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Authors	[Alan Encinas, Arne Ragossnig, Andreas Bartl, Mirjam Brands & Georg Sostaric]
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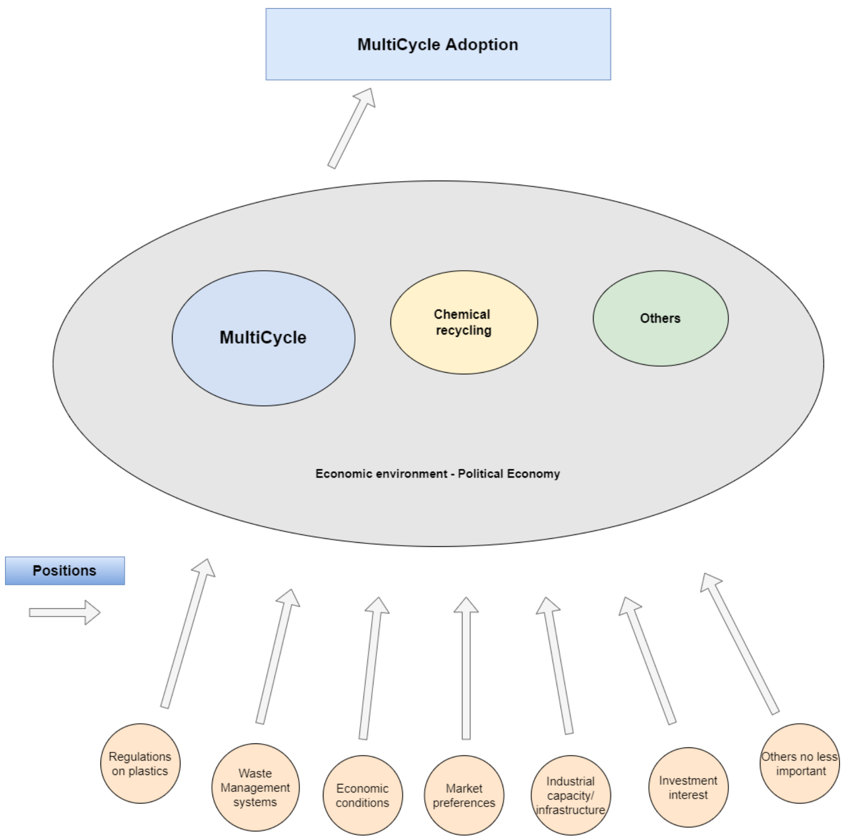
Executive Summary

The European Union H2020 project MULTICYCLE is delivering an industrial recycling pilot plant for thermoplastic-based multi-materials allowing selective recovery of pure plastics and fibres from mixed wastes without downgrading. The project concept is based on an artificial intelligence monitoring system for multimaterial recognition and the patented *CreaSolv ® recycling process for material recovery and the subsequent processes to re-introduce the recycled materials as feedstock to manufacture new products. The objective is to demonstrate a potential shift to a circular economic model in multilayer packaging / flexible films and fibre-reinforced thermoplastic automotive composites. There is also a potential of applicability in many other segments.

This document is a compilation of key positions on various issues based on the research in the MultiCycle project that stakeholders envision as necessary or desired to advance plastics recycling to the level allowing for achieving the defined recycling targets. The document includes the two target waste types for the project scope: Multilayer Plastic Flexible Packaging and Composite Thermoplastics in the Automotive Industry and End-of-Life Vehicles (ELV).

The following diagram is a graphic representation of the environment on which the position paper aims to establish the messaging and the factors influencing them.



A combination of conditions, regulations and trends affect the economic environment around the Multilayer flexible packaging production and recycling. The magnitude and relevance of the conditions is determined by the actions and interventions of actors in the governance arrangements for multilayer plastic production and recycling.

Some important decision-makers and influences in the governance arrangements are the government institutions, civil society organisations, NGOs and the academia.

The objective of the position paper is to advocate for the adjustments from governance actors on conditions, regulations, and trends to provide the MultiCycle proposition the required conditions to develop. As MultiCycle is intending to serve as the perfect fit to contribute to addressing the plastic challenge and specifically providing a solution for both multilayer packaging and composite thermoplastic. The positions of this paper are the recommendations on how those influences should be drawn towards the economic environment.

