SYSTEMIQ

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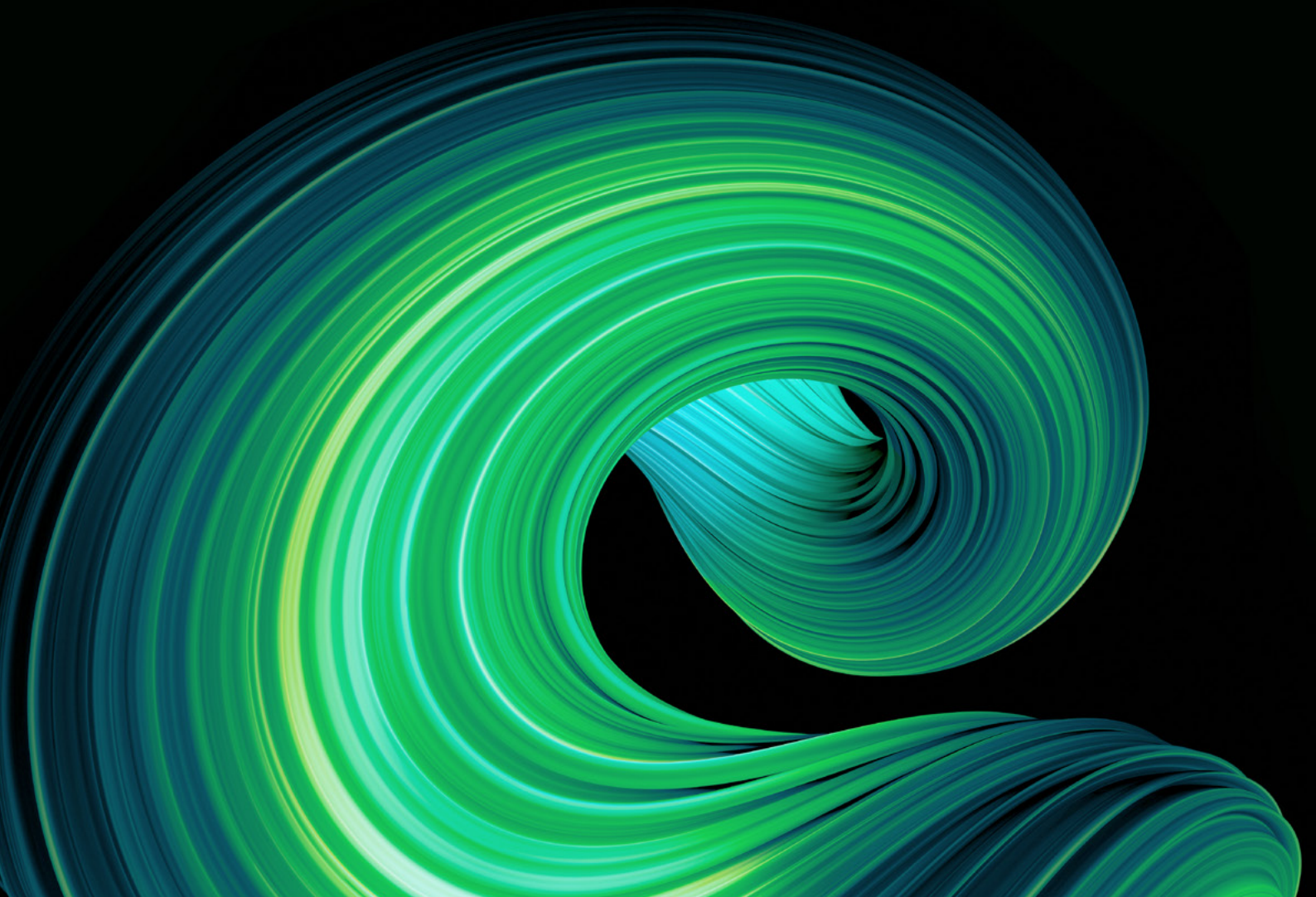
ReShaping Plastics

