

Novel EU ELV Directive – implications and solutions paths for the automotive industry



A Introduction

The European Green Deal is the central framework for the economic and environmental transformation of Europe into a more sustainable and circular society. It encompasses numerous individual measures and regulations, with new proposals constantly being developed for various industrial sectors. Building the circular economy represents a significant challenge for the coming decades, alongside the better-known challenge of reducing greenhouse gas emissions to combat human-induced climate change. The goal is to transition from linear product life cycles to circular business models. Such models aim to increase the use of post-consumer recycled material (PCR) and circular plastics in general or introduce product rental and sharing. Both of these options will reduce demand for new resources.

This paper explores the challenge for the automotive sector to incorporate circular plastics into its products – part of the journey towards material circularity. It examines the topic from the perspective of the regulatory environment and addresses specific industry challenges, ultimately presenting a comprehensive approach to enable sustainable transformation. This key industry serves as a role model for how our holistic approach can be effectively applied to other economic sectors.



B The regulatory environment in the EU



The first European regulation on end-of-life vehicles (ELVs) was introduced in 2000, in the shape of Directive 2000/53/EC (see Figure 1). It aimed to reduce the environmental impact of ELVs by promoting reuse, recycling and recovery of vehicle components and materials, and sought to minimise waste from vehicles and improve the environmental performance of all economic players involved in vehicle life cycles. Since it came into force, at least 85% of an ELV by weight must be reused or recovered, with a target of 95% by 2015. Moreover, vehicle manufacturers are required to design vehicles that facilitate dismantling, reuse and recycling in order to push the sector towards a circular economy and reduce pollution. The directive has significantly impacted the industry, leading to more environmentally friendly vehicle designs and increased recycling rates. It has also reduced the environmental hazards associated with vehicle disposal.

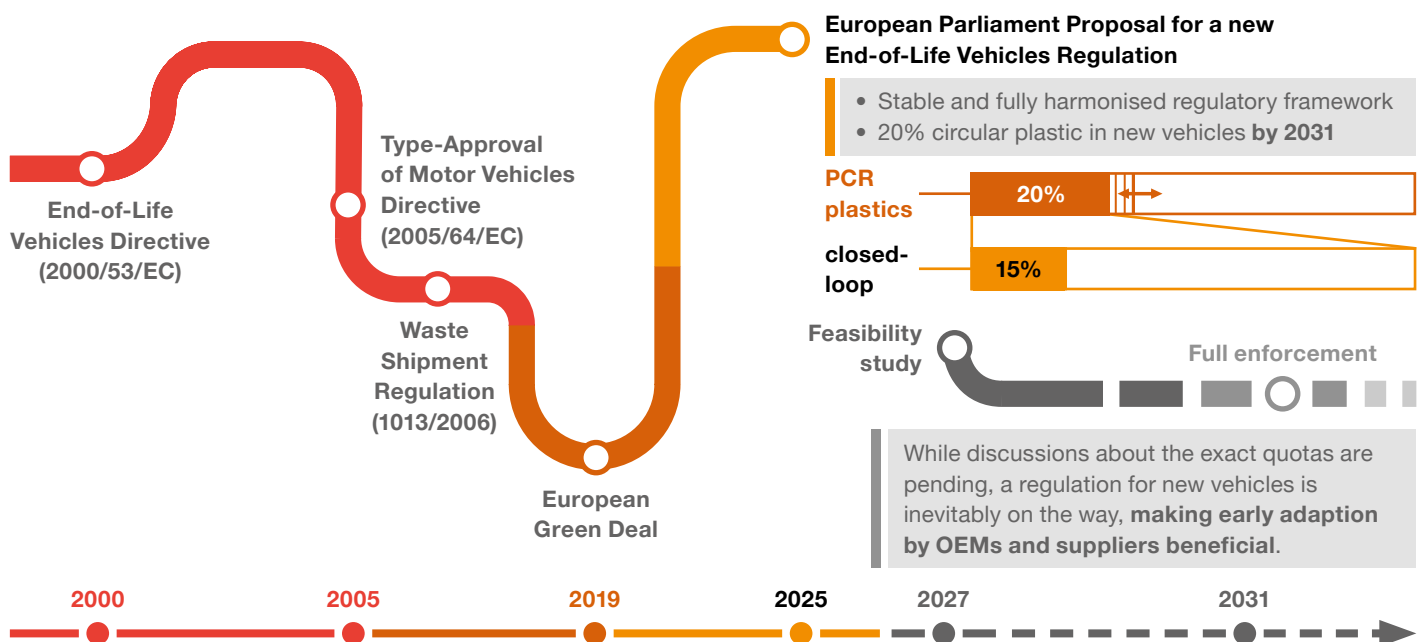
Other regulations followed, aiming to reduce waste and increase recycling rates. For instance, Directive 2005/64/EC regulates the type approval of motor vehicles, focusing on reusability, recyclability and recoverability, while Regulation (EC) No 1013/2006 on waste shipments regulates the transport of waste into, out of and within the EU.

With the launch of the European Green Deal in 2019, an even more ambitious vision emerged: the transformation of the EU economy to become climate-neutral, competitive

and circular. Achieving this goal has necessitated revisions and additions to existing regulations, one of which is the central focus of this paper – the new ELV Directive, for which the European Parliament published a proposal in February 2025. The proposal introduces stricter regulations for the development and end-of-life management of vehicles within the EU by merging the Type Approval Directive and the existing ELV Directive into a single, harmonised framework. A key element of the new directive is the recycled plastic quota, which specifies the percentage of the total mass of plastic in a new vehicle that must comprise recycled or bio-based plastics, collectively referred to as “circular plastics”. The European Parliament’s preferred approach from January 2025 includes a 20% quota for circular plastics in vehicles by 2031, with 15% of this amount required to come from closed-loop¹ recycling.