The current infrastructure for waste management of ELV is not designed to process and recycle thermoplastics, composites and complex mixtures for the automotive industry. New technologies that attain to those waste with the possibility of being added to current infrastructure as modular additions are needed and desired. This way, the targets could be met without drastic transformations of the current infrastructure in place. MULTICYCLE can provide this modular addition to enhance circularity of currently non-recyclable materials.

The process of the project MULTICYCLE can deliver an output material of very similar quality compared to virgin plastic with no or little contamination according to the application requirement. This has been tested in the experimental phase of the project in several work packages. The demonstration of recycled polymers from flexible packaging waste has proven that recycled polymers do meet virgin like characteristics.

We invite stakeholders to approach the MULTICYCLE Project and get their residue streams tested to evaluate the recycling potential of today's non-recyclable materials within the recycling *supply chain.*

Disclaimer:

The positions outlined in the following position paper are not official positions of ISWA members or ISWA bodies. The following is a product of a technical research from ISWA and the research team as an outcome of the MultiCycle project in which ISWA participates as a technical partner.

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MultiCycle position paper and Policy Recommendations on Multilayer Plastic Packaging

MultiCycle recycling process as a sound technological proposition to reach the targets of the revision of the waste framework directive

The general objective of the Packaging & Packaging Waste Directive (PPWD) is to prevent negative impacts of packaging in the environment. Moreover, the Circular Economy Action Plan has the goal of making all packaging recyclable or reusable by 2025. The 55% recycling target of plastic by 2025 would mean a dramatically increased share of recycling also for packaging, this would require a significantly increased use of recycled content in new products as well, estimated at almost 50% for PET and ~30% for PE and PP.

The current infrastructure for waste management is not designed to process and recycle small flexible packaging. New technologies that attain to those waste items with the possibility of being added to current infrastructure as modular additions are needed and desired. This is exactly what the MultiCycle proposition aims at. This way, the targets could be met without drastic transformations of the current mature infrastructure.

The MultiCycle proposition for sorting and recycling polymers from flexible packaging is a proven and promising solution able to provide an effective, low carbon-intensive process with the potential to be broadly implemented around the EU. The MultiCycle project setting with an AI identification system using optical sensing along with the CreaSolv® technology can meet end-market requirements of the target products of the project. At this current stage, the process has proven to provide high-quality materials and products for packaging solutions with recycled PE and PP.

The process can deliver an output material of very similar quality compared to virgin plastic with no or little contamination according to the application requirement. This has been tested in the experimental phase of the project in several work packages. The packaging demonstration has proven that the process is producing packaging solutions containing high amounts of recycled PET, PP, and PA. According to the associated Life Cycle Costing studies of the project, the MultiCycle solution has also proven to provide a competitive processing pricing compared to virgin materials when upscaled.

Plastic products will still be very present in day-to-day life in a wide array of applications due to the great convenience they provide to consumers and producers. As mentioned before, the circularity targets for packaging require increasing the amount of recycled content in packaging and recyclates will have to be integrated more in plastic packaging formulations.

Decision-makers, industry representatives, and the academic community should actively explore the possibilities of improving circular flows of materials in packaging using novel technologies. The MultiCycle recycling process is an interesting proposition that can be implemented as an addition for current infrastructures and can deliver an effective solution for multilayer plastic packaging.

Desired improvements on the regulatory framework to establish better conditions for circularity of flexible packaging materials

A coherent regulatory framework supporting a European single market for secondary raw materials is required to enhance recycling rates through economies of scale while maintaining the necessary safeguards for controlling substances of very high concern. A single market would allow transactions of secondary materials from places of surplus to places of deficits, this could see the birth of new value chains that were not possible before due the need for compliance of strict end-of-waste status.

At the same time, it is important to establish the required considerations and processes to avoid dangerous or toxic trace substances ending up in the loop. Technological solutions that offer recycling solutions and also products from recyclates should be tested and audited for this purpose to ensure the quality and toxic-free condition of the products.

Consistent definitions for the terms of recycling, recyclability, recycled materials, and recycled content are necessary to take accurate measurements and design policies. Additionally, a harmonised balance approach for measuring recycled content could be beneficial to compare countries in the EU and prioritise incentives or highlight successful case studies. Those measures would allow actors in the value chain to increase their collaboration and be steered towards the real objectives of the circular economy action plan, effectively following the waste hierarchy and thus, minimising the mass of materials that have no further use and go into final sinks (landfill and incineration/energy or fuel recovery).