PATHWAYS TO A CIRCULAR, CLIMATE NEUTRAL PLASTICS SYSTEM IN EUROPE

Executive Summary



About SYSTEMIQ

SYSTEMIQ was founded in 2016 to drive the achievement of the Paris Agreement and the UN Sustainable Development Goals, by transforming markets and business models in four key systems: land use, circular materials, clean energy, and sustainable finance. A certified B Corp, SYSTEMIQ works to unlock economic opportunities that benefit business, society, and the environment; it does so by partnering with industry, financial and government institutions, and civil society. In 2020, SYSTEMIQ and The Pew Charitable Trusts published "*Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution*" - a first-of-its-kind model of the global plastics system that describes how to radically reduce ocean plastic pollution.

For more information, contact us at plastic@systemiq.earth
or visit www.systemiq.earth

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Disclaimer

The scenarios developed in this report have high uncertainty and should not be considered as predictions. The range of scenarios modelled are meant to provide high level insights by presenting alternative pathways towards achieving plastics system circularity and GHG reductions. The scenarios presented in this report are not the only possible scenarios, they are one view among an almost infinite number of scenario variations that can be generated. However, they are intended to be the most illuminating combination of pathways to guide plastics systems decision making within and between stakeholder groups. There can be no assurance that estimates or projections will be realized, that forward-looking statements will materialize, or that actual results will not be materially different to those presented. All forward-looking statements included are based on information available on the date hereof. The "ReShaping Plastics" report was prepared by SYSTEMIQ with strategic guidance from an independent Steering Committee with representation from the public sector, civil society and industry and supported by an external Expert Panel. While the report was financed by Plastics Europe, the Steering Committee and Expert Panel helped ensure its independence and unbiased nature. The statements and views presented in this report do not necessarily reflect those of Plastics Europe, or any individual or organization associated with this project.

Preface

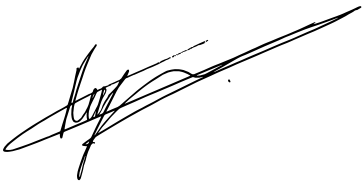
Signed:

Jyrki Katainen

President of the Finnish Innovation Fund Sitra,
Former European Commission Vice-President,
Former Prime Minister of Finland,
Steering Committee Chair

Prof. Kim Ragaert

Chair of Circular Plastics at Maastricht University
Steering Committee Deputy Chair



Yoni Shiran

SYSTEMIQ Partner
Programme Director

Plastic is both an icon of prosperity and a cautionary example of how linear models of consumption can undermine Earth's planetary limits. Plastic has been long valued for its consumer benefits – affordability, convenience, performance, flexibility, durability – but a rapid shift in awareness among governments, civil society, investors, producers, and consumers is leading to mounting demands that industry take the necessary steps to embrace circular economy approaches and mitigate climate change, in line with the Paris Agreement and Glasgow Climate Pact and the goals of the European Green Deal and Circular Economy Action Plan.

In recent years, a number of excellent studies have advanced our understanding of the plastics system, both at a global and national level. However, most studies and dialogues about plastic in Europe, focus *either* on the question of circularity *or* on the question of plastic's climate impact. But these are not separate issues. The plastics system must adapt in ways that ensure that it is both circular ***and*** generates minimal carbon emissions – hence we need to design a system that addresses these two challenges simultaneously. The "ReShaping Plastics" report aims to do precisely that.

The goal of this study is to accelerate the transition to a circular, net zero carbon emissions plastics system in Europe by providing a practical, science-based roadmap. Our hope and belief are that this work will strengthen the collaboration between industry, the public sector, civil society, and investors in the search for a better plastics system for Europe based on a shared fact base.

In July 2020, The Pew Charitable Trusts and SYSTEMIQ published "Breaking the Plastic Wave", a study that developed a first-of-its-kind full-system model to quantify the economic, environmental, and social implications of different plastic pollution scenarios on a global scale. The new "ReShaping Plastics" study now applies that modelling approach to the European plastics system to illuminate potential pathways to a fully circular, net zero carbon emissions plastics system. It is driven by the conviction that a new and shared evidence base is required to plot a science-based pathway to address current systemic challenges in the plastics system.

