE	Linear Low-Density Polyethylene
PC ABS	Polycarbonate Acrylonitrile-Butadiene-Styrene (thermoplastic alloy)
PC PBT	Polycarbonate (PC) and Polybutylene Terephthalate (PBT).
PET	Polyethylene Terephthalate
PP	Polypropylene
PP GF 30%	Glass Fiber reinforced Polypropylene
PP Minerals 20%	Polypropylene reinforced with 20% mineral fillers
PP mix	Polypropylene mix
PVC	Polyvinyl Chloride
PPWR	Packaging and Packaging Waste Regulation
PS	Polystyrene
PU	Polyurethane
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SUPD	Single-Use Plastics Directive
SUV	Sport Utility Vehicle
WSR	Waste Shipment Regulation

1. Summary

The shift to a Circular Economy (CE) is crucial for addressing resource scarcity, price volatility, and environmental impacts. By 2030, CE could reduce the EU's material consumption by 32% and greenhouse gas emissions by 48%. However, remanufacturing which is a key strategy in CE remains low, with a remanufacturing intensity of just 1.1%, in the EU automotive sector.

SCANIA, like other OEMs, remanufactures limited components, while truck cabins, with their complex material mixes and high emissions, remain largely unexplored in terms of circularity. Most cabin components, including up to 300 kg of plastics per cabin, are incinerated or landfilled at end-of-life (EoL). There is an economic and environmental opportunity in reusing, refurbishing, or recycling cabin components.

To optimize cabin circularity and business potential, understanding current material flows and developing a circular business model is critical. The CIRCAB project aimed at studying the feasibility of enhancing cabin circularity by creating an ecosystem with value chain partners to optimize material handling at every stage.

The CIRCAB project concluded with its intended outcomes, including extensive knowledge about the current state of plastic flows across different actors, industrial best practices, business drawbacks and the potential for reusing plastic components from production and end-of-life (EoL) trucks, technological limitations and opportunities in recycling, and legal frameworks promoting the circularity of plastics used in the automotive sector. The CIRCAB project has concluded with a strong urge and commitment for a radical shift that is needed to enhance the circularity of plastic components.

2. Sammanfattning på svenska

Övergången till en cirkulär ekonomi (CE) är avgörande för att hantera resursbrist, prisvolatilitet och miljöpåverkan. Fram till år 2030 kan en cirkulär ekonomi minska EU:s materialförbrukning med 32 % och växthusgasutsläppen med 48 %. Trots detta är återtillverkning, som är en central strategi inom CE, fortfarande begränsad till endast 1,1 % inom den europeiska fordonssektorn.

SCANIA, liksom andra fordonstillverkare (OEM), återtillverkar endast ett begränsat antalkomponenter, medan lastbilshytter, med sina komplexa materialblandningar och höga utsläpp, inte blivit undersökta ur ett cirkularitetsperspektiv. De flesta hyttkomponenter – inklusive upp till 300 kg plast per hytt – förbränns eller deponeras vid

livscykelns slut (End-of-Life, EoL). Här finns både ekonomiska och miljömässiga möjligheter i att återanvända, renovera eller återvinna hyttkomponenter.

För att optimera hyttens cirkularitet och affärspotential är det avgörande att förstå de nuvarandematerialflödena och att utveckla en cirkulär affärsmodell.

Projektet CIRCAB syftade till att undersöka möjligheten att öka hyttens cirkularitet genom att skapa ett ekosystem med värdekedjepartners för att optimera materialhanteringen i varje steg av livscykeln.

Projektet CIRCAB avslutades med sina avsedda resultat, inklusive omfattande kunskap om det nuvarande tillståndet för plastflöden mellan olika aktörer, bästa industriella praxis, affärsmässiga hinder och potentialen för att återanvända plastkomponenter från produktion och uttjänta lastbilar (EoL). Projektet identifierade även teknologiska begränsningar och möjligheter inom återvinning, samt rättsliga ramar som främjar plastcirkularitet inom fordonssektorn.

CIRCAB-projektet avslutades med en stark uppmaning och ett tydligt engagemang för dengenomgripande förändring som krävs för att öka cirkulariteten hos plastkomponenter.

3. Background

The shift to a Circular Economy (CE) is essential to address resource scarcity, price volatility, and environmental impacts. By 2030, CE could reduce the EU's primary material consumption by 32% and greenhouse gas emissions by 48%.^{1,2} The European Environment Agency estimates business benefits from CE could range from EUR 245 billion to EUR 604 billion.³ However, remanufacturing, which is one of the main strategies for CE, remains low in the EU automotive sector, with a remanufacturing intensity of just 1.1%, focused on a few common components.⁴

Like many other Original Equipment Manufacturers (OEMs), SCANIA remanufactures a few common components, but large parts of the truck, especially the cabin, remain largely unexplored in terms of circularity. The truck cabin, in particular, represents significant mass, complex material mixes, and emissions during production and at the end-of-life (EoL) stages. The EoL management of most cabin components is unknown to SCANIA. In some cases, cabin components such as plastics, up to 300 kg per cabin, are incinerated in the best scenarios.

While there is a need for a better handling strategy for all cabin components throughout the cabin value chain and particularly at their end-of-life to reduce environmental

¹ Ellen MacArthur Foundation, n.d. The circular economy in detail, Deep dive [WWW Document]. URL <https://ellenmacarthurfoundation.org/the-circular-economy-in-detail-deep-dive#:~:text=The>, accessed 3.8.23).

² McKinsey, 2015. Europe's circular economy opportunity. McKinsey & Co. 1–7.

³ European Environment Agency, 2016. Circular economy in Europe - developing the knowledge base, Publication Office of the European Union.

⁴ Parker, D., Riley, K., Robinson, S., Symington, H., Tewson, J., Jansson, K., Ramkumar, S., Peck, D., 2015. Remanufacturing Market Study, European Remanufacturing Network. <https://doi.org/EC--09 404 ERN WP2.2.docx>

impacts, a substantial economic potential exists in reusing cabin components as spare parts, either through direct reuse, refurbishment or recycling. To maximize business potential and optimize circularity, it is essential to understand the current material flow streams and the potential circular flow of cabin components to develop a viable business model. This is an essential value (waste) management and business model that is currently lacking in efforts to enhance the circularity of cabins.

Furthermore, regulations concerning the handling of plastics, particularly from end-of-life (EoL) vehicles, are becoming increasingly stringent. Among others, one of the new proposals in the revised EoL directives is to increase the recycled content in vehicles, including heavy trucks, to 25% with a portion of this required to come from closed-loop recycling within the automotive sector.

Currently, less than 1% of cabins are reused or refurbished. While 60% of the cabin mass is recycled as low-quality metal, 40%, mainly plastics and electronics, is incinerated or landfilled. Given that cabins make up 25% of a truck's value, improving cabin circularity could drive significant economic and environmental benefits for SCANIA, especially in Europe's €700 million dismantling industry.

This creates an economic and environmental imperative, aligned with upcoming regulations, to explore the feasibility of enhancing the circularity of plastics in trucks. However, to make this possible, a joint effort is needed from the core value chain actors. Therefore, CIRCAB included a Tier 1 supplier, manufacturer, service provider, dismantler, recycler, and recycled-material compounder, covering all lifecycle stages including part supply, production, use, dismantling, and end-of-life (EoL), with a focus on plastics.

4. Purpose, research questions and method

The purpose of this research is to study the feasibility of enhancing the circularity of truck cabins by establishing an ecosystem that involves relevant value chain partners to ensure optimized material handling at different stages of the cabin lifecycle.

Aligned with this purpose, the pre-study project **CIRCAB** was launched to generate new knowledge by addressing the following research questions:

1. What is the current state of circularity of plastic components within the ecosystem of the CIRCAB project partners and in the wider automotive sector?
2. What are the challenges associated with plastic circularity?
3. What are the existing and emerging legal requirements regarding plastics circularity?
4. What actions are needed to enhance the circularity of automotive plastics?

A qualitative research approach was adopted to answer these questions. Since the study primarily focuses on exploring existing knowledge and theories, focus groups and individual interviews with domain experts were considered the most appropriate methods. A semi-structured format with predefined goals and questions was used to guide the interviews while allowing sufficient flexibility to incorporate relevant insights.

For the literature review, internet searches were conducted, as the review focused specifically on legal aspects and industrial best practices, making this approach an appropriate and sufficient tool.