A set of regulatory measures aimed at improving the capacities on collection and sorting of plastic packaging waste should be pursued; including both increased in total volume capacity and material separation effectiveness. Delivering cleaner fractions to recycling plants with fewer possibilities of critical contaminations should be a priority to establish improved recycling processes.

Legislative instruments aiming to support, speed up, and scale the R&D efforts of the recycling sector are required for transitioning to the circular model for all (flexible) packaging materials.

Alignment needed between all actors in the value chain of multilayer plastic materials to achieve the targets of recycling of the EU

A comprehensive alignment in the value chain is required and desired to establish the technical capacities and business cases to increase identification and recycling to the level of the targets of the EU. Collection, sorting, recycling, and users of recyclates need to work in collaboration to establish the processes and practices that would allow them to comply with the conditions of the products they produce, which are at the same time the inputs of the other value chain actor.

Improving collection and sorting is key to allowing technologies and business cases to thrive as it simplifies the complexity of any material separation within the recycling process. The obtention of more pure recyclable streams should be prioritised to lay the ground for better recycling alternatives as MultiCycle.

In terms of sorting, a key intervention is required so the current economic model for compensating the services is changed. This is required to avoid the current scenario on which operators must process a certain number of tonnes per hour to earn enough to pay for the costs. This condition does not allow them to slow down the processing of waste streams so that the yield of recyclables can increase in quantity and purity.

More specifically, sorting of packaging waste procedures and guidelines should be harmonised as industry standard to allow the conditions for the materials collected to be employed in advanced recycling technologies with high recovery rates and high-quality secondary raw materials.

Extended Producer Responsibility (EPR) schemes should play a key role in promoting and financing the required modifications to each modular process in the value chain to achieve the desired alignment that will enable the system to increase recycling rates. EPR and its different configurations can provide a very important contribution in increasing recycling as typically Producer Responsibility Organisations

(PROs) are important actors that drive the process of recycling in the EU. The efforts on this front can be sustained by the increasing willingness of companies to solve the plastic challenge.

Increase and support the research and development of cross-value chain initiatives to sustain the advancements required for adapting to changing market needs. The adaptability of the value chain should be a priority as consumer demands and industry requirements are likely to change in the future.

Finally, it is desired and required the enforcement of the article EU Directive 2008/98/EC of 19 November 2008 on waste, Article 3 (17) that states that products from recycling used in fuels or to produce energy should not be classified as being recycled to achieve recycling rates. Additionally, this would allow a level playing field with no room for interpretation within the EU.

Establish sound policies with the incentives needed to increase recycling of multilayer packaging

The current situation in the economy coupled to the linear consumption model should be counterbalanced with tailored interventions in the form of sound policies with proper economic instruments. The market by itself has not been able to regulate the externalities created by extensive plastic use in many appliances of our lives. Economic incentives and deterrents can play a crucial role in steering the market towards increasing the share of recycled content in packaging.

Currently, virgin materials are cheaper and widely available. Additionally, recycling at this moment is not yet financially competitive as the volume of plastics recycled is too low and there is a lack of demand for recycling plastics as well as poor collection efficiencies. As the volume of recycled plastics increases, the cost of sorting and recycling will get lower, so the efforts on supporting financially the transformation will be more focused as a kick-starter for establishing the material loop.

At the same time, it results crucial to increase the efforts on decarbonising the economy and orienting it towards obtaining materials from both primary and secondary sources. Recycling plastics is the key to lowering the environmental and carbon footprint of plastic packaging. The extended use of virgin materials for plastic products should be disincentivized with the implementation of a carbon tax for the applications that could be replaced with high-quality secondary raw materials. This scenario could increase the drive for looking for alternatives solutions on the packaging market dominated by virgin plastics.

As mentioned before, multilayer plastic packaging still delivers great convenience in many applications and thus, seems unlikely to be pushed in the direction of a phaseout shortly. For this reason, policies should combine push and pull measures.

While decreasing the use of virgin plastic is required, the adoption of novel technologies that contribute with solutions for increasing recycling rates and availability of recyclates across the value chain such as MultiCycle should be incentivised. Support with subsidies from governments for the required investments with that purpose is key to enabling industrial players to test and consolidate the technological upgrades.