Although the exact figure is still subject to debate, a quota is set to be implemented, meaning that the automotive industry, its suppliers and many other players will have to adapt quickly. The associated plastics market is simultaneously undergoing rapid changes to meet the increased demand for circular plastics, presenting both risks and opportunities for several value chains. The following chapter takes a closer look at the plastics market and explores how automotive companies can adapt to these new requirements, highlighting the challenges and potential innovations in this transforming industry.

Fig. 1 Selection of EU regulatory developments and outlook for circular plastic quotas in new vehicles



¹ Closed-loop PCR refers to recycled plastics used for the same product as before recycling.

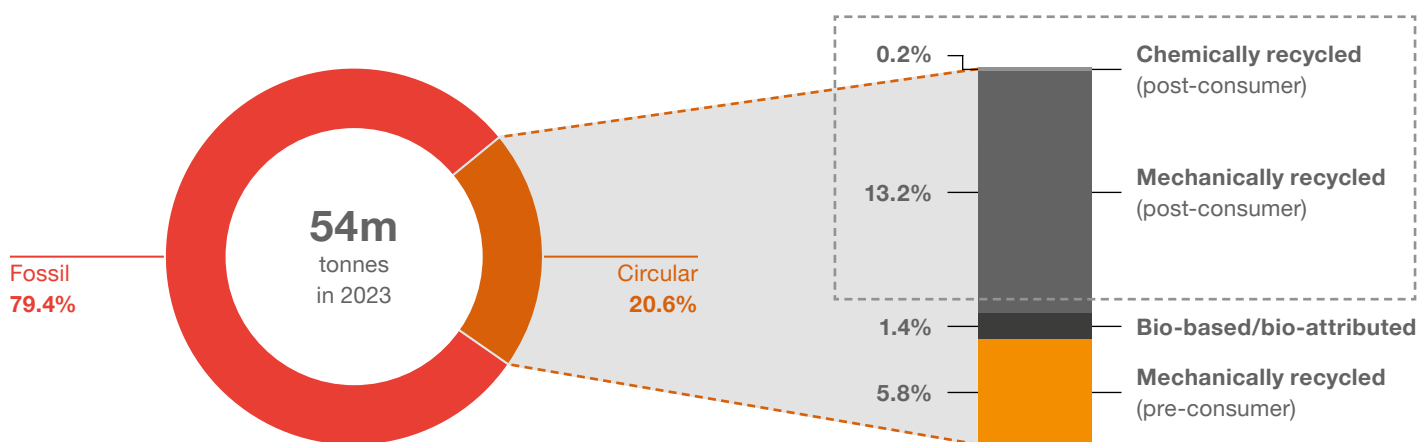
C The European plastics market

1 Plastic production outlook

Around 80% of European plastic production is still fossil-based and therefore virgin plastic, as can be seen in Figure 2; this contrasts with around 20% circular plastic production. A further distinction can be drawn between pre-consumer recycling (i.e. in manufacturing), post-consumer recycling and bio-based plastics.

It is interesting to note that the lion's share of recycled plastic comes from mechanical recycling, with chemical recycling only playing a very minor role. This is mainly due to the complexity and cost of this method, although some technological advancements have been made and are being made.²

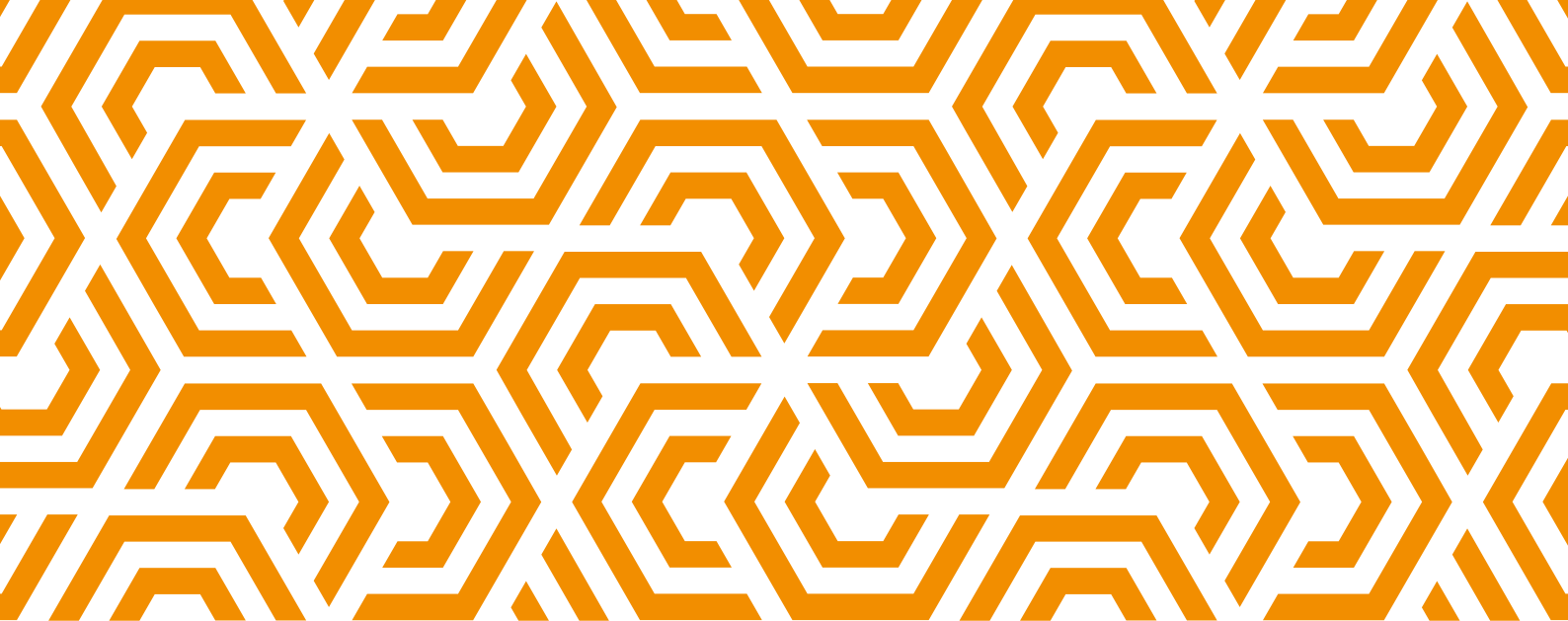
Fig. 2 European plastic production by production method in 2023¹



¹ Plastics Europe, Plastics – The Facts, 2024.