5. Disclaimer

During the course of the project, data were collected on the current state of material inflows, outflows, and waste streams related to plastic components. However, due to the sensitive nature of this information, the data are not disclosed in this report.

Initially, the project aimed to conduct both an economic and environmental analysis of the proposed improvements. However, it became evident at an early stage that the circularity of plastics in the automotive sector faces several fundamental challenges, such as the absence of a straightforward infrastructure for sorting plastics, limited supply chains for plastic collection, and a lack of established applications for recycled plastics.

Under these circumstances, conducting a detailed economic and environmental performance analysis was deemed impractical. Instead, the project focused on identifying feasible pilot initiatives and engaging relevant stakeholders across the value chain to build the necessary foundation for future large-scale implementation.

6. Objective

The CIRCAB project studied the feasibility of enhancing the circularity of truck cabins by establishing an ecosystem that engages relevant value chain partners to optimize material handling across all stages of the cabin lifecycle. Building on extensive insights from the project, CIRCAB aimed to address the complex challenges associated with the reuse and recycling of plastics in the automotive sector.

The project developed a comprehensive understanding of existing material flows, industrial practices, and technological and business barriers that hinder plastics circularity. Current recycling systems for automotive plastics are limited by fragmented supply chains, insufficient collection and sorting practices, and economic constraints such as high minimum batch volumes and low allowable recycled content. To overcome these barriers, CIRCAB emphasizes the importance of collaboration among manufacturers, suppliers, recyclers, and policymakers to create viable and scalable circular solutions.

CIRCAB further aimed at exploring the possibility of innovation in plastic recovery and reuse by testing new business models, exploring digital tools for traceability and material management, and developing logistics and sorting systems to support high-quality recycling. The project also aligned itself to the regulatory landscape, such as the revised End-of-Life Vehicle Directive, which mandates that 25 percent of plastics in vehicles must be recycled by 2035—underscoring the urgency for industry transformation. Through this collaborative and systemic approach, CIRCAB aimed at laying the groundwork for taking steps in advancing circularity, sustainability, and competitiveness in the heavy-vehicle industry.

7. Results and deliverables

The results of this project are organized in light of the research questions, thoroughly discussing the current state of plastics circularity, the challenges associated with it, the legal requirements, and the steps needed to enhance circularity.

7.1 Current state of plastic circularity:

Plastic circularity across the value chain:

Plastic components in trucks weigh over 500 kilograms and are distributed throughout the vehicle, as shown in Figure 1. The cabin, in particular, contains more than half of these plastics, making it an important area of focus. These plastics enter the waste stream through production scrap, after-sales spare parts replacing faulty components in workshops, and the dismantling of end-of-life (EoL) vehicles.

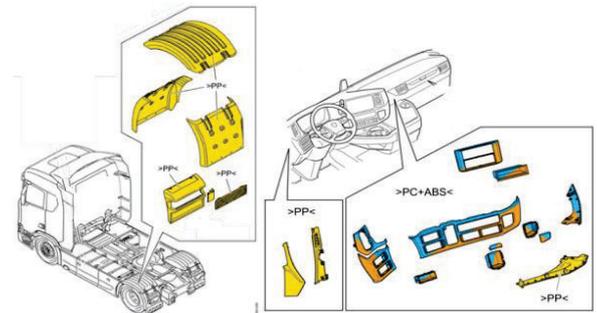


Figure 1: Illustration of plastic components installed in the truck cabin and around the wheels.

An ideal circular system in this context would ensure that plastic components still functioning properly, especially production scrap and components dismantled from EoL trucks, are reused, while non-functional components are recycled. To understand the current state of plastics circularity, several sources where waste streams originate were visited and observed. These included the Scania cab production site in Oskarshamn, the plastic components production site at AQ Plast AB in Anderstorp (one of Scania’s suppliers), and the Scania truck dismantling site in Hovsjö.

At the Oskarshamn site, the assembly line for the overhead shelf (*Takhylla*) was visited. Most assembly areas have designated spaces for sorting different types of waste. All plastics are collected in bins labeled “*plastics with scrap*” (“*plast med skrot*”). The

contents of these bins are transferred daily to a central container outside, which is emptied by the waste-handling company. It was reported that the recycling company shreds the collected plastic waste to recover any metals, after which all plastics are sent for incineration. Due to the high-quality standards in production, plastic components are often discarded even when they are fully functional. These components were of particular interest in exploring potential circular pathways. Although there have been isolated cases where such components were sold through Scania's Used Parts business unit, most follow the same waste stream and are eventually incinerated.

If a vendor-supplied component is found to be defective, the supplier replaces it after receiving a complaint from Scania. However, suppliers are generally unwilling or unable to take back faulty parts for further processing or reuse. Often, they require photographs of the defective components as proof before issuing replacements, which means Scania does not have the right to sell these components even if they seem economically and environmentally more rational.

A visit to a supplier's site provided a clearer picture. In their production process, some plastic waste, mainly the support structures formed during molding, is reused. However, there is a strict requirement that only clean plastics can be reused; if plastics fall on the floor or risk contamination, they are discarded. Additionally, OEMs impose limits that restrict the supplier from reusing more than 20% of plastics from production waste. Beyond this limit, all remaining plastic waste is incinerated.

The situation at the dismantler reflects a conventional used-parts business model, where vehicle components are dismantled from trucks and sold as used parts. Plastic components that still have market demand are inspected and stored on shelves while awaiting purchase. All other plastic components without demand are sorted as "*plastics with scrap*" and sent for incineration after metal recovery. Even the components stored on shelves are periodically discarded if unsold after a certain period, to make room for new parts. It is noteworthy that although a business model and sales channel exist for used parts, none of the reusable plastic components from production waste have ever been sold through this channel.

As described above, the circularity of plastic components is very limited or completely missing across the entire value chain. To gain a better understanding of whether this situation is unique to this value chain, sector, or geographical location, a thorough review of best industrial practices has been conducted, which is discussed in the following section.

Industrial practices of plastic circularity:

In 2022, the overall plastics recycling rate in the EU was estimated at 26.9%, while the share of circular plastics in new products reached 13.5%, representing a significant increase since 2018, although it still accounts for a minority share⁵.

Packaging remains the largest application for plastics, accounting for 19% of the EU's total 83.4 million tonnes of packaging waste. The plastic packaging recycling rate was 41% in 2022, with material recycling showing modest growth over the past decade. In Sweden, about 30% of plastic packaging waste is recycled⁶.

In vehicles, plastics account for approximately 20% of the total weight (200–350 kg per car), primarily consisting of PP, PU, PVC, ABS, PA, and PET⁷. Although the overall end-of-life vehicle (ELV) recycling rate in the EU is around 85%, plastics continue to lag behind metals due to the complexity of shredder residues⁸. Current recycling practices largely rely on voluntary initiatives and OEM–recycler collaborations, though binding quotas are anticipated under the forthcoming ELV Directive⁹.

Recycling Infrastructures and Methods

Kerbside **collection** and bring-bank systems remain the backbone for light packaging such as bottles, trays, and films. Deposit return systems (DRS) for beverage containers are rapidly expanding across Europe, achieving median return rates of around 91%, which enables high-quality rPET and rHDPE recovery, significantly outperforming most other regions¹⁰.

Commercial and industrial plastics, including films and rigid packaging, are often source-separated under contracts, producing higher-quality feedstock than household collections. In the automotive sector, supply chains depend heavily on plastic packaging (films, crates, foams), which is increasingly being replaced with recyclable mono-material solutions, driven by OEM sustainability targets and alignment with the Packaging and Packaging Waste Regulation (PPWR). Vehicles are collected under the ELV Directive (2000/53/EC). Dismantlers remove fluids, batteries, tyres, and certain plastic parts such as bumpers, dashboards, and tanks¹¹.

⁵ “The Circular Economy for Plastics - A European Analysis”, Plastics Europe, March 2024, https://plasticseurope.org/wp-content/uploads/2024/03/CEreport_executivesummary_2024.pdf. Accessed Aug. 28, 2025.

⁶ “41% of plastic packaging waste recycled in 2022”, Eurostat, 24 October 2024, <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20241024-3>. Accessed Aug. 28, 2025.