Develop supportive eco-labels and business to business (b2b) instruments to certify circularity of packaging materials

Certification instruments can serve as one of the main alternatives to government-based interventions to regulate environmental externalities from market failures. They provide consumers an indication of the processes and oversight the product or service had to comply to obtain such labels. Eco-labels in plastic packaging could play an important role if designed and marketed appropriately and if they are easy to understand for consumers.

Incentivising the adoption of eco-labels gives businesses and consumers the possibility of making informed and conscious choices regarding the circularity of their products (and packaging) and thereby can have a considerable influence on promoting circularity. Such labels should be designed and implemented across consumer-packaged goods and packaging solutions for diverse applications.

The design of a potential certification scheme should take into consideration a scientific and social base and should be designed for impact. It should also include all the necessary instruments to ensure compliance of the requirements of all actors. An impartial and independent body should oversee certification and validation of the practices from the participating industries.

Business-to-business (b2b) certification schemes between producers of packaged goods and packaging solutions providers can help significantly to steer the value-chain practices towards circularity. Specific requirements on sourcing, processing, and production of raw materials in the value-chain can create an enhanced environmental performance of the whole life-cycle of plastic packaging. For this purpose, it is very important to include in the schemes a prioritisation of recycled content.

Brand owners should be encouraged and incentivised to act into unlocking the demand for circular plastic packaging. Offering products with circular packaging properly verified and labelled as such can reach the consumer and influence their behaviour by enabling freedom of choice. With a growing interest from society in taking on-board sustainable products in their day-to-day purchases, it results important to offer certified packaging solutions to them.

Communication campaigns around promoting the value and impact of choices for certified products (and their packaging) should be conducted. At the same time, they should actively encourage and educate society into increasing their separation efforts at the source of generation.

Supportive information tools for championing technology adoptions such as MultiCycle

Improving the ways of measuring the environmental impacts of technology adoptions is key to compiling the information required for championing the best alternatives for increasing recycling. Solutions should be monitored and compared; thus, models and scenarios can get enough clarity to support business cases for companies across the value chain.

Integrated platforms for data collection and exchange should be created and maintained. Innovative solutions for traceability of materials and recyclates are required to use the best available technologies in data management and exchange. Disruptive technologies such as blockchain and the Internet of Things (IoT) can serve this purpose as they allow precise recording and traceability and many possibilities for data analysis.

All actors including recyclers, sorters, users of recyclates, and brand owners should be reporting and assessing the information from the platform to make better decisions in their sourcing, producing, and processing of plastic packaging.

These types of initiatives could be better suited for success when the authorities and regulatory bodies of the industry are supporting the efforts and financing R&D projects to improve implementation.

MULTICYCLE position paper on Composite Thermoplastics in the Automotive Industry and End-of-Life Vehicles

Introduction

Plastics from ELV are currently managed in the European Union without any attention to the recovery of thermoplastic-based polymers, which, when it comes to automobiles, are reinforced.[1] The automotive industry uses almost 10 % of all plastics generated in Europe.[2] Fibre reinforced plastics make up a share of approximately 25 % of a car's mass and up to 50 % of a car's volume.[3]

In 2018 a total of more than 6 million ELV were generated which result in a total mass of almost 7 million metric tonnes[4]. Considering 25 % plastics in a car, this means a total of 1.75 million metric tonnes of plastics waste stemming from ELV every year, which is not yet recycled. However, this numbers do not include the material loss resulting from exporting ELV to other countries outside of Europe. If including this, the resulting material loss almost doubles.[5]

In general, ELVs are collected and freed of any hazardous substances, which sometimes means the partial disassembly of a car. This disassembly, however, does not focus on keeping the value of plastics. It mainly focusses on getting the car ready for shredding processes. After shredding, the metals are separated which leaves the valuable plastics in a mixture of a variety of substances like textiles, films, foams, and inorganic materials like glass. This waste stream can be referred to as the so-called fluff, which currently is either thermally treated or landfilled. [6]

Further dismantling would in fact increase any possible yield of plastic components, but the disassembly of cars is very cost intensive and requires manpower. Automated disassembly processes are not possible, due to the very different existing models of cars.

Composite plastic parts in the automotive industry currently face two major challenges which are (1) ending up in a complex waste stream i.e. the shredder light fraction and (2) being non-recyclable when applying mechanical recycling technologies in the first place due to its product design.