² Plastics Europe, Plastics – The Facts, 2024.

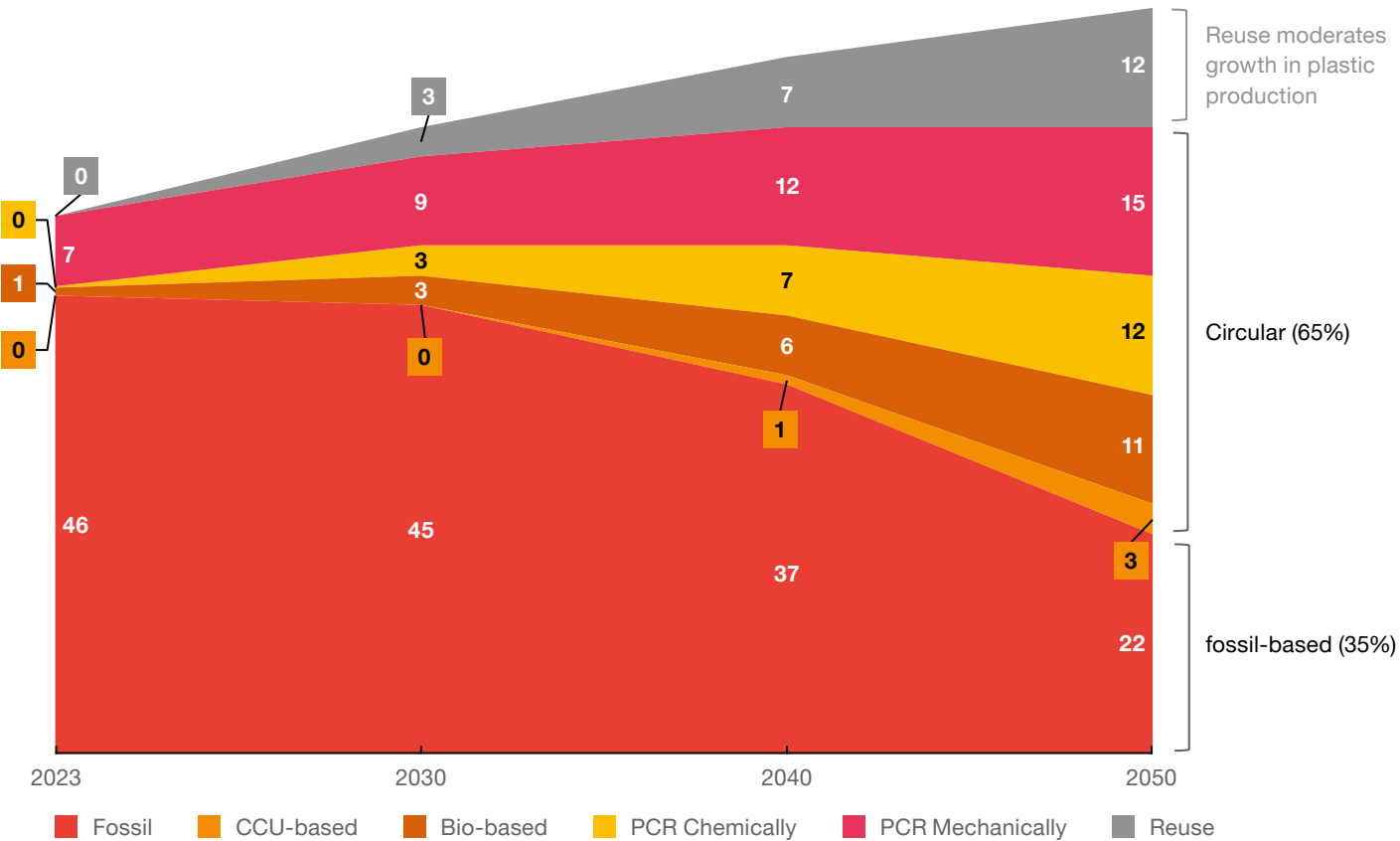




According to a market analysis by Plastics Europe (see Figure 3), the proportion of circular plastic will increase dramatically in the coming decades, with an estimated 65% of the plastic produced in the EU falling into this category by 2050. A couple of causes are apparent here: regulations such as the new ELV Directive are boosting demand for PCR plastic in several industries, while advancements in recycling technology are also making circular plastic cheaper, especially when produced in large quantities.³

Interestingly, Plastics Europe’s market analysis anticipates that new business models, such as reuse or refurbishing, will offset some of the projected growth in plastic production. By 2050, this could affect around 12 million tonnes of plastic, meaning that some of the anticipated increase in production may not occur. Overall, the transformation poses several challenges for the plastics industry – for example, in terms of quality assurance, supply chains and competitive costs.⁴

Fig. 3 Outlook for European plastic production (million tonnes)¹



¹ Plastic Europe, The Plastic Transition 2023.

³ Plastics Europe, The Plastics Transition, 2023.

⁴ ibid.