The analysis underpinning this report was designed to be impartial and a rigorous governance mechanism was deployed. An independent Steering Committee was established comprising a balanced mix of senior leaders across civil society, the public sector, and industry. The Steering Committee provided strategic guidance and direction in all major project decisions and had complete independence in approving the strategic approach and recommendations. Detailed assumptions underlying the analysis were also peer-reviewed and approved by an independent Panel of Experts with deep competence in the range of subject areas touched on by this study.

This work was designed to help guide policymakers, industry executives, investors, and civil society leaders through highly contested, often data-poor, and complex terrain. Our wish is that the results of "ReShaping Plastics" can serve as a map for stakeholders in search of solutions to enhance the circularity and reduce the greenhouse gas emissions of the European plastics system. But such a solution requires political leaders, policymakers, business executives, and investors to shift from incremental to systemic change.

The circular, net zero carbon emissions plastics system vision is one which designs out waste, eliminates unnecessary production and consumption, keeps products and materials in the economy, and safely collects and disposes waste that cannot be economically processed, thereby permanently increasing material circularity, reducing GHG emissions, and stopping plastic pollution.

Providing the evidence and insight needed to realize this vision of a circular, net zero carbon emissions European plastics system is the North Star guiding the "ReShaping Plastics" project.

Acknowledgements

Steering Committee

To ensure the independence of this study, we assembled a balanced Steering Committee composed of members from the public sector, civil society, and industry. The Steering Committee provided strategic guidance and direction in all major project decisions. We are deeply grateful to all the organizations and individuals who contributed for their unique perspectives. Steering Committee members endorse the overall project approach and findings, although not all statements in this publication necessarily represent the views of all individuals or the organizations they represent.

The Steering Committee members are:

Jyrki Katainen
President of the Finnish Innovation Fund Sitra,
Former European Commission Vice-President,
Former Prime Minister of Finland,
Steering Committee Chair

Prof. Kim Ragaert
Chair of Circular Plastics at Maastricht University
Steering Committee Deputy Chair

Stéphane Arditi
Director of Policy Integration
and Circular Economy
European Environmental Bureau (EEB)

Ton Emans
President PRE & Director
Group Recycling Cedo

Sirpa Pietikäinen
Member
European Parliament

Werner Bosmans
Team leader 'Plastics', DG Environment,
European Commission

Virginia Janssens
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Joan Marc Simon
Executive Director
Zero Waste Europe

Marco Ten Bruggencate
Commercial Vice President
Dow Packaging & Specialty Plastics

Dr. Martin Jung
President, Performance Materials Division
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Prof. Martin Stuchtey
Founder SYSTEMIQ, Professor for Resource
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University Innsbruck
Project Principal

Cyrille Durand
Lead, Plastics & Packaging
World Business Council for Sustainable Development (WBCSD)

Rob Opsomer
Executive Lead - Systemic Initiatives
Ellen MacArthur Foundation

Expert Panel

To ensure the scientific accuracy of this study, we assembled a panel of 10 experts representing different sectors and parts of the value chain. The Expert Panel reviewed all assumptions and provided input into the approach. We are deeply grateful to all the organizations and individuals who contributed for their deep content expertise. Expert Panel members endorse the overall project approach and findings, although specific statements do not necessarily represent their individual views or those of the organizations they represent.

The Expert Panel members are:

Dr. Irene Feige

Head of Circular Economy
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BMW

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Partner
Berndt+Partner Consultants GmbH

Thomas Hohne-Sparborth

Head of Sustainability Research
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Per Klevnäs

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Sabine Oberhuber

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Sabine Pahl

Professor of Urban and
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Endorsements

This report sets a comprehensive picture on how the plastic industry in Europe can meet the carbon neutrality challenge. Its findings makes it clear: we need to start by reducing, reusing, substituting and recycling which are all circular economy features. More costly and uncertain technological approaches such as carbon capture storage and use may only play a secondary role, once circular solutions have been fully implemented. We hope this will help create a sound base to prioritise policy developments and innovations in the plastic sector.