Nevertheless, the use of plastic composites in cars will increase in the future, as these materials save weight, reduce emissions, and extend the range of alternative fueled vehicles in terms of increasing the efficiency.[7, 8] All together up to 40 different types of plastics are used in cars which also provide other convenient features like corrosion and rust resistance, flexibility, and comfort.[9] Especially the tremendous strength to weight ratio is created with composites.[10]

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[1] Cardamone, G.F.; Ardolino, F.; Arena, U. (2022): Can plastics from end-of-life vehicles be managed in a sustainable way?; Sustainable Production and Consumption, Volume 29, Pages 115-127, available online on https://www.sciencedirect.com/science/article/pii/S2352550921002621?via%3Dihub
[2] Plastics the Facts 2019 available online on https://plasticseurope.org/wp-content/uploads/2021/10/2019-Plastics-the-facts.pdf
[3] Inglezaiks, J. & Zorpas, A. (2009): Automotive shredder residue (ASR), WIT Transactions on Ecology and the Environment, 120:256-262, available online on https://www.researchgate.net/publication/261365583_Automotive_shredder_residue_ASR_A_rapidly_increasing_waste_stream_waiting_for_a_sustainable_response
*CreaSolv® is a registered trademark of CreaCycle GmbH

[4] Korica, P.; Cirman, A.; Gotvajn, A.Z. (2022): Comparison of end-of-life vehicles management in 31 European countries: A LMDI analysis; Waste Management & Research 1-11; DOI: 10.1177/0734242X221074118
[5] Oliveux, G.; Dandy, L.O.; Leeke, G.A. (2015): Current status of recycling of fibre reinforced polymers: Review of technologies, reuse and resulting properties; Progress in Materials Science (2015) 61-99
[6] Cardamone, G.F.; Ardolino, F.; Arena, U. (2022): Can plastics from end-of-life vehicles be managed in a sustainable way?; Sustainable Production and Consumption, Volume 29, Pages 115-127, available online on https://www.sciencedirect.com/science/article/pii/S2352550921002621?via%3Dihub
[7] ISWA Survey on fibre reinforced thermoplastics within the automotive sector – statement agreed on by a car manufacturer with a production range of 4 million vehicles per year
[8] https://www.automotiveplastics.com/wp-content/uploads/Transitioning-to-a-Circular-Economy_10-1-20_singlepage.pdf
[9] Transitioning Toward a Circular Economy for Automotive Plastics and Polymer Composites, available on https://www.plasticsindustry.org/sites/default/files/2016-03256-SPI-PMW-Auto-Recycle-web.pdf
[10] Bartl, A.; Hackl, A.; Mihalyi, B.; Wistuba, M.; Marini, I. (2005): Recycling of fibre materials; Institution of Chemical Engineers; Process Safety and Environmental Protection, 83 (B4): 351-358

With the current targets set being the reduction of greenhouse gas emissions by at least 55 % in 2030[11] and driving circularity forward aligning with the Circular Economy Action Plan[12], MULTICYCLE notes the following **key issues** and proposals to overcome non-sufficient recycling operations in the field of ELV's and promote circularity in mobility with the use of currently non-recyclable fibre reinforced thermoplastic composites.

KEY ISSUES

1. THE CURRENT RECYCLING INFRASTRUCTURE AND BUSINESS CASES MAINLY FOCUS ON FERROUS AND NON-FERROUS MATERIALS AND NOT ON PLASTICS.

The situation in the automotive sector for recycling and recovering materials is somewhat more difficult, than for other areas. Ideally, larger components, e.g., bumpers, are dismantled and, after sorting for mainly PP and PA, fed directly to further recycling operations. In practice however, dismantling is very cost intensive and therefore ELV are most often sent to shredders.

The European Directive 2000/53/EC on End-Of-Live Vehicles prescribes a target of 95 % of reuse and recovery with a minimum of 85 % of reuse and recycling. This means that 10 % of the weight of an ELV can be recovered via energy recovery. The remaining 85% must be recycled or reused. In practice this translates to recycling of metal parts and parts that are reusable. Parts, which are currently non-recyclable or difficult to recycle end up in incineration plants and are accountable as recovery in terms of energy recovery. The target of recycling of 85 % was achieved by 31 European countries in 2019 and the target of 95 % recovery rate is almost achieved being 93 % in 2019.[13] Nonetheless the figures presented represent the ELV processed within European borders. ELV crossing the European borders to other countries are not available for the European Recycling Industry (as presented in the second issue).