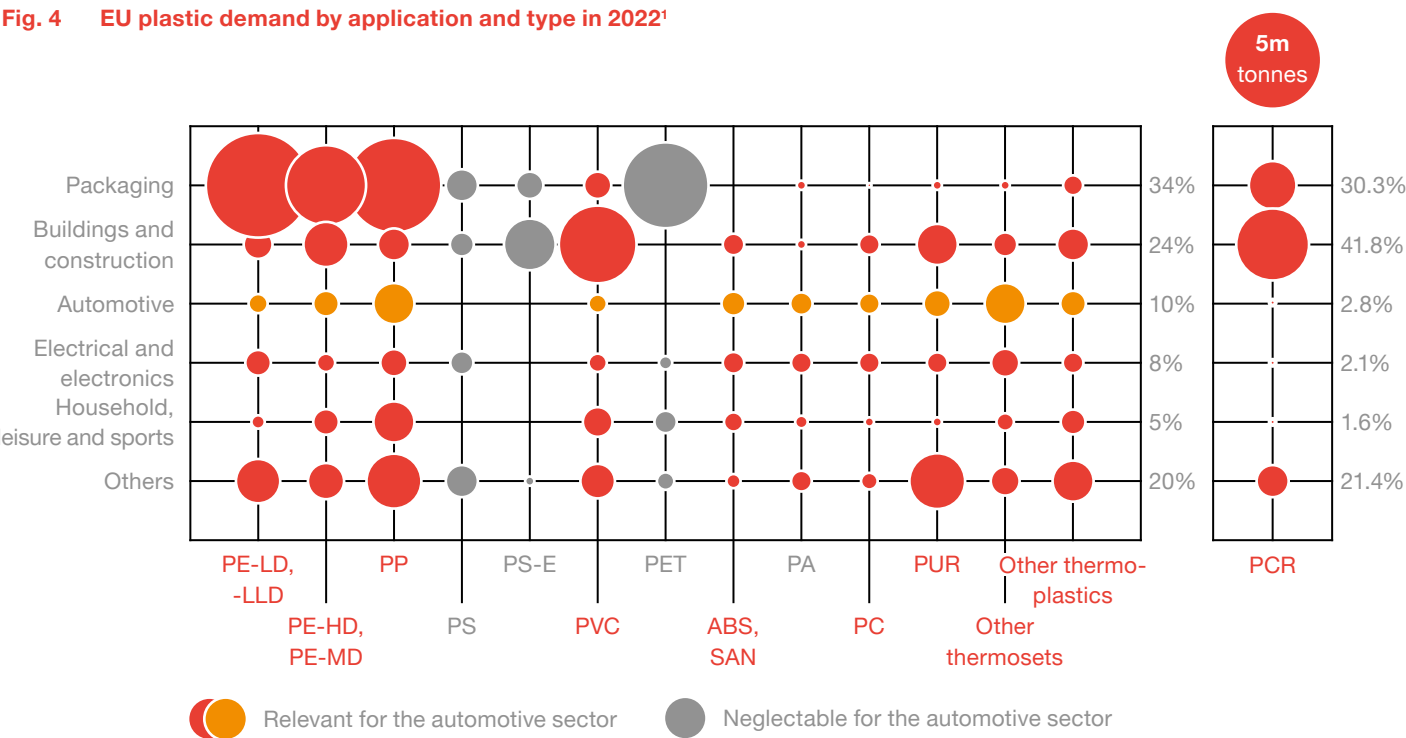
2 Competitors for PCR plastic supply

The transformation of the plastics industry towards circularity presents opportunities and risks for automotive manufacturers and suppliers. With the use of recycled and bio-based plastic set to become mandatory, high demand is to be expected – but supply from the plastics industry will be low at first. This is why early adopters and, above all, bulk buyers of plastic will have an advantage when it comes to procurement. As Figure 4 shows, there is stiff competition for several types of virgin plastic, especially in the packaging and construction industries. However, these industries also have a certain amount of market power due to their very high levels of consumption, which can drive shortages in the market when supply is limited. The automotive industry is a junior player compared to packaging or construction, particularly in the case of polyethylene (PE), polypropylene (PP) and polyvinyl

chloride (PVC). There is also competition for many other types of plastic, and this will continue to increase, especially for recycled products.⁵

Figure 4 also shows that the automotive industry does not play a significant role in current demand for circular plastic. Packaging and construction currently account for around 70% of this demand, while only 3% of PCR plastic is used for motor vehicles. This means that automotive manufacturers and suppliers are entering a market that is largely dominated by other industries, which is why we firmly believe that it is essential to address and this topic and develop strategies for it at an early stage. The following chapters focus exclusively on the automotive industry – from challenges in integrating recycled plastic into products, to a holistic approach to benefit from the transformation.⁶

Fig. 4 EU plastic demand by application and type in 2022¹



¹ Based on aggregated and rounded estimates for 2022 by Plastics Europe.

⁵ Based on aggregated and rounded estimates for 2022 by Plastics Europe.