We also appreciate the recognition of the data gap that still exists, and of the current focus on climate impacts, which leave the door open for reinforced data collection and monitoring, as well as for further investigations on other human health and environmental impacts, complementary to the climate perspective.

The plastic sector's sustainability journey needs to continue and intensify, and we welcome the idea to set up a stakeholders platform to best approach such a journey.

Stéphane Arditi
Director of Policy Integration and Circular Economy
European Environmental Bureau (EEB)

The plastics Industry is committed to the EU's circularity & emission reduction goals. We strongly believe that plastics have a critical contribution and enabling role to the transition of many downstream industries to net zero. This will require collaboration throughout the value chain and an enabling framework from policymakers to drive a sustainable and competitive Europe. SYSTEMIQ's report is an important step in our joint understanding and journey.

Marco Ten Bruggencate
Commercial Vice President
Dow Packaging & Specialty Plastics

This report shows a path for the European plastic industry to achieve climate neutrality by 2050 and puts the application of the circular economy principles in the core of this transition. Adoption of circular strategies for both private sector and civil society are needed to tackle the three most pressing challenges of climate crisis, nature loss and mounting the inequality. Cross industry collaboration within the plastic value chain will be instrumental to overcome the challenges. Plastics Europe has the opportunity to lead the transformation and we look forward to contribute to that through our work with WBCSD's Circular Plastics & Packaging project.

Cyrille Durand
Lead, Plastics & Packaging
WBCSD

The report is a good read for all people involved in the plastic industry as well as for policymakers and all speaking about CO_2 neutrality. The report shows the potential of near, mid and long-term solutions as well as the current unknown's related to the end life of the plastics that are being used in Europe. For instance, it is still unknown what happens to the 40 % statistic gap between the volume put on the market and the volume of plastic waste collected. Prevention and re-use models are also taken into consideration in this report. It gives a good understanding of the recycling technology available today such as mechanical recycling which is efficient cost effective circular technology well established in Europe. Besides that the investments needed to reach the European targets. As well as the issues related to chemical recycling such as the choice and the competition on feedstock, the right technology and the competitiveness, regulation and traceability.

The report also shows opportunities for diverse technologies for industrial decarbonization without switching to alternative feedstock energy or resources.

Ton Emans
President PRE & Director
Group Recycling Cedo

The plastics industry is working towards higher levels of circularity and reducing the emissions throughout its value chains. The "ReShaping Plastics" report helps all stakeholders to better understand feasibilities and limitations on this path. Foremost, it aims to encourages all stakeholders to closely co-operate and listen to each other in order to advance a truly sustainable plastics economy.

Dr Martin Jung
President, Performance Materials Division
BASF

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This formidable work addresses a key current issue, plastics in society. The report summarises the scale of the challenge and develops powerful future scenarios to inform concerted action. The key message is 'Act Now', because we cannot continue as we have done for roughly the last 80 years, which have seen increasing volumes of commercial plastic used in a linear fashion. Plastic use is treated as a system with diverse actors, demands and pressures, with no simple lever for change ("no silver bullet"). The report emphasises holistic thinking, for example, by rejecting the false dichotomy between upstream and downstream solutions. The important potential of behaviour change is considered as an integral part of the system, but without assigning excessive responsibility to the individual consumer, rather, consumers should be supported and enabled to be part of the solution. I truly hope this work gets the attention it deserves and leads to rapid impact, future-proofing essential uses of plastics but drastically reducing leakage to the environment.

Sabine Pahl
Professor of Urban and Environmental Psychology
University of Vienna

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In general there are no good or bad materials. There are just materials in wrong use or badly handled. Plastics are a valuable material, which we are going to need also in the future, but we need to design out the waste from plastic goods and create 10-fold resource efficiency in material use to halt the prognosis of the sharply increasing plastic production. We need to create a closed-loop plastic economy. This report is a significant step in this road.