Traditionally, recycled plastics or composites made from recycled plastics are used in applications with lower value. Even though a lot of pressure has been put to improve recyclates quality, especially the structural parts in automobiles pose limitations for the use of recyclates.[14] High value applications for recyclates require high levels of purity that virgin materials can deliver easily but recovered materials might not. Due to current recycling routes, the use of plastic recyclates for manufacturing processes face severe limitations being impurities, availability, cost of recyclates and a possible lack of mechanical properties after being processed in recycling plants. [15] The probably biggest limitation is the mix of materials where plastic composites are to be found. This hinders further recycling processes and results in different contaminations of the plastic materials.

The most reinforcements used are glass fibres. Various studies on glass fibre reinforced composites lead to the conclusion that the best way to recycle these materials is to be co-incinerated in cement kilns. The price of virgin glass fibres is so low that no process currently available can provide recycled glass fibers with the same characteristics as virgin fibers at a competitive price.[16] This also means, that the valuable plastic parts are being incinerated.

[11] The European Green Deal, available on https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52019DC0640
[12] An EU Action Plan for the Circular Economy, available on https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614
[13] Korica, P.; Cirman, A.; Gotvajn, A.Z. (2022): Comparison of end-of-life vehicles management in 31 European countries: A LMDI analysis; Waste Management & Research 1-11; DOI: 10.1177/0734242X221074118
[14] Gu, F.; Hall, P.; Wu, T. (2012): The recycling of plastics from ELVs -- background, practices and potentials; Advanced Materials Research, June 2012; DOI:10.4028/www.cientific.net/AMR.542-543.271
[15] ISWA Survey on fibre reinforced thermoplastics within the automotive sector
[16] Oliveux, G.; Dandy, L.O.; Leeke, G.A. (2015): Current status of recycling of fibre reinforced polymers: Review of technologies, reuse and resulting properties; Progress in Materials Science (2015) 61-99

This leaves the current recycling industry with two main obstacles concerning the infrastructure of ELVs being the non-economically feasible disassembly of ELVs and focussing only on valuable metals within the ELV waste streams.

2. VALUABLE MATERIALS LEAVING THE EUROPEAN ECONOMY VIA EXPORT AND LINEAR ECONOMY SYSTEMS

Around 3.4 to 4.7 million ELVs (~30 - 40% of all deregistered cars) are exported from the EU every year which results in a massive loss of valuable materials for the European economy and the recycling industry. Additionally, to the material loss of Europe, it is not assured that the leaving ELVs are being treated according to state-of-the-art technology standards in other countries. This again poses a threat to the environment and affects all of us.[17]

The linear economy system is next to the leakage of ELVs via illegal exports the second big issue in losing valuable materials. Linear economy systems basically mean the collection and treatment of waste in terms of taking out all recyclable materials, which are economically feasible to recycle, and feeding the resulting residues to either waste to energy recovery or landfills. This issue also directly responds to the previous key issue concerning current recycling infrastructures. Since the recycling infrastructure only focusses on metal parts, there are several technical problems for recycling the remaining shredder light fractions where plastic composites accumulate. In order to ensure high quality recycling, the waste stream has to be known which means classifying the material content. Looking at the fluff, this is simply not possible. Recyclers mostly do not know where their input stream comes from and what content it is made of exactly.

The second reason for linear economy systems is the product design of fibre reinforced plastics. Currently there are no appropriate recycling technologies existing to deal with these designed products. They are made of a mixture of different matrix and reinforcement materials being polymers, fibrous reinforcements (glass and carbon fiber), and fillers (particles, fire retardants, colourants, etc.). Especially fillers are often not allowed to enter recycling routes due to their sometimes hazardous properties. The REACH Regulation (EC) No 1907/2006 and CLP Regulation (EC) No 1272/2008 in Europe deal with substances, which can cause harm to human health or the environment and clearly state non-recyclability of certain substances and materials. This means, that materials used quite some time ago can cause severe difficulties for recycling today. Especially flame retardants, plasticizers, lubricants, and the mineral content pose a threat to the recyclability and usability of recycled thermoplastic polymers for any recycling operations.[18] Conventional waste management and recycling routes are not able to phase out these kinds of substances and pose a very strong limitation for the possible use of recyclates.

Today's recycling infrastructure can also cause contamination during processing, which results in linear economy systems. This specifically refers to the fluff, which is currently generated.