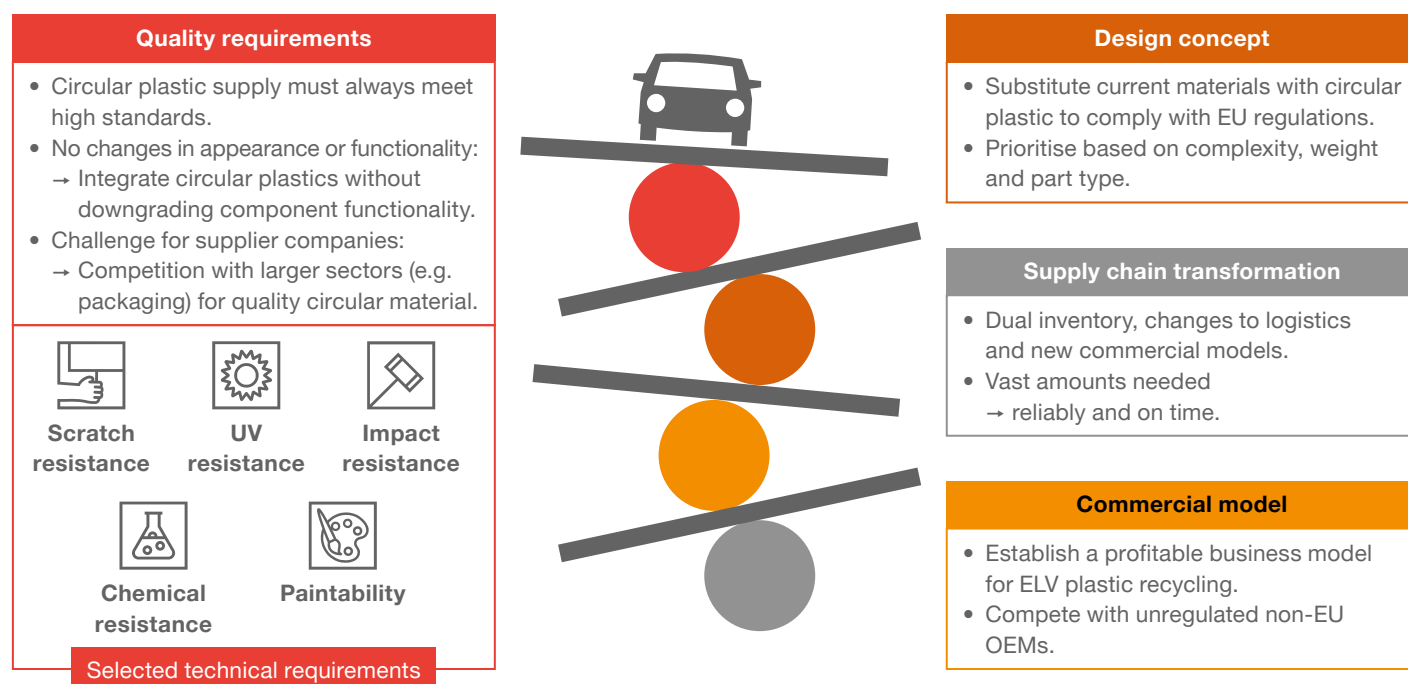
⁶ *ibid.*

D Industry challenges for automotive OEMs and suppliers

Integrating recycled plastics into products presents several challenges for OEMs and suppliers, requiring a multifaceted approach to address them effectively. As illustrated in Figure 5, the process begins with establishing a viable commercial model for the return and recycling of ELVs. This is followed by a comprehensive transformation of the supply chain, which must be adapted to accommodate

the necessary logistics for recycled materials. There are also significant design challenges in developing new parts that both comply with the regulations and meet consumer expectations. Success in this transformation hinges on addressing all these areas simultaneously, ensuring a cohesive strategy that aligns with sustainability goals and market demands.

Fig. 5 Challenges for OEMs and suppliers implementing circular plastics



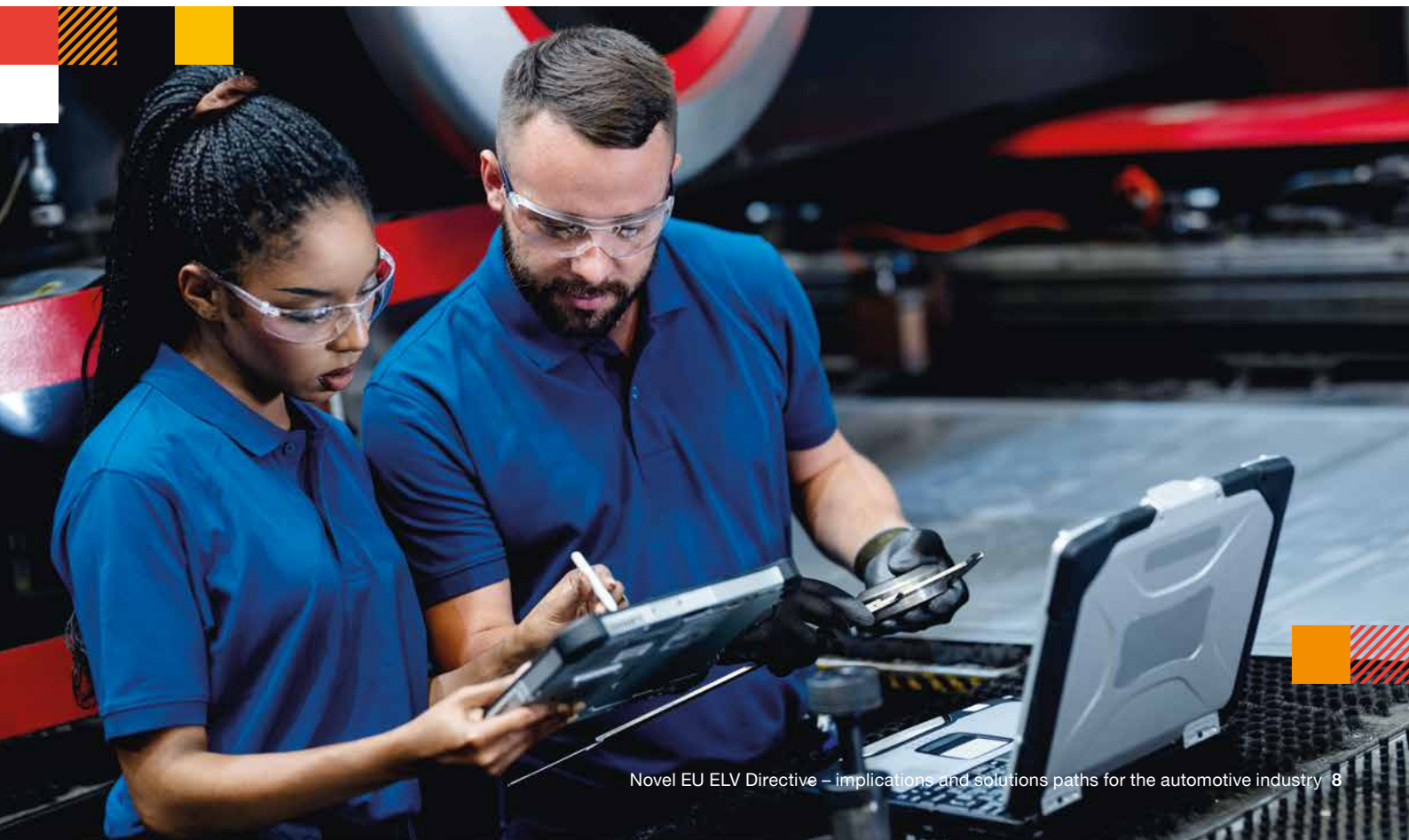
1 Supply chain transformation and commercial model

The introduction of circular plastics poses several challenges in the supply chain. Firstly, current logistics for plastic granulates and complete vehicles are optimised to keep transport costs as low as possible. Recycling of ELVs means that either complete vehicles or individual plastic parts must be transported to the recyclers (e.g. the supplier companies themselves). As plastic can incur high transport costs due to its lightweight and bulky nature, tight packaging is essential. New logistics solutions with appropriate equipment must be established for transporting both complete ELVs and plastic parts. The underlying recycling model is also a topic for discussion; for example, knockdown or dismantling could take place at decentralised facilities, and the plastic could then be recycled into new granulate at a central location, forming a hub-and-spoke model.