⁷ “Accelerating the recycling of automotive plastics”, Danish Technological Institute, Press release, 6 August 2024, <https://www.dti.dk/services/accelerating-the-recycling-of-automotive-plastics/46177>

⁸ “Plastics, the circular economy and Europe's environment”, European Environment Agency, 28 January 2021, <https://www.eea.europa.eu/en/analysis/publications/plastics-the-circular-economy-and>

⁹ “Proposal for a Regulation of the European Parliament and of the Council on circularity requirements for vehicle design and on management of end-of-life vehicles, amending Regulations (EU) 2018/858 and 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC”, European Commission, <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52023SC0256>. Accessed Aug. 27, 2025.

¹⁰ “New fact sheet offers insight into performance of deposit return systems”, Reloop, <https://www.reloopplatform.org/new-fact-sheet-offers-insight-into-performance-of-deposit-return-systems/>. Accessed Aug. 28, 2025.

¹¹ Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicle, Article 7, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0053>

For **sorting**, Near-infrared (NIR), eddy current, optical colour, and air-knife systems are used to separate plastics by polymer type and colour (PET, HDPE, PP, and sometimes PS or PVC). Digital watermarking has also been tested to enhance sorting accuracy. These invisible, stamp-sized codes printed on consumer packaging carry detailed material information. In pilot trials, digital watermarking achieved more than 90% sorting accuracy, showing strong potential to improve the efficiency and precision of packaging waste separation^{12,13}.

The recycling landscape is dominated by **mechanical recycling**, which remains the workhorse of plastic recovery. Rigid PET and HDPE, and increasingly PP, make up the majority of current recycling streams. Film recycling (mainly PE) is improving but continues to face challenges due to contamination and multilayer structures. Europe's mechanical recycling capacity now exceeds 13 million tonnes¹⁴, a significant increase from 6 million tonnes in 2017.

For vehicles, a growing number of dismantlers now remove bumpers separately. These are shredded, washed, and compounded into rPP for use in wheel-arch liners, underbody shields, and non-visible interior parts. Seat fabrics and carpets increasingly incorporate rPET from bottles, supported by the abundant supply generated through deposit return systems (DRS). Some recyclers process post-industrial PA from textiles, airbags, and fishing nets into compounds used for engine covers and under-hood parts^{15,16}.

Chemical recycling remains small but is gradually emerging. Europe's installed chemical recycling capacity reached 150,000 tonnes in 2023. The main technologies used are pyrolysis (for polyolefins) and depolymerisation (e.g., converting PET into monomers). The output primarily consists of oils and monomers that re-enter crackers or polymerisation units under mass-balance accounting^{5,17,18}. Pyrolysis of PP and PE from ELV shredder residues is currently at the pilot stage. PET depolymerisation is still largely packaging-driven, although some OEMs are exploring the use of rPET monomers for fibres and films in vehicle interiors¹⁹.

Mechanically and chemically recycled plastics are used in various applications, as presented in Table 1. However, recycled plastics used in new vehicles remain modest, averaging less than 10%. However, several OEMs, including BMW, Renault, Mercedes,

¹²“HolyGrail 2.0 confirms digital watermarking as key to circular packaging”, Innovation News Network, 11 April 2025, <https://www.innovationnewsnetwork.com/holygrail-2-0-trials-digital-watermarking-key-to-circular-packaging/57100/>, Accessed Aug. 28, 2025.

¹³ “Pioneering digital watermarks for smart packaging recycling in the EU”, AIM, <https://www.digitalwatermarks.eu/>, Accessed Aug. 28, 2025.

¹⁴ “EU’s plastic waste mechanical recycling capacity”, European Environment Agency, March 2024, <https://www.eea.europa.eu/en/circularity/sectoral-modules/plastics/eus-plastic-waste-mechanical-recycling-capacity>, Accessed Aug. 28, 2025.

¹⁵“Solvay produces recycled PA from old car parts”, Plastic Recycling Update, <https://resource-recycling.com/plastics/2016/11/29/solvay-produces-recycled-pa-from-old-car-parts/>, Accessed September 5, 2025.

¹⁶“How the Auto Industry Is Embracing Plastic Recycling”, Design News, August 4, 2023,

<https://www.designnews.com/autocomponents/how-the-auto-industry-is-embracing-plastic-recycling>, Accessed September 5, 2025.

¹⁷“Plastics recycling industry figures 2023”, Plastic Recyclers Europe, https://www.plasticrecyclers.eu/wpcontent/uploads/2024/11/Plastics-Recycling-Industry-Figures_2023.pdf, Accessed Aug. 28, 2025.

¹⁸“Position paper: Recycling technologies for plastics”, Fraunhofer CCPE, https://www.ccpe.fraunhofer.de/content/dam/ccpe/de/dokumente/2109_POSITION_PAPER_CCPE_EN.pdf.

¹⁹ “What are the primary end-use industries driving demand for polyethyleneterephthalate (PET) films globally”, Polyethylene Terephthalate Film Market, February 8, 2025, <https://pmarketresearch.com/chemi/polyethylene-terephthalate-film-market/>, Accessed September 5, 2025

and Volvo, have launched pilot programs for incorporating post-consumer PP, PET fibres, and rPA^{20,21,22,23}.

In current practice, most plastics recovered from end-of-life vehicles (ELVs) are either downcycled into lower-grade products such as construction materials, fillers, or composite boards, or sent for energy recovery. This is particularly common for mixed shredder residues, which are difficult to separate efficiently.

Table 1: Typical applications of recycled plastics

Plastic Waste Type	Typical End Products
PET bottles	New bottles, fibres, sheets
HDPE	Non-food bottles, pipes, blow-moulded containers
PP	Crates, buckets, automotive parts, household goods
Films (LDPE/LLDPE)	Garbage bags, construction films, flexible packaging (can be reprocessed into film with compounding upgrades)
PS, PVC, EPS	Insulation materials, profiles, and other construction products

Automotive Plastic Recycling Landscape

The application of recycled plastics in the automotive industry is progressing slowly, but it is happening. For instance, Volvo aims to ensure that 25% of the plastics used in every new Volvo car come from recycled materials starting in 2025²⁴. In 2020, the company presented a prototype to demonstrate what can be achieved. A special Volvo XC60 T8 plug-in hybrid was built with around 170 plastic parts (approximately 60 kg) replaced by recycled materials. The hood absorber, located under the bonnet and designed to reduce noise, was made from plastic foam previously used inside car seats. The seats themselves were produced from recycled plastic bottles, while the carpets and mats were made from fishing nets recovered from the sea. Parts of the luggage compartment were manufactured using recycled ketchup and shampoo bottles.

Kia has set a similar target, aiming for 20% of all plastic parts in its vehicles to be made from recycled plastics by 2030²⁵.

²⁰“The future is neutral, innovating in the circular economy”, Renault Group, <https://www.renaultgroup.com/en/group/brandsentities/the-future-is-neutral>.

²¹“BMW Group sustainability overview - FY 2023”, BMW Group, https://www.bmwgroupwerke.com/content/dam/grpw/websites/bmwgroup_com/ir/downloads/en/2024/bericht/BMW-GroupSustainability-Overview-FY-2023.pdf.

²²“Ambition 2039”, Mercedes Benz Group, <https://group.mercedes-benz.com/sustainability/environment-climate/decarbonisation/ambition-2039-our-path-to-co2-neutrality.html>.

²³“Volvo Cars annual and sustainability report 2023”, Volvo Cars, <https://www.media.volvocars.com/global/en-gb/media/documentfile/324897/volvo-cars-annual-and-sustainability-report-2023>.

²⁴“Volvo Production To Include 25% Of Recycled Plastics”, 10 February 2020, <https://www.dsf.my/2020/02/volvo-production-to-include25-of-recycled-plastics/>, Accessed Sept. 24, 2025.

²⁵“Kia using innovative, sustainable materials in its latest vehicle interiors”, *Plastics Engineering*, 20 October, 2023, <https://www.plasticsengineering.org/2023/10/kia-using-innovative-sustainable-materials-in-its-latest-vehicle-interiors-002397/#1>, Accessed Sep. 24, 2025.

Some additional examples of the application of recycled plastics in the automotive industry for specific plastic types are described below.

PET

PET is commonly used for upholstery yarns, seat fabrics, carpets, headliners, insulation, and other non-structural interior trim components. Typical recycled feedstock includes post-consumer beverage bottles and polyester textile waste. Many car manufacturers already use recycled PET in carpets and other fabric applications^{25,26,27}. As early as 2019, every Ford EcoSport SUV was equipped with carpets made from recycled PET bottles²⁷.