[17] Oliveux, G.; Dandy, L.O.; Leeke, G.A. (2015): Current status of recycling of fibre reinforced polymers: Review of technologies, reuse and resulting properties; Progress in Materials Science (2015) 61-99

[18] ISWA Survey on fibre reinforced thermoplastics within the automotive sector

3. When will End-of-Life occur?

The average lifetime of a passenger car is estimated at almost 11 years, whereas busses and trucks have an average lifespan of about 20 years. Busses and trucks, however, are not within the scope of the current ELV Directive.[19] The exact point of end-of-life is not quite defined, as a car still possesses value and a financial profit can be gained, even though when there is an intention of disposing it.

Especially when it comes to big goods, the waste status mainly depends on whether the repair costs exceed the value of the good or not. In Austria, for example, a car can be roadworthy but can also be ELV if its repair costs exceed the current value of the car. Then it basically depends on the car's owner, if it is still going to be used or being disposed of. If the car is not roadworthy but can be repaired at costs which do not exceed the value of the car, it is also not considered to be ELV. In Italy, for example, the roadworthiness is essential for the distinction between ELV and a functioning car.

The regulatory framework is not harmonized throughout the European Member States when it comes to any kind of waste. This is due to the fact, that the Waste Framework Directive and the ELV Directive are directives, which can be implemented individually in every member state of the European Union. This leads to different interpretations of the waste status and the terms of recyclability or recovery of wastes.

The extended use of a car can also result in substances suddenly becoming hazardous due to new regulations and advanced scientific research. This again leads to linear economy systems, as described in the second issue of this paper. In fact, newly produced cars cannot be treated with one and the same procedure to recover polymers as cars produced 10 or 20 years ago.[20]

The main obstacle here and in all waste management related topics is that there are no recycling technologies in place today for tomorrow's materials reaching their end of life.

PROPOSALS

An appropriate recycling process for fibre reinforced thermoplastics should ideally be efficient, eco-friendly, cost-effective, and with a minimum impact on fibre length and the quality of polymers.

Automakers are already committing to circularity [21]. BMW has pledged to replace artificial materials with recycled and sustainable raw materials throughout their entire value chain. Ford establishes an interim target of 20 % renewable and recycled plastics by 2025. Volvo set a goal of using 25 % recycled plastics in cars starting in 2025. Nissan aims for 30 % to be material alternatives that do not depend on newly extracted resources by 2022. Toyota will use eco-friendly materials, use auto parts longer, develop recycling technologies and manufacture vehicles from ELV. GM, in partnership with their suppliers, will at least use 50 % of the materials in their vehicles from sustainable sources by 2030.

MultiCycle can participate in reaching these goals. However, rules and incentives are needed, to ensure investment security, especially for the recycling party. MultiCycle notes the following proposals, to overcome the described **key issues**.

[19] Korica, P.; Cirman, A.; Gotvajn, A.Z. (2022): Comparison of end-of-life vehicles management in 31 European countries: A LMDI analysis; Waste Management & Research 1-11; DOI: 10.1177/0734242X221074118

[20] ISWA Survey on fibre reinforced thermoplastics within the automotive sector

[21] Transitioning Toward a Circular Economy for Automotive Plastics and Polymer Composites, available online on https://www.automotiveplastics.com/wp-content/uploads/Transitioning-to-a-Circular-Economy_10-1-20_singlepage.pdf

1. Increasing the availability of recyclable waste streams and support technological solutions for advanced recycling technologies

The supply chain of recycled materials needs to be better connected to achieve a high usage of post-consumer recycled materials. With a better-connected supply chain, we can come closer to closing the loop with plastic composites in the automotive sector. This means knowing what happens at the product design and knowing what is needed at different recycling stages.

To focus recycling and increase recycling rates there must be recyclable waste streams available to begin with. The availability of recyclable waste streams addresses (1) the product design and (2) waste collection and treatment systems. These two factors essentially influence whether a waste stream can be recycled or not.

(1) Product design

The product design should consider Design for Recycling and Design for Disassembly. Recyclability must be considered when designing new products to drive circularity forward. In the case of the automotive industry, the design for recycling can mean either using less materials in a mix or labelling their contents to make it transparent for the recycling industry. The Design for Disassembly addresses possible guidelines ensuring easy and possible automated dismantling of cars to provide pure waste fractions, which do not only focus on the metal parts.