A commercial model needs to be developed by which car dealers can benefit from trading-in and dismantling ELVs, with recyclers committed to purchasing the plastic parts at competitive prices. This model has yet to be established, particularly with regard to ensuring a closed-loop supply of circular plastics for new vehicles. In addition, the use of circular plastic may result in the need for dual inventory management – manufacturers, for example, will need to stock both virgin PP and PCR-PP. Inevitably, increased costs for labour and warehousing will arise, making it crucial to strategically select where to use circular plastic to satisfy regulations, taking the entire supply chain into consideration. Certain design specifications and customer preferences will also play a crucial role, as explained below.

Fig. 6 Circular plastic challenges for the automotive supply chain

Logistic challenges 	Novel commercial model 	Dual inventory management 
• Current virgin plastic granulate transportation is highly optimised → New solutions and techniques necessary to transport ELV/parts efficiently to central recycling hubs → Expensive transportation of ELV parts due to low density of plastics → Decentralised dismantling and central granulation (Hub and Spokes)	• No incentive for car retailers to collect and dismantle ELVs → Dealers buying ELV need a reliable commercial system from OEMs to benefit from buy backs → Logistics need to be established from dealers to recyclers	• More materials due to circular plastics, e.g. virgin and PCR-PP → Dual inventory management could be necessary → A constant supply of quality circular plastics must be guaranteed → Competition with other sectors for scarce supply expected

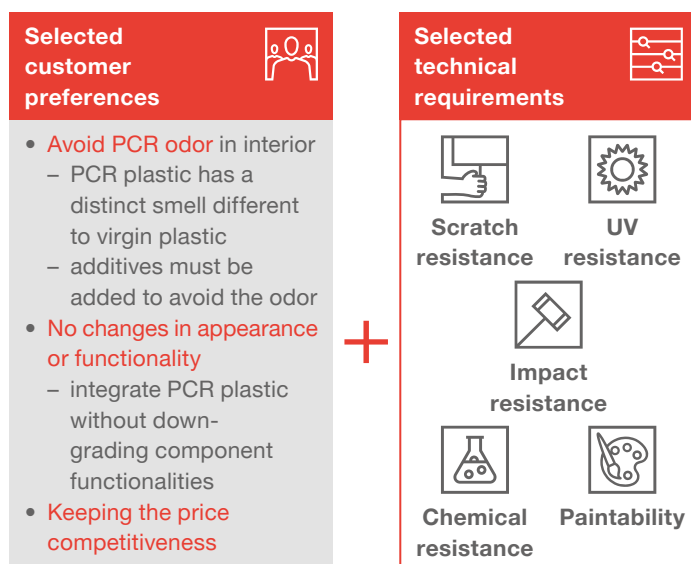


2 Quality requirements and design concepts

When it comes to quality and design, there are two categories of requirements that will be challenging to meet. On the one hand, there is the customer side, which places certain demands on a new car. For example, manufacturers will need to achieve the same functionality and appearance despite the use of circular plastics. In addition, the price of the car cannot be significantly higher, otherwise it will no longer sell. PCR odour is a good example of a customer-related challenge: the smell of PCR plastic can be significantly different from the conventional new car smell which customers expect. To avoid this problem, additional expensive additives will have to be added during recycling, which is why PCR is currently used more for exterior parts.

On the other hand, plastic parts in vehicles must also meet numerous technical requirements, as shown below in Figure 7. For example, plastic parts must have a certain level of scratch, chemical and impact resistance, depending on their intended purpose. Moreover, many parts must also be paintable and resistant to UV radiation. If existing plastic parts are analysed according to these requirements, both from a technical and a customer perspective, the areas where circular plastics can be used are limited. This makes it even more important to consider a holistic strategy for meeting the regulatory requirements at an early stage in order to be prepared for the transformation. A holistic approach to help automotive players achieve this can be found in the chapter below.

Fig. 7 Customer and design challenges when using circular plastics



E A holistic approach

To roll out circular plastics effectively, manufacturers need to adopt a holistic approach, addressing the transformation strategically and with a long-term perspective. This will ensure that the shift to circular materials is both effective and sustainable over time.