Beverage containers often consist of cardboard lined with thin layers of polyethylene and aluminium. This poly-al combination is now being recycled and used in the central console, dashboard, and interior front and rear door panels of the new Fiat Grande Panda²⁷. The new Audi A6 e-tron also incorporates recycled plastics in several components. For instance, recycled PET is used in headliners, seats, door mirrors, pillars, and sun visors²⁸.

Nylon (Polyamide)

Nylon is used for durable interior textiles, carpets, specialty trims, and sometimes under-hood components such as brackets and fasteners, where heat resistance is required. In 2020, Jaguar Land Rover announced plans to use recycled nylon for floor mats and trims in future models²⁹, although it remains unclear whether this has since been implemented. The regenerated material, marketed under the trade name *Econyl*, is produced by Aquafil. Its feedstock includes industrial plastics, fabric offcuts from clothing manufacturers, and fishing nets sourced from aquaculture as well as those recovered from the ocean. The waste nylon is depolymerised into its raw material and then transformed into nylon yarn. Mercedes-Benz also uses recycled nylon in the floor mats of the S-Class³⁰, and several other car manufacturers are pursuing similar initiatives^{24,25}.

PP

Polypropylene is widely used in the automotive industry for interior trim components such as door panels, consoles, and seat backs, as well as for battery housings, ducting,

²⁶ "Ford turns plastic bottles into carpets to help recycle more than 1 billion drinks containers every year", Ford Media Center, 19 June 2019, <https://media.ford.com/content/fordmedia/feu/en/news/2019/06/19/ford-turns-plastic-bottles-into-carpets-to-help-recycle-more-tha.html>, Accessed Sep. 24, 2025.

²⁷ "Fiat launches industry-first car using recycled material from used beverage cartons", Interplas Insights, 25 June 2025, <https://interplasinsights.com/plastics-materials/automotive-plastics-materials-news/fiat-launches-industry-first-car-using-recycled-material-fro/>, Accessed Sep. 24, 2025.

²⁸ "Sustainable production and materials", Audi Media Center, 28 Juni 2024, <https://www.audi-mediacyter.com/en/the-audi-q6etron-electric-mobility-on-a-new-level-15929/sustainable-production-and-materials-15946>, Accessed Sep. 24, 2025

²⁹ "JAGUAR LAND ROVER WILL USE PLASTIC WASTE IN NEXT-GENERATION SUSTAINABLE LUXURY INTERIORS Jaguar Land Rover will use plastic waste in next-generation sustainable luxury interiors", Jaguar Media Centre, 29 September 2020, <https://media.jaguar.com/en-gb/news/2020/09/jaguar-land-rover-will-use-plastic-waste-next-generation-sustainable-luxury-interiors>, Accessed Sep. 23, 2025.

³⁰ "Recycled materials in vehicle interiors", Automotive Manufacturing Solutions, 2 December 2020, <https://www.automotivemanufacturingsolutions.com/press-and-body/recycled-materials-in-vehicle-interiors/522432>, Accessed Sep. 24, 2025.

certain exterior trims, and underbody shields. By weight, it is the most common plastic used in vehicles.

Automotive manufacturers increasingly use recycled PP in parts such as door panels, dashboard elements, seat backs, and trim pieces³¹. Recycled PP is also applied in exterior components like bumpers, fenders, and grille frames. Volkswagen, for example, incorporates recycled PP in its bumpers.

In the rapidly growing electric vehicle (EV) market, lightweight and durable materials are essential. Recycled PP is often used in the production of battery casings for EVs, Tesla, for instance, uses recycled PP in some of its battery packs. It is also found in components such as engine covers and air filter housings.

Ford Motor Company has long used recycled materials in its vehicles, including recycled PP in bumpers, interior panels, and under-the-hood components. BMW has also used recycled PP for several years in both interior and exterior applications; the BMW i3, for example, features recycled PP in multiple components. Similarly, Volkswagen uses recycled PP in its ID.3 electric car³¹.

ABS

In vehicles, ABS is used for dashboards, interior trim, bezels, instrument panels, and various housings. Recycled ABS granules are commonly used to manufacture dashboard components, interior trims, and bumpers³².

PBT

PBT is used in connectors, electrical housings, under-hood components, and wire harness connectors. Yazaki Corp. and Toray Industries Inc. have developed a chemically recycled PBT formulated specifically for molding connectors in automotive wire harnesses³³. However, it remains unclear whether this material is currently in use by automotive manufacturers.

PC and PC/ABS Blends

Polycarbonate is used in headlamp lenses, instrument clusters, exterior trims, and structural lighting components. Since it is often used in optical applications, recycled feedstock must be of very high purity.

Covestro has developed a PC material containing 50% recycled content sourced from end-of-life car headlamps. Volkswagen and NIO are currently testing this material for use

³¹“Recycled PP for automotive: driving sustainability in the auto industry”,ECO Recycling Today, 2025,

<https://www.recyclingtoday.org/blogs/news/recycled-pp-for-automotive-driving-sustainability-in-the-auto-industry>, Accessed Sep. 24, 2025.

³²“All you need to know about ABS plastic recycling”, Exir, 21 May 2024, <https://exirpolymer.com/abs-recycling-process/>, Accessed Sep. 24, 2025.

³³“Yazaki and Toray Jointly Develops Recycled PBT Resin Grade for Automotive Wiring Harness Connectors Contributing to Carbon Neutrality”,Toray, 14 May, 2024, https://www.plastics.toray/zh/news/article.html?contentId=6on23o1q&utm_source=chatgpt.com, Accessed Sep. 25, 2025.

in future vehicle models³⁴. Samyang Corp. in South Korea has also developed a polycarbonate resin containing more than 90% post-consumer recycled content, targeting both interior and exterior automotive components³⁵.

HDPE

HDPE is used in fuel tanks, fluid containers, and certain ducts. The use of recycled HDPE in the automotive industry is increasing, although specific vehicle models incorporating it have not been disclosed^{36,37}.

PVC

PVC is commonly used in wiring insulation, interior coverings, and seals. Although PVC recycling is technically feasible, it remains complex due to the presence of additives and chlorine content. The industry trend is moving toward PVC alternatives; however, some instances of PVC recycling for automotive applications have been reported^{38,39}.

PU

Polyurethane is widely used in seating foams and insulation. PU is being recycled to a limited extent for use in automotive seating applications^{40,41,42,43,44}, though detailed information on specific vehicle models is not available.

³⁴ “Covestro advances automotive circularity with recycled headlamp materials”, Chemanalyst News, 21 April 2025, <https://www.chemanalyst.com/NewsAndDeals/NewsDetails/covestro-advances-automotive-circularity-with-recycled-headlamp-materials-36029>, Accessed Sep. 25, 2025.

³⁵ “Eco-friendly Polycarbonate Boasts 90% Recycled Content”, PlasticsToday, 13 January, 2023, <https://www.plasticstoday.com/automotive-mobility/eco-friendly-polycarbonate-boasts-90-recycled-content>, Accessed Sep. 25, 2025.

³⁶ “Recycled high-density polyethylene (rHDPE) – properties, applications, and benefits”, Ambio, <https://www.ambiomaterials.com/en/materials/rhdpe>, Accessed Sep. 25, 2025.

³⁷ “An analysis of HDPE tank structure, the use of recycled materials and case studies from major car manufacturers promoting the circular economy”, Rmix, <https://www.rmix.it/news/an-analysis-of-hdpe-tank-structure-the-use-of-recycled-materials-and-case-studies-from-major-car-manufacturers-promoting-the-circular-economy-en/>, Accessed Sep. 25, 2025.

³⁸ “Recycled automotive PVC waste becomes new car heel mats”, Sustainable Plastics, 23 June 2021, <https://www.sustainableplastics.com/news/project-proves-feasibility-closed-loop-pvc-recycling-automotive-industry>, Accessed Sep. 25, 2025.

³⁹ “PVC in automobiles”, Vinyl Council of Australia, <https://www.vinyl.org.au/automotive>, Accessed Sep. 25, 2025.

⁴⁰ “Adient, Jaguar Land Rover and Dow develop closed-loop polyurethane foam seats”, Ardient, 2 Dec. 2024, <https://www.ardient.com/media/news/2024/12/02/ardient-jaguar-land-rover-and-dow-develop-closed-loop-polyurethane-foam-seats/>, Accessed Sep. 25, 2025.