Sirpa Pietikäinen
Member
European Parliament

”

As we are already front runners in waste logistics and collection, it is important to differentiate the European plastics system and its challenges from the global one. Littering is not the main European challenge and therefore gratuitous reductions and substitutions are not the answer. ReShaping Plastics has given us a long-awaited science-based quantification on the potential gains of different approaches to reaching net zero. Single solutions will not cut it and neither will continued responsibility-shifting between actors. Read the report, absorb the recommendations and get to work. Everyone.

Kim Ragaert
Full Professor & Chair of Circular Plastics,
Faculty of Science and Engineering
Maastricht University

”

This report on the future of the European plastics system is an important roadmap for an industry that is facing an existential challenge to carve-out a cleaner, more sustainable future, and provides important guidance for the entire value chain on where the biggest impacts need to happen. As a pioneering investor in the technologies that can support this transition, we hope this report serves as an important catalyst to drive further capital towards the solutions required to achieve a circular, net zero plastics industry.

Jamie Rowles
Head of Investments
Sky Ocean Ventures

”

With plastic pollution continuing to abound, the ReShaping Plastics study is a key framing exercise to bring in circularity and decarbonisation into the agenda. This report portrays the scale of political, technological and financial leap forward needed in order to make plastic a sustainable material. The findings of this report constitute a measuring tape that we should use to evaluate whether the upcoming laws and industry commitments can deliver to the challenge of stopping plastic pollution.

Joan Marc Simon
Executive Director
Zero Waste Europe

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Closing the loop for plastics is an essential part in the development of circular economy. This idea generates a broad range of challenges, as plastics have an enormous diversity in properties and applications. Low hanging fruit has been captured, so we need to develop more innovative strategies. The current report provides a solid basis to understand where the opportunities lie to make the necessary step changes in the plastics system.

Prof. Karl Vrancken
Research Manager Sustainable Materials
VITO

”

Around the world, businesses and governments are taking action to build a circular economy for plastics, by eliminating the plastics we don't need, innovating towards new business models and materials, and circulating the plastics we do use. Yet, despite recent progress, we know that much more and faster action is required. This report provides a strong fact base to support such accelerated action in Europe, and I encourage all stakeholders to engage with it.

Rob Opsomer
Executive Lead - Systemic Initiatives
Ellen MacArthur Foundation

Executive Summary:

5 essential findings

Plastic provides excellent utility for society across many sectors, including healthcare, construction, food chains, energy and transportation. Plastic has long been valued for its consumer benefits – affordability, convenience, flexibility, durability - and increasingly for its contribution to climate change mitigation, for example by insulating buildings or light-weighting vehicles. However, a rapid shift in awareness among governments, civil society, investors, producers, and consumers has led to growing demands that the makers and users of plastic – along with other industries – take the necessary steps to mitigate climate change and embrace circular economy approaches, in line with the Paris Agreement and Glasgow Climate Pact and the goals of the European Green Deal and Circular Economy Action Plan.

Despite progress on circularity and bold commitments on greenhouse gas (GHG) emissions, the plastics sector faces significant challenges. The European plastics system in 2021 is predominantly linear, with only 14% of plastic waste estimated to be recycled each year and the remainder being either incinerated with energy recovery, landfilled, exported, or littered. Countries are increasingly pivoting from landfilling waste to incineration with energy recovery, a European policy objective[i] that is in-line with the waste hierarchy, but which increases system-level GHG emissions from plastic in Europe, particularly as the growth in renewable energy generation makes the environmental outcomes of waste-derived electricity comparatively worse. This shifting dynamic means that goals to increase circularity and reduce the amount of plastic waste disposal are now closely aligned with goals to reduce GHG emissions from the plastics system.

The dominant environmental challenges faced by the European plastics system[ii] are high levels of waste generation and GHG emissions from both production and disposal, with environmental littering representing a relatively low percentage of waste volumes, although continuing to raise concerns. While each of these challenges in isolation would require significant logistical changes and investments, addressing them concurrently presents an even bigger challenge. To address this, there is a high expectation for the European plastics system to: (a) ambitiously implement circularity principles across the value chain; (b) define and commit to a credible path to net zero GHG emissions; and (c) continue intensifying efforts to eliminate plastic pollution in the environment.