1 PwC's four-step approach

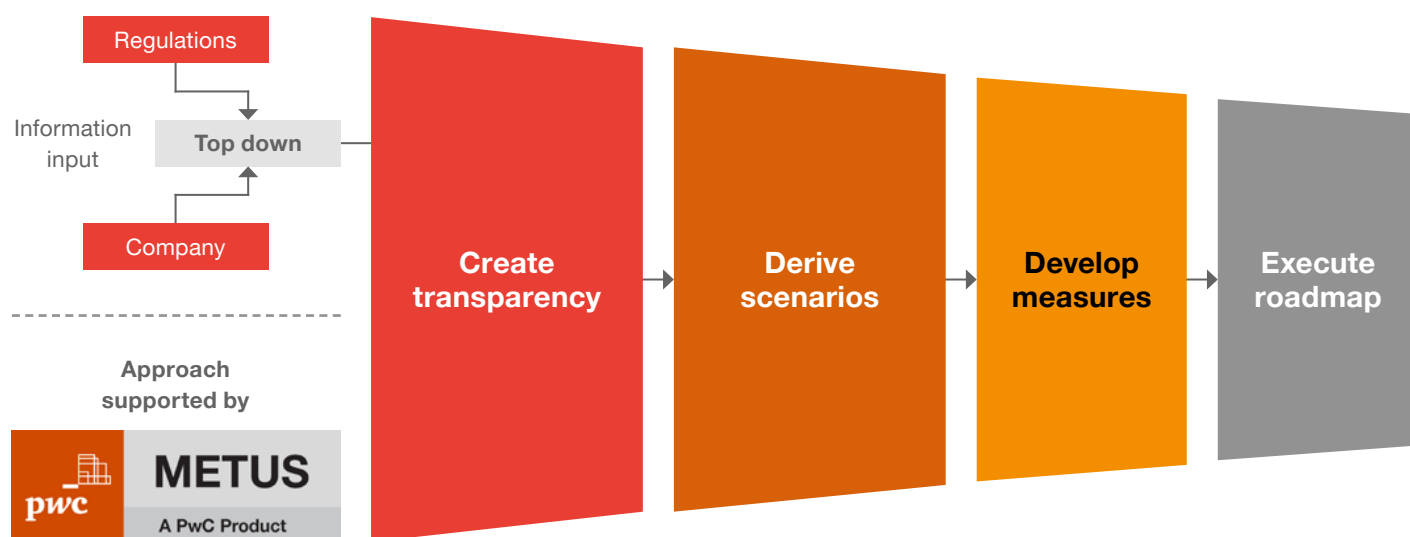
Our approach consists of four phases, as illustrated in Figure 8. The first step is to create transparency regarding the updated directive and its impact on your company and your products. From this understanding, you need to identify the risks associated with the upcoming regulatory changes, allowing the creation of an internal longlist outlining potential approaches to the transformation.

In the second step, scenarios should be developed to explore how you can comply with the regulations for circular plastic use and what strategic action you could take to become a pioneer in this area. This will, of course, bring its own financial advantages.

Next, the third step is about developing specific measures to implement the transformation, both in the short and the long term. This could involve forming strategic partnerships, adopting circular design principles or exploring new business models – these are discussed in more detail in Chapter E.2.

Finally, a roadmap should be drawn up and reviewed that prioritises the initiatives according to their urgency and sets out a clear path for the coming years.

Fig. 8 PwC's four-step approach for automotive companies and suppliers to achieve compliance with circular plastic regulations



2 Areas of action

After establishing transparency on the applicable circular plastic regulations and plastic usage in your existing product architecture, different scenarios and measures must be evaluated to implement your circular transformation successfully and for the long term. There are numerous concepts and principles supporting this process which can generally be categorised into distinct areas of action. Identifying and developing specific measures from these areas will empower your company to ensure a structured and effective transformation process.



2.1 Strategic partnerships

Strategic partnerships are key to successfully integrating circular material into the automotive industry. OEMs and suppliers are in competition with other industries, such as packaging or construction, for limited supplies. This makes it important to establish and maintain partnerships as early as possible.

Long-term partnerships with circular material producers and ELV recyclers can guarantee a reliable, on-time supply of high-quality circular plastics and enable knowledge transfer for developing new car parts. For instance, plastic resin producer LyondellBasell has entered a partnership with Audi to create new PCR parts from mixed automotive waste.⁷ Similarly, OEM Polestar is collaborating with MBA Polymers to introduce PCR plastic parts in its electric vehicles.⁸ Companies should establish partnerships with other OEMs to develop new circular plastic parts. Jointly manufactured products have the advantage of driving knowledge transfer, meeting the aforementioned quality requirements, and optimising the use of circular material.

2.2 Circular design principles

As described in Chapter D.2, the development of new circular plastic parts poses several problems, and varying requirements must be met. When selecting where to use circular material, heavy parts with low requirements should be replaced first. Components that have a particularly high number of requirements, on the other hand, should be replaced only where absolutely necessary. This includes both technical requirements – such as safety-related impact resistance – and customer expectations, such as avoiding PCR odour in the interior.

There are three circular design principles that will save resources in the long term and simplify the reuse of ELVs. Firstly, the principle of design for recycling should be applied, in which end-of-life recycling is already taken into account during the development phase. According to this principle, glue should be avoided and replaced by clip systems wherever feasible. A modular product design, especially one emphasising the use of mono-materials, can significantly simplify manufacturing, assembly and recycling processes. Modular design also facilitates easier upgrades and repairs, thus extending the product's life cycle. Leveraging our METUS software enables you to capitalise on modular designs to streamline production, reduce costs and successfully introduce circular materials to your products.

The second principle is design for material efficiency, which primarily aims to reduce the weight of plastic parts. This makes it easier to fulfil EU regulations, as products designed

using this principle use less plastic overall. The last principle, design for conformity, requires that all manufactured parts must first and foremost fulfil quality requirements, be it safety standards or functionality (as outlined above). Otherwise, the resulting cars cannot be registered or sold at all, despite the circular quotas being met.

2.3 Digital Product Passport

The EU's Digital Product Passport scheme enhances transparency and sustainability by providing detailed information on a product's materials, components and environmental impact, facilitating efficient end-of-life recycling. It plays a crucial role in boosting recycling rates for plastic by ensuring accurate tracking and reintegration of those materials into new products.

A key benefit of the Digital Product Passport is improved traceability, enabling stakeholders to follow a product from manufacturing to disposal. This is vital for identifying materials, streamlining recycling processes and supporting a circular economy. The passport also fosters collaboration across the supply chain, ensuring compliance with environmental regulations and providing transparent information to empower consumers. This transparency will build confidence in circular plastic products and drive demand for increased recycling rates.

2.4 Platform-as-a-Service

Platform-as-a-Service (PaaS) business models offer an innovative approach for the future of the automotive industry. By shifting from vehicle ownership to leasing and subscriptions, customers gain benefits such as cost savings, less onerous responsibilities and increased flexibility. Moreover, PaaS improves recycling rates of plastic components from ELVs by centralising the collection process, leading to greater efficiency and effectiveness. Unlike traditional systems where individuals are responsible for disposal, PaaS facilitates a coordinated strategy that ensures more comprehensive collection and better quality control of recycled materials.