⁴¹ “Grupo Antolin produces headliner from recycled PU materials”, Automotive Interiors World, 22 Nov. 2021, <https://www.automotiveinteriorsworld.com/news/materials/grupo-antolin-produces-headliner-from-recycled-pu-materials.html>, Accessed Sep 25, 2025.

⁴² “Dow, Gruppo Fiori develop new way to recycle car seat foam without vehicle dismantling”, Automotive Dive, 18 Sep. 2025, <https://www.automotivedive.com/news/dow-gruppo-fiori-new-method-recycle-automotive-polyurethane-foam-seats/760438/>, Accessed Sep 25, 2025.

⁴³ “Chemically recycled commercial polyurethane (PUR) foam using 2-hydroxypropyl ricinoleate as a glycolysis reactant for flexibility-enhanced automotive applications”, RSC Advances, 41, 29966 - 29978, (2024), <https://pubs.rsc.org/en/content/articlelanding/2024/ra/d4ra04972a>.

⁴⁴ “Dow introduces polyurethane solutions sourced from recycled raw material to its MobilityScience™ platform in collaboration with Adient and Autoneum”, Dow, 23 June, 2021, <https://corporate.dow.com/enus/news/press-releases/dow-introduces-pu-solutions-sourced-from-recycled-raw-material-to-mobilityscience-platform.html>, Accessed Sep 25, 2025.

Barriers to Using Recycled Plastics in Automotive Applications

There are multiple challenges hindering the uptake of recycled plastics in the automotive sector. Recyclers report persistent issues related to the quality and contamination of incoming materials, including food residues, labels, and incompatible multilayer structures. These impurities reduce yields and negatively affect economic performance. Market volatility and competition from virgin materials also pose challenges. Cheaper virgin imports and energy price spikes further undermine the profitability of recycling facilities. Policy stability and long-term procurement contracts are therefore increasingly critical for maintaining operational viability.

Films and flexible plastics represent a rapidly growing waste stream but remain technically complex to recycle. While mono-material PE designs offer improvements, legacy multi-material structures continue to hinder high-quality outputs. Chemical recycling shows promise for hard-to-recycle streams but currently operates at a small scale and remains both cost- and energy-intensive. The debate continues over its actual climate benefits and how to allocate environmental credits for end products¹⁷.

A large share of plastics remains mixed in shredder residues, which are both technically and economically challenging to recycle. Up to 25% of an end-of-life vehicle's (ELV) mass ends up as shredder residue, composed mainly of plastics and textiles, and is typically landfilled or incinerated.

Automotive-grade polymers require high mechanical strength, dimensional stability, and long service life. Post-consumer recyclates often fall short of these requirements without extensive modification. Additionally, ELV plastics may contain restricted substances such as brominated flame retardants and phthalates, which limit recyclability under REACH regulations^{45,46}.

Furthermore, packaging regulations such as the Single-Use Plastics Directive (SUPD) and the Packaging and Packaging Waste Regulation (PPWR) are redirecting high-quality rPET and rHDPE materials toward packaging applications, leaving the automotive sector struggling to secure a reliable and cost-competitive feedstock supply.

As discussed above, both the state-of-the-art of plastics circularity within the CIRCAB value chain and the review of industrial best practices confirm serious weaknesses in plastics circularity. In light of this, the project investigated the major challenges faced by different value-chain actors to understand what must be done in the short and long term to

⁴⁵ Commission Regulation (EU) 2023/2055 of 25 September 2023 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microplastics. <https://eur-lex.europa.eu/eli/reg/2023/2055/oj/eng>

⁴⁶ "Commission Regulation (EU) 2023/2055 - Restriction of microplastics intentionally added to products", European Commission, https://single-market-economy.ec.europa.eu/sectors/chemicals/reach/restrictions/commission-regulation-eu-20232055-restriction-microplastics-intentionally-added-products_en. Accessed Aug. 22, 2025.

enhance the circularity of plastic components. These findings are presented in the section below.

7.2 Challenges associated with plastic circularity:

The project team visited the facilities of several stakeholders, including Scania’s Cab Production, a Tier 1 supplier, a compounder, a recycler, and a dismantler, to gain a comprehensive understanding of the current state of plastic recycling.

The team also had the opportunity to host a workshop called Framgångsboosten in Anderstorp, which was attended by stakeholders beyond the CIRCAB project. Participants included companies responsible for collecting, sorting, and producing recycled raw materials, companies that produced finished granulates from these materials, and companies that manufactured products from both virgin and recycled plastics.

In addition, during the course of the project, two more recyclers/compounders were interviewed to collect complementary information. These visits and interactions revealed a set of critical challenges that need to be addressed to enhance the recycling of plastics—particularly high-performance plastics used in automotive applications.

The outcomes of these visits, interviews, and the workshop are presented below as the main challenges identified from the perspectives of different stakeholders.

Manufacturer’s Perspective

- A cabin consists of more than 10 different types of complex plastics, and sorting them into their respective fractions is not feasible with the current infrastructure.
- There is no supply chain in place for reusing or recycling plastics.
- There is no knowledge, time, resources or infrastructure to sort plastics to different types.
- Only basic material sorting is possible.
- The volume of waste is not large enough to justify establishing a dedicated system for a different purpose.
- There is no interest from the suppliers of the plastic components, or no supply chain in place to return the components that are wasted in the production.
- The quality of components made from recycled plastics has never been thoroughly tested or validated. Therefore, there is a knowledge gap regarding the use of recycled plastics in new components.

Plastic Parts Supplier's Perspective

- Customers do not allow the use of recycled content beyond a certain level (e.g., a maximum of 20%).
- Collecting rejected plastic components from customers is not economically feasible due to their low volume.
- Since customers cannot sort plastics by type, mixed plastics are not usable for producing new components.
- Parts coming from external sources pose a risk of contamination and require a dedicated industrial cleaning process, which is not feasible in the current context.

Plastic Compounder's perspective

- There is a lot of discussion, but only a few companies show genuine interest in using recycled plastics.
- To offer a specific type of plastic compound, a minimum batch size of that plastic, supplied within a certain time frame to ensure continuous flow, is required — a requirement that many customers find too high to meet.
- An intermediate actor is needed to shred and clean the plastics before they can be processed.
- Due to limited availability, producing a specific type of plastic compound made entirely from recycled plastics is often not possible.

Plastic Recyclers' perspective

- Recyclers' processes are optimized for a few specific types of plastics, mainly post-consumer plastics such as PET, HDPE, and PVC.
- Recyclers require a high volume and continuous flow of the same types of plastic waste to achieve economies of scale and make recycling economically feasible.
- The low cost of virgin plastics creates tough competition for plastic recyclers.
- Large recyclers use cold-water washing of plastics, which restricts the process to only plastics that float in water.
- Recyclers often lack the resources and technologies to sort plastics into specific types.
- Long transport distances for plastic waste significantly reduce the potential economic benefits of recycling.
- There is limited understanding among customers and the general public about the benefits and profitability of using recycled plastics.
- Political decisions and regulations do not always have the intended effect, creating uncertainty and inconsistency for recyclers.

EoL Tuck Dismantler's Perspective

- There is insufficient knowledge, time, resources, and infrastructure to sort plastics by type.
- Even when these factors are in place, identifying plastic types is often difficult due to dirt and contamination in components dismantled from end-of-life (EoL) trucks.

While the volume of waste-plastic streams is a key challenge for the economic feasibility of recycling, it cannot be used as an excuse to avoid recycling plastics that are not currently recovered, especially under increasing legislative pressure. As national and EU-level regulations become tighter, there is no alternative to enhancing plastics circularity across industrial sectors. The following section outlines the relevant legislative frameworks—both directly and indirectly influencing the automotive sector—that require manufacturers to improve the circularity of plastics used in vehicles.

7.3 Legal requirements regarding plastics circularity

This section summarizes the legal frameworks that affect—and are anticipated to affect—the handling of plastics in the automotive sector. Please note that this summary reflects the authors' views and interpretations and is provided for informational purposes only. For legal purposes, refer to the original documents cited in the references.

A major share of plastics used in the European Union goes to packaging. According to 2010–2021 statistics, about 40% of packaging in the EU is plastic. Most plastics used are primary (virgin) materials. Packaging also accounts for 36% of municipal solid waste⁴⁷. The automotive industry also generates plastic packaging waste from logistics, spare parts, and aftermarket activities. Therefore, improving circularity in the sector requires close attention to all plastics, including how packaging plastics are managed.