(2) Collection and treatment systems

As with many recycling initiatives, the material collection logistics present a significant hurdle. Considering this it could be most practical to target auto body shops where whole car parts are being replaced and present a pure waste fraction.[22] The collection in Europe mainly works via shredder companies to ensure environmentally feasible treatment. The treatment system, as already mentioned, focusses on removing any hazardous substances like fluids and gas and on the recovery of metals. The way these treatment systems work leads to non-recyclability of plastic composites as they end up in the very complex shredder fractions. The treatment of ELV must take other materials than metals into consideration, too, to drive circularity forward. It is essential to dismantle ELV parts to recover high quality thermoplastics resins and keep these parts out of shredding.[23]

Alternative recycling technologies, as the MultiCycle process offers, can be used in addition to conventional recycling operations to increase recycling rates.

When promoting technological solutions for advanced recycling technologies the quantity of plastics stemming from ELV sent to recycling operations can be increased from 2.6 % to up to 50 % which would refer to a total mass of 500,000 metric tonnes per year. The amount sent to combustion facilities could be cut down from 980 kilo tonnes per year to 230 kilo tonnes per year[24]

[22] PLASTICS INDUSTRY ASSOCIATION (2022): Recycling plastic car bumpers coul dprevent millions of pounds of waste; accessed https://www.plasticsindustry.org/article/recycling-plastic-car-bumpers-could-prevent-millions-pounds-waste

[23] ISWA Survey on fibre reinforced thermoplastics within the automotive sector

[24] Cardamone et al. (2022): Can plastics from end-of-life vehicles be managed in a sustainable way?; Sustainable Production and Consumption 29 (2022) 115-127; available online on https://www.sciencedirect.com/science/article/pii/S2352550921002621

2. Create regulatory conditions for a thriving circular market for composite thermoplastics

To effectively increase circularity several considerations must be taken to create an adequate regulatory environment for it. First, ensuring the enforcement of EU Directive 2008/98/EC of 19 November 2008 on waste, Article 3 (17) that states that products from recycling used in fuels or to produce energy should not be classed as being recycled for the purpose of achieving recycling rates.

Strict regulation should be established to solve the problem of disposal of old vehicles which have no utility. The waste hierarchy concept should be truthfully followed to allow more material recovery and prevent leakage out of the European Economy.

More ambitious recycling and material recovery targets for ELV plastic waste fractions are desired and needed for the transition to circularity. EuRIC[25] states that a recyclates quota in new cars of 35 % until 2035 is technically doable and shall be targeted by the European Policy. MultiCycle also favors this target.

EPR schemes and other instruments that could support an increased collection and separation of polymers should be implemented. However, this must be carried out with great caution as new implemented EPR models could take away waste streams from already existing sorters and shredding companies.

To reach higher recycling rates in compliance with existing legislation, ensure the protection of human health and the environment, contents plastic composites which present or can present substances of very high concern shall be obliged to be laid open. [26]

3. Develop and impulse desirable instruments and incentives for promoting circular business models

Only materials which stay within the European Economy are available for the European recycling industry. To ensure this the traceability of ELV and its components should be substantially improved to mitigate illegal exports to non-EU countries.

Partnerships between actors in the whole production and recycling value chain should be promoted and pursued to establish business cases to achieve circularity targets. This means that not only materials shall be kept in a circular model but also knowledge. Knowledge transfer and communication can be referred to as missing link in the Circular Economy. The Circular Economy Package should encourage this by rewarding incorporation and use of traceable post-consumer recycled (PCR) content back into new products[27]. This knowledge transfer also calls for transparency of materials content to ensure that recyclers know what they are dealing with.

The extensive use of virgin materials for plastic products should be disincentivized with the implementation of a carbon tax for applications that could be replaced with high-quality secondary raw materials.

Further dismantling of ELV at recycling sites is very cost intensive and is therefore not done in a great way. Incentives promoting the further disassembly and the design for disassembly can help create pure waste fractions, which are easily available for further recycling options.

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[25] EuRIC Position Paper on the revision of the ELV and 3R type approval Directives, available on https://www.euric-aisbl.eu/position-papers/download/1660/561/32
[26] ISWA Survey on fibre reinforced thermoplastics within the automotive sector
[27] MGG Recycling (2022): Complex Waste Plastics Recycling Industry "Wish List" to promote a rapid transition to a Circular Economy, accessed on https://www.mgg-recycling.com/wp-content/uploads/ELV-and-WEEE-recycling-industry-Circular-Economy-Wish-List.pdf