Using digital platforms, PaaS models provide valuable data on the life cycles of plastic components, optimising logistics and reducing contamination. This data-driven strategy not only increases recycling rates but also fosters collaboration across the automotive supply chain. By encouraging partnerships among manufacturers, recyclers and other stakeholders, PaaS can help drive innovation in recycling technologies and support the industry's circular plastic goals.

⁷ www.lyondellbasell.com/en/news-events/products--technology-news/lyondellbasell-and-audi-create-first-automotive-plastic-parts-from-mixed-automotive-plastic-waste.

⁸ <https://omnexus.specialchem.com/news/industry-news/polestar-and-mba-polymers-to-encourage-use-of-pcr-plastics-in-evs-000235870>.

F Conclusion and outlook

The automotive sector is at a pivotal moment, adapting to new regulations and embracing the circular plastic transformation. As explained above, this represents a major challenge with numerous problem areas and risks that can only be dealt with holistically. At PwC, we believe that there are clear advantages for early adopters who proactively tackle the circular transformation and identify areas for action. Whether you need help with fostering transparency around upcoming plastic regulations, developing modular product structures, or implementing variant and complexity management, we have the expertise to assist you in navigating this transformation effectively.

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About us

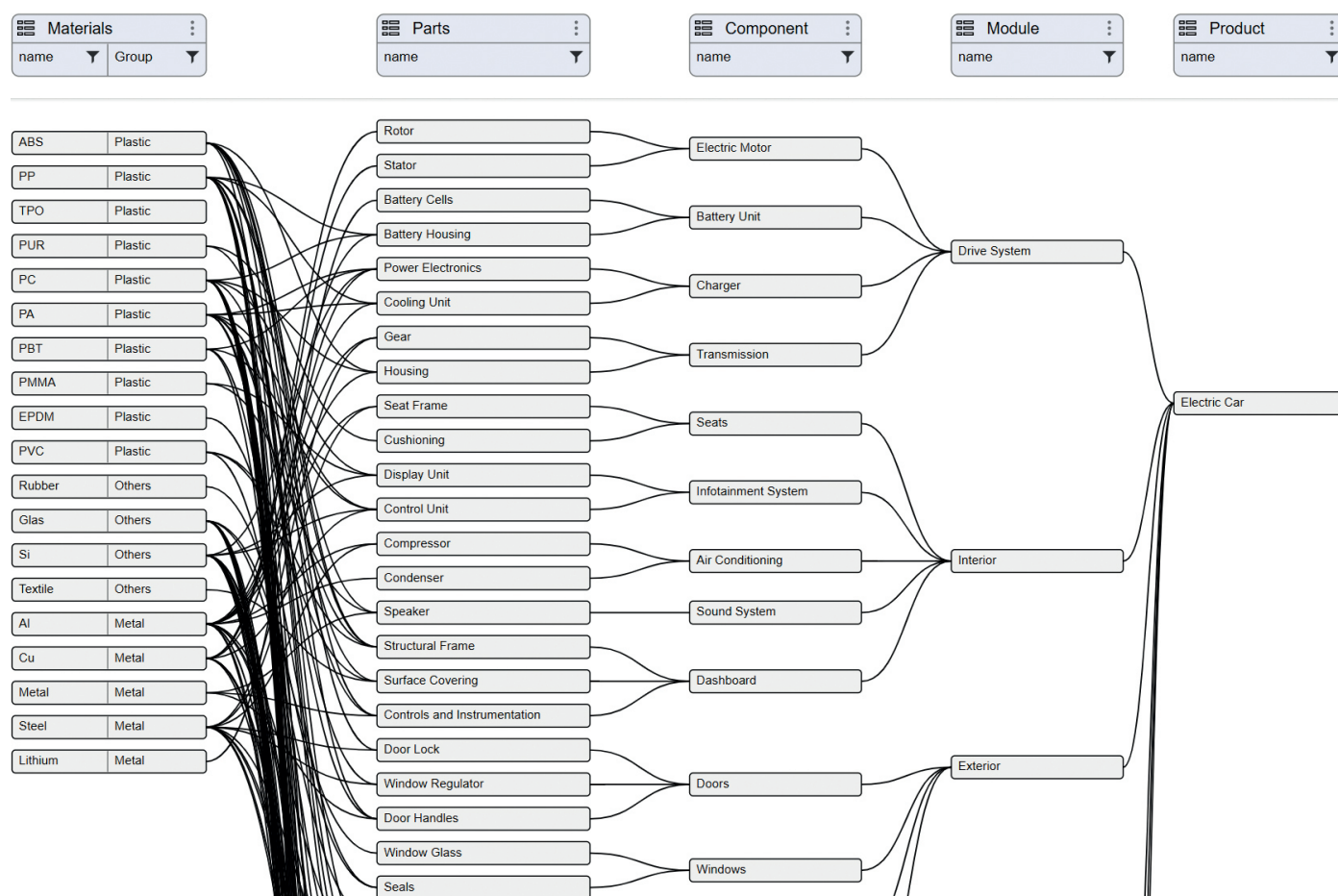
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Appendix: METUS model for integrating circular plastics

PwC METUS can help you achieve the best possible results from the circular transformation. Visualising the interconnections and interdependence in a modular product structure will help create transparency and enable informed decision-making regarding possible changes and new developments. Figure 9 shows the modular product structure of an electric vehicle (EV) as an example, connecting the car's parts with the materials used in order to gain knowledge about material use and interdependence.

Fig. 9 Modular product structure of an EV, mapping materials to parts using METUS



Using the METUS model, different scenarios in our holistic approach can be tested and evaluated to find the best way forward, with the aim of using more circular plastic in the product and thus complying with upcoming regulations for the industry. The scenarios can be assessed based on various KPIs – for example, changes in material cost, fulfilment of technical requirements, and consequences for product variants and functionality. Figure 10 illustrates a transformation scenario implementing three PCR plastics to meet the 20% overall circular plastic quota. Implications for material costs are calculated accordingly, enabling further analysis.

Fig. 10 Implementing circular plastics in the product structure – scenario and analysis