However, while many stakeholders want to take meaningful action, the economic, fiscal, environmental, and social implications of different pathways are often unclear, making it difficult to determine which actions should be prioritized for different plastic applications, or to understand the synergies between different solutions. Fast and coordinated system changes are needed in order for all industries to align with climate mitigation and circularity goals, but without a shared view of potential scenarios and trade-offs, grounded in science and economics, stakeholder positions could become increasingly polarized and opportunities for convergence and collective action could be lost.

"ReShaping Plastics" focuses on four of the most important plastic-using sectors: packaging, household goods, automotive, and construction. The scope of this study covers 75% of total European plastic demand and 83% of known post-consumer waste generation.[iii] The study draws on analyses carried out by researchers, civil society organizations, companies, universities, and government agencies. It has been guided by an independent Steering Committee and Expert Panel with representation from government, industry, academia, and civil society. At the heart of the study is a data-driven model of the European plastics system, which allows the research team to assess the impact of different interventions and system scenarios from now until 2050. This scenario analysis produced five essential findings that could help leaders and decision makers across the public sector, private sector and civil society to find an effective pathway towards a highly circular, low-carbon emission plastics system.

1 The European plastics system is already adapting to address the challenges of climate change mitigation and circularity, but not yet fast enough to align with the goals of the Circular Plastics Alliance, European Green Deal, or the Paris and Glasgow climate agreements.

i The Landfill Directive limits the share of municipal waste landfilled to 10% by 2035.
ii Some plastic enables the reduction GHG emissions during the use phase, such as through insulation of housing and light-weighting vehicles; this study focuses on plastic production and end-of-life carbon emissions and did not quantify emission savings during the use phase.
iii Europe refers to the 27 European Union member states and the United Kingdom. Note that industrial packaging is out of scope for this study.

Current industry and policy actions[iv] could more than double system circularity from 14% to 33% by 2030 (measured as the share of expected plastic demand that is reduced, reused, or recycled). This would lead to a reduction of 11 million tonnes (Mt) of CO_2e emissions and 4.7 Mt less plastic waste disposed in landfills or incinerators, compared to a continuation of business as usual trends by 2030. While this is positive development, these actions are insufficient to address the scale of the challenge and would still leave a highly resource inefficient system. Government and company actions are not currently on track to deliver 10 Mt of recycled plastic production by 2025 commitment made by the Circular Plastics Alliance (a multistakeholder initiative under the European Strategy for Plastics) and do not align the industry with the necessary trajectory for achieving the Paris and Glasgow climate agreements. Achieving existing commitments will require a substantial effort on behalf of industry, regulators, and other stakeholders, but they still do not go far or fast enough.

2 There is no "silver bullet" solution to significantly reduce waste disposal and GHG emissions. Upstream and downstream solutions are complementary and are most effective when deployed together.

To date, many stakeholders have focused on either "upstream" (pre-consumer, such as material redesign, plastic reduction, and substitution) or "downstream" (post-consumer, such as mechanical and chemical recycling) solutions. Our analysis shows that this is a false dichotomy. Scenarios of single-group levers modelled in this study are not adequate to change the system. Upstream solutions that aim to reduce or substitute plastic use are critical but will need to be scaled carefully to limit adverse social or environmental effects. While there are significant opportunities to reduce, redesign or – in some cases - substitute plastic in the system, relying on these solutions alone leaves substantial waste disposal and GHG emissions, even if solutions are scaled ambitiously. Similarly, downstream solutions are essential but limited by economic viability and the realistic speed of infrastructure development and feedstock tolerance. Relying on an ambitious scale-up of mechanical and chemical recycling also leaves substantial waste disposal and GHG emissions in the system. All these solutions have an important role to play in the future plastics system, and none can be left out, but none are sufficient on their own.

3 Ambitious adoption of circular economy approaches in the plastics value chain – i.e. applying upstream and downstream solutions together - can drive significant reductions in GHG emissions and waste disposal in the next decade and beyond.

The Circularity Scenario developed in this study applies proven circular economy technologies and approaches together and at scale, within feasibility constraints. It provides an affordable and achievable pathway for reducing GHG