Key EU instruments that are relevant for automotive sector are:

- **Packaging and Packaging Waste Regulation (PPWR)** – in force since 11 Feb 2025; reshapes Europe's plastics-recycling rules and sets new requirements for packaging design, collection, and recycling.
- **Single-Use Plastics Directive (SUPD)** – primarily addresses items such as plastic beverage bottles and associated collection/recycling targets.
- **REACH** – restricts intentionally added microplastics in products such as abrasives, adhesives, paints, coatings, and sealants.

⁴⁷ Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC. <https://eur-lex.europa.eu/legal-content/EN-SL/ALL/?from=EN&uri=CELEX%3A32025R0040>

- **Waste Shipment Regulation (WSR)** – prohibits exports of plastic waste to non-OECD countries, necessitating treatment within OECD markets.
- **End-of-Life Vehicles (ELV) directive** – the current directive 2000/53/EC⁴⁸ is expected to be replaced by a new regulation in 2027, with mandatory recycled-content quotas for plastics in new vehicles from 2030⁴⁹.

Packaging and Packaging Waste Regulation (PPWR)

Regulation (EU) 2025/40 entered into force on 11 Feb 2025 and applies generally from 12 Aug 2026 (with staged dates for specific duties)⁴⁷. It covers the entire packaging life cycle and replaces the Packaging and Packaging Waste Directive 94/62/EC (PPWD)⁵⁰. Because the legal form changes from a directive to a regulation, the rules will apply uniformly across all EU Member States, reducing national variation in implementation.

Through the PPWR, Europe is moving from aspirational recycling targets to enforceable obligations on design, recycled content, and collection, with export constraints that ensure more plastic waste is treated according to EU standards.

Key legal obligations affecting plastics recycling

- **Recyclability by 2030:** All packaging must be recyclable by 2030. The Commission will adopt delegated acts defining design-for-recycling (DfR) criteria and performance grades (adoption due before 2028, followed by a compliance timeline). DfR becomes a legal condition for market access⁵¹.
- **Minimum recycled content:** Plastic packaging must contain a minimum share of recycled plastic in 2030 and 2040. Levels differ by packaging category, with special rules for contact-sensitive applications^{52,53}.
- **EU-wide labelling:** Common labels for material identification and sorting (including digital tools) to improve consumer separation and feed cleaner recycling streams⁵⁴.
- **EPR harmonisation and fee modulation:** Stricter requirements on extended producer responsibility (EPR) schemes, including eco-modulated fees linked to

⁴⁸ Directive 2000/53/EC of the European parliament and of the council of 18 September 2000 on end-of life vehicle, Article 7, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0053>.

⁴⁹ “Proposal for a Regulation of the European Parliament and of the Council on circularity requirements for vehicle design and on management of end-of-life vehicles, amending Regulations (EU) 2018/858 and 2019/1020 and repealing Directives 2000/53/EC and 2005/64/EC”, European Commission, <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX%3A52023SC0256>.

⁵⁰ European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste, European Union, <https://eur-lex.europa.eu/eli/dir/1994/62/oj/eng>.

⁵¹ “The New EU Packaging and Packaging Waste Regulation – Highlights and Challenges Ahead”, Keller and Heckman LLP, <https://www.khlaw.com/insights/new-eu-packaging-and-packaging-waste-regulation-highlights-and-challenges-ahead>

⁵² “Packaging Waste”, European Commission, https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en

⁵³ “PPWR Survival Guide”, The European Organisation for Packaging and Environment (European) AISB, <https://www.europen-packaging.eu/wp-content/uploads/2025/01/EUROOPEN-PPWR-survival-guide-May-2025.pdf>

⁵⁴ “Packaging Waste Regulation - Boosting business and protecting the planet”, European Commission, https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste/packaging-packaging-waste-regulation_en

recyclability/performance grade—financially favouring packaging that actually recycles. Historic target architecture from the old directive remains as context⁵⁵.

Packaging placed on the EU market will increasingly require third-party-verifiable recycled-content accounting and conformity with DfR criteria, shifting procurement toward traceable, high-grade recyclates and standardised proofs of compliance.

Single-Use Plastics Directive (SUPD)

The Single-Use Plastics Directive (SUPD) will remain in force alongside (PPWR). While it primarily imposes bottle-specific obligations, less directly relevant to the automotive industry, it is mentioned here for completeness.

- **Recycled content requirements:** PET beverage bottles must contain at least 25% recycled PET (rPET) by 2025, and all plastic beverage bottles must contain at least 30% recycled plastic by 2030 (averaged at the Member State level)^{56,57}
- **Collection targets:** Separate collection rates must reach 77% by 2025 and 90% by 2029, typically achieved through deposit return systems (DRS) or equivalent measures^{56,57}.
- **Design requirements:** Tethered caps are mandatory to reduce litter and improve collection efficiency^{56,57}.
- **Counting and verification:** The European Commission has established rules for calculating, verifying, and reporting recycled content in SUP bottles and is consulting on additional provisions to explicitly accommodate chemical recycling and mass balance approaches^{58,59}.

Waste Shipment Regulation (WSR) — exports and trading recyclables

The 2024 recast of the Waste Shipment Regulation (EU) 2024/1157 introduces stricter controls on waste shipments. Crucially, it prohibits the export of plastic waste to non-OECD countries from 21 November 2026, with the possibility for certain non-OECD states to requalify under strict environmental and traceability conditions.

Exports to OECD countries will also be subject to enhanced scrutiny and prior-notification procedures, curbing the offshoring of low-grade plastics and redirecting materials toward EU/EEA-based treatment or other high-standard recycling destinations.

⁵⁵ “Packaging and Packaging Waste Regulation (PPWR)”, European Commission, https://environment.ec.europa.eu/document/download/63fd2c88-e85a-412c-bcf4-372eff99008a_en?filename=Slides%20for%20the%20SH%20event%2010122024.pdf

⁵⁶ “Single-use Plastics”, European Commission, https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en

⁵⁷ “Single-use plastics – fighting the impact on the environment”, EUR-Lex, European Commission, <https://eur-lex.europa.eu/EN/legal-content/summary/single-use-plastics-fighting-the-impact-on-the-environment.html>

⁵⁸ “SUPD & PPWR Update on plastics”, European Commission, <https://www.iscc-system.org/wp-content/uploads/2025/02/SUPD-and-PPWR-%E2%80%93-Update-on-Regulatory-Developments-%E2%80%93-Werner-Bosmans-Policy-Officer-DG-ENV-European-Commission-Belgium.pdf>

⁵⁹ “Plastic waste: Commission consults on new rules for chemically-recycled content in plastic bottles”, European Commission, 8 July 2025, https://environment.ec.europa.eu/news/commission-consults-new-rules-chemically-recycled-content-plastic-bottles-2025-07-08_en

This measure is expected to strengthen local recycling markets, though it will also increase compliance demands for transboundary waste movements^{60,61}.

For the automotive industry, this means that plastic waste such as bumpers, dashboards, and shredder residues must be processed within the EU or OECD countries starting 21 November 2026.

Key implications include:

- Ban on plastic waste exports to non-OECD countries (from Nov 2026), limiting the offshoring of mixed automotive plastics. OEMs will therefore need to develop EU-based recycling partnerships for materials such as bumper covers, dashboards, and PP/ABS blends.
- Increased competition for high-grade recyclates (e.g., post-consumer PP, rABS, rPET) due to the growing demand from packaging and consumer goods sectors driven by SUPD and PPWR mandates. Automotive supply chains will need to secure recycle supply early to avoid future shortages.

Chemicals and Product-Safety Rules Shaping Recyclability (REACH)

Commission Regulation (EU) 2023/2055 introduces a staged ban on intentionally added microplastics in products and mixtures, aiming to reduce secondary microplastic pollution and promote the development of safer, alternative formulations under the REACH framework^{62,63}.

Recycling processes for plastics used in food-contact materials, such as recycled PET, require process-level authorisation under Regulation (EU) 2022/1616. This involves assessment by the European Food Safety Authority (EFSA) and inclusion in EU registers. The regulation determines which recycled plastic streams can be safely used in food packaging and significantly affects demand and pricing for food-grade rPET⁶⁴.

⁶⁰ Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste, amending Regulations (EU) No 1257/2013 and (EU) 2020/1056 and repealing Regulation (EC) No 1013/2006.

<https://eur-lex.europa.eu/eli/reg/2024/1157/oj/eng>

⁶¹ “Plastic waste shipments”, European Commission, https://environment.ec.europa.eu/topics/waste-and-recycling/waste-shipments/plastic-waste-shipments_en

⁶² Commission Regulation (EU) 2023/2055 of 25 September 2023 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microplastics. <https://eur-lex.europa.eu/eli/reg/2023/2055/oj/eng>

⁶³ “Plastics - Environmental Aspects - Vocabulary”, CEN Standard EN 17615:2022, https://standards.iteh.ai/catalog/standards/cen/ba1cc690-d5eb-4a30-95de-2de4e12639dd/en-17615-2022?srsId=AfmBOoqyhYjGaujoEOma8uNkuWRE_XPkajph9g13crodo5CHxJW-Vv

⁶⁴ “Commission Regulation (EU) 2023/2055 - Restriction of microplastics intentionally added to products”, European Commission, https://single-market-economy.ec.europa.eu/sectors/chemicals/reach/restrictions/commission-regulation-eu-20232055-restriction-microplastics-intentionally-added-products_en

The automotive industry may be impacted from 2026, when bans on certain microplastics used in coatings and additives come into force. A broader ban on microplastics in industrial applications, such as abrasives, adhesives, and sealants, will follow in 2028.

The use of recycled plastics in vehicles is further constrained by restrictions on legacy additives, including phthalates, brominated flame retardants, and other Substances of Very High Concern (SVHCs). Recyclers must demonstrate compliance through input material control and chemical testing⁶⁵.

While REACH has less direct relevance to structural plastics, it does affect tyres (due to wear particles) and surface coatings, requiring suppliers to redesign formulations to reduce intentional microplastic content.

Additionally, OEMs are under increasing pressure to integrate Digital Product Passports (DPPs), which will include detailed information on material composition and recycled content, aligning with the Ecodesign for Sustainable Products Regulation (ESPR).

End-of-Life Vehicle (ELV)

While EU plastics legislation has traditionally focused on packaging, the automotive industry now faces a growing set of regulatory requirements related to recycled content, end-of-life vehicle (ELV) management, waste shipment, and chemical compliance, all of which directly affect the use of plastics in vehicles.

New EU frameworks—such as the Packaging and Packaging Waste Regulation (PPWR), the Single-Use Plastics Directive (SUPD), and the Waste Shipment Regulation (WSR)—are creating strong market pressure for recycled plastics (recyclates). At the same time, the ongoing recast of the ELV Directive is expected to introduce mandatory recycled-content requirements for plastics in new vehicles.

In combination with REACH restrictions (e.g., bans on microplastics and limits on legacy additives in recyclates) and national taxes on virgin plastics, the regulatory environment is increasingly compelling OEMs and suppliers to integrate traceable and compliant recycled polymers into vehicle components.

Under the current ELV Directive (2000/53/EC)⁴⁸, vehicles must achieve a 95% recovery rate and 85% recycling rate by average weight at end-of-life. However, a 2023 European Commission proposal—part of the Sustainable Products Initiative—seeks to merge the ELV Directive with the Waste Framework Directive (WFD)⁶⁶, while introducing mandatory recycled-content targets for plastics in vehicles for the first time.

⁶⁵ S. Wagner and M. Schlummer, "Legacy additives in a circular economy of plastics: Current dilemma, policy analysis, and emerging countermeasures", Resources, Conservation & Recycling, 158, 104800, (2020).

⁶⁶ Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, European Union, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02008L0098-20180705>

The proposed targets include 25% recycled plastic in new vehicles by 2030, of which 25% must originate from post-consumer recycled (PCR) plastics.³⁴⁹ Furthermore, the proposal expands producer responsibility, making OEMs accountable for the collection and treatment of end-of-life vehicles.

This shift means that OEMs must design recycled plastics into key vehicle components—such as dashboards, trims, and underbody structures—while ensuring material traceability and compliance with recyclability standards throughout the supply chain.

Claims, labelling and consumer-facing requirements

“Recyclable” claims will increasingly be benchmarked against the PPWR’s recyclability criteria, performance grades, and harmonised labelling requirements. To ensure consistency, national label fragmentation should be avoided, and all on-pack claims must align with EU definitions and accurately reflect real end-of-life performance ^{51, 54}.

In parallel with the PPWR and SUPD regulations, the EU has also introduced consumer-protection reforms aimed at curbing generic environmental claims—commonly referred to as *greenwashing*—unless they can be scientifically substantiated. This trend is expected to strengthen further, with the European Commission and Member State authorities actively enforcing these provisions, particularly for recyclability and recycled-content claims. All environmental claims should therefore be aligned with forthcoming EU methodologies for verification and reporting, ensuring transparency, credibility, and compliance across all markets ⁶⁷.

Standards, verification and market access

Users must rely on harmonised standards, such as those for traceability, recycled-content chain-of-custody, and design-for-recycling testing protocols to demonstrate compliance with the PPWR and SUPD. It is advisable to contractually require audit-ready data from suppliers (using either mass balance or physical segregation, as permitted under the specific regulatory framework) and to closely monitor the European Commission’s implementing and delegated acts, which will define calculation methods, verification procedures, and performance grades ^{51, 58}.

Furthermore, any environmental claim such as “recycled content,” “recyclable,” “plastic-free,” or “climate-neutral” must meet the EU’s consumer-protection standards and conform to the forthcoming Green Claims Directive methodologies ^{51, 58, 67}.

The section below presents the automotive plastics recycling roadmap until 2030, providing an overview of the key events expected to occur in this area.

⁶⁷ “Design for Recycling Guidelines”, RecyClass, <https://recyclass.eu/recyclability/design-for-recycling-guidelines/>

Automotive Plastics Recycling Roadmap (2026–2030)

2026

- 12 August 2026 – PPWR general application begins
 - All packaging used in logistics, spare parts, and aftermarket must comply with PPWR general rules (labelling, EPR harmonisation).
 - Begin using harmonised sorting labels on all packaging.
- 21 November 2026 – Waste Shipment Regulation (WSR)
 - Export of plastic waste to non-OECD countries becomes prohibited.
 - Automotive plastic waste (e.g., bumpers, dashboards, shredder residues) must be processed within the EU or OECD.
 - OEMs should secure EU-based recycling partnerships to ensure compliance.
- 2026–2027 – REACH microplastics restriction transition
 - Initial bans apply to specific microplastics used in coatings and additives.
 - Suppliers must begin redesigning compounds and coatings to meet compliance requirements.

2027

- PPWR delegated acts expected
 - The European Commission will adopt detailed recyclability criteria and performance grades for packaging.
 - Suppliers of spare parts packaging and logistics systems must test and certify recyclability grades \geq B/C, likely a condition for eco-modulated EPR fees.
- ELV Directive recast finalisation (expected 2027)
 - The new ELV Regulation will replace Directive 2000/53/EC, introducing mandatory recycled-content quotas for plastics in new vehicles (effective from 2030).
 - OEMs should begin mapping polymer flows (PP, ABS, PET, PA) and launching pilot projects using rPP, rABS, and rPET.

2028

- PPWR recyclability requirements take effect
 - All packaging placed on the market must be designed for recycling according to Commission criteria.
 - Eco-modulated fees will apply — non-recyclable packaging will face higher compliance costs.
 - OEMs and Tier 1 suppliers should transition to fully recyclable transport packaging (e.g., mono-material films, recyclable foams).
- REACH microplastics restriction – expanded scope
 - Broader bans on microplastics in industrial applications will apply (e.g., abrasives, adhesives, sealants).
 - Tier 1 suppliers must audit sealants, paints, and underbody coatings for compliance.

2029

- PPWR recycled-content verification rules
 - The European Commission will adopt methods for calculating and verifying recycled content, including possible mass-balance acceptance for chemically recycled plastics.
 - Automotive suppliers must be ready to demonstrate recycled content in packaging plastics and prepare for similar obligations for vehicle plastics.
- ELV recast transition phase
 - OEMs will be required to report baseline levels of recycled plastic use in vehicles.
 - Contracts with recyclers should be in place to secure the supply of post-consumer polymers.
- Waste Shipment Regulation review
 - Possible tightening of export requirements for OECD countries, introducing stricter due diligence for exports of automotive shredder residues.

2030

- SUPD recycled-content mandate (bottles – indirect impact)
 - All plastic beverage bottles must contain at least 30% recycled content.
 - Although not automotive, this will increase competition for food-grade rPET, making it harder to source for automotive applications (e.g., carpets, seat fabrics, trims).
- PPWR recycled-content obligations take effect
 - Plastic packaging must contain minimum category-specific recycled-content quotas.
 - Automotive parts packaging (e.g., foils, containers, crates) must comply with these obligations.
- ELV Regulation – recycled-content quotas for vehicles
 - New vehicles must contain at least 25% recycled plastic overall, of which 25% must be post-consumer recycled (PCR).
 - Compliance is likely to be monitored per vehicle platform type, with OEM-level verification required.
- REACH microplastics restriction – full implementation
 - All derogations expire for most uses.
 - Automotive suppliers must be fully transitioned to microplastic-free formulations in coatings, adhesives, tyres, and plastics.

Combining the findings from the state-of-the-art in plastic recycling, dialogue with relevant stakeholders about the challenges and opportunities, and an analysis of the existing and upcoming legal framework, the CIRCAB project has outlined the research and development needs required to enhance the circularity of plastics used in trucks. These needs are described in the following section.

7.4 R&D Needs to Enhance Plastic Circularity – CIRCAB 2

One of the aims of the CIRCAB project is to outline the research and development needs to enhance plastic circularity. The CIRCAB project concluded with a strong commitment and a clear recognition of the radical transformation needed to enhance the circularity of plastic components. Building on this foundation, the next phase, CIRCAB 2, has been launched with the goal of demonstrating enhanced circularity through large-scale industrial recycling pilots of automotive plastic components and by establishing a viable business model for reusing these components in the aftermarket.

CIRCAB 2 focuses on reaching an advanced stage of closed-loop circularity. In this phase, the reuse of plastic components is enabled through a business model that reintroduces them as spare parts, while the remaining plastic waste is recycled and used as raw material for producing new plastic components.

The following R&D activities need to be carried out to achieve an advanced stage of closed-loop circularity:

- **Recycling Pilots:** Demonstrate large-scale recycling pilots for high-performance plastics such as PP blends, PC/PBT, and PC/ABS, which are currently incinerated.
- **Sorting Solutions:** Develop and implement new sorting methods to ensure that PP blends, PC/PBT, and PC/ABS are properly separated at the source.
- **Logistics and Collection:** Establish a logistics and collection infrastructure, and demonstrate its capability by collecting sorted plastics from multiple locations.
- **Prototyping and Validation:** Develop multiple prototypes using recycled plastics, and test and validate both the recycling processes and the quality of the components produced.
- **Experimentation for Future Plastics Design:** Conduct experiments to test and validate the quality of components produced with varying proportions of recycled content. Additionally, explore different cleaning technologies to identify the most effective methods for removing contaminants such as oil, mud, and particles.
- **Business Model Development:** Develop a business model to introduce plastic components currently classified as production waste (due to not meeting quality standards) into the aftermarket, and to increase the volume of used components recovered from end-of-life (EoL) trucks.
- **Digital Tools for Sorting:** Develop and demonstrate a digital tool to facilitate the efficient sorting of plastic components.

A key insight repeatedly emphasized by stakeholders throughout the CIRCAB project is that achieving the right volume of plastics is crucial for making recycling economically, technically, and environmentally viable—particularly for high-performance plastics such

as PP blends, PC/PBT, and PC/ABS, whose presence in waste streams is significantly lower compared to more common plastic types such as PET and HDPE.

In addition, CIRCAB project highlights that achieving the required volumes of high-performance plastics for recycling is only possible through strong collaboration across the entire value chain. This includes active engagement among truck manufacturers, plastic component suppliers, and end-of-life (EoL) truck dismantlers. In addition, recyclers with the necessary technological capabilities to process high-performance plastics—supported by logistics providers able to collect materials from multiple locations across Sweden—are identified as critical enablers for the successful implementation of large-scale recycling pilots.

Building on these insights, it has been identified that the success of large-scale industrial recycling pilots depends on establishing a comprehensive value chain comprising at least one manufacturer, two Tier 1 suppliers, three plastic compounders/recyclers (one with logistics support), and a dismantler. Within the manufacturer's organization, cross-functional collaboration among the production, cab assembly, aftermarket, service, and R&D departments is essential for developing an integrated business model for the reuse and recycling of plastic components.

The research needs outlined above have been proposed to Vinnova for funding, which is a major outcome of this project.

8. Dissemination and publications

8.1 Dissemination

How are the project results planned to be used and disseminated?	Mark with X	Comment
Increase knowledge in the field	X	The project provides a comprehensive overview of the current state of circularity for plastics in the heavy vehicle sector, mapping material flows, identifying key challenges, and presenting actionable insights for improving recycling and reuse practice. The report will be published as an open-access technical report through KTH's DiVA portal to ensure broad dissemination.
Be passed on to other advanced technological development projects	X	The findings serve as a foundation for further R&D, particularly identifying critical and necessary future work, which entails demonstrating large-scale recycling pilots and developing circular business models for automotive plastics.
Be passed on to product development projects	X	Results on feasible recycling pathways, material quality requirements, and business models will inform product design and development initiatives by OEMs and suppliers, encouraging the integration of recycled plastics in new vehicle components.
Introduced on the market		N/A
Used in investigations / regulatory / licensing / political decisions		N/A

Dissemination of the project results has also taken place through SuPRA (Sustainable Polymer Research Arena), where insights have been shared with companies and organizations participating in SuPRA events. CIRCAB was specifically presented at a SuPRA event hosted by Husqvarna, enabling dialogue and exchange of experiences between various actors in the plastics and automotive industries. This type of knowledge transfer strengthens opportunities for collaboration and further implementation of circular solutions within the sector.

8.2 Publications

This technical report is intended to serve as a publication and will be made open access through KTH's DiVA portal.

9. Conclusions and future research

The CIRCAB project has shown that the transition toward circular plastics in the heavy vehicle sector is both essential and highly challenging. The project identified that although awareness of circularity has increased among stakeholders, practical implementation remains limited. Barriers such as the lack of dedicated sorting infrastructure, fragmented supply chains, contamination in waste streams, and the absence of established business models continue to hinder large-scale recycling of high-performance plastics. In particular, the low availability of clean, sorted plastic waste and the economic competitiveness of virgin plastics remain critical obstacles.

At the same time, the study revealed considerable opportunities for improvement. Strong collaboration between OEMs, suppliers, dismantlers, recyclers, and policymakers can create synergies that enable cost-effective collection and recycling systems. The project confirmed that regulatory developments at the EU level—such as the revised End-of-Life Vehicle (ELV) Regulation, the Packaging and Packaging Waste Regulation (PPWR), and REACH restrictions- are rapidly transforming the legal landscape. These instruments will make the use of recycled plastics not only an environmental priority but also a legal and market necessity. The CIRCAB findings, therefore, provide a timely knowledge base for companies to anticipate future requirements and align their strategies with upcoming circular-economy targets.

Through field visits, interviews, and workshops, the project built a clear picture of the current state of plastic flows within the truck cabin value chain. It showed that although functional reuse channels exist for metal components, similar systems for plastics are largely missing. High-quality plastic components are often discarded or incinerated even when reuse would be technically feasible. Addressing this gap will require both industrial commitment and systemic change, including traceability mechanisms, improved design for recycling, and incentives for circular business practices.

Looking ahead, as future work, the **CIRCAB 2** project has been proposed, which builds directly on these findings to demonstrate large-scale industrial recycling pilots and develop business models for reusing and recycling plastic components. It also proposes that the forthcoming work needs to test practical solutions for sorting, logistics, and material validation, providing an important step toward achieving closed-loop circularity for truck plastics.

In summary, CIRCAB has laid the foundation for an industry-wide transformation by clarifying the current barriers, mapping feasible circular pathways, and engaging key stakeholders. Future research should continue to focus on scaling pilot results, improving material traceability through digital tools, and aligning industrial initiatives with evolving regulatory frameworks. Through coordinated action across the value chain, the heavy-vehicle industry can accelerate the shift toward a circular and resource-efficient future.

10. Participating parties and contact persons



Kungliga Tekniska Högskolan

Farazee Asif (*Corresponding Author*)
Assistant professor, Docent
e-mail: aasi@kth.se
Phone: 08 7909076

TRATON

TRATON AB

Lotta Jähkel
Sustainability coordinator - Cab Research & Adv.Eng.

Associated partners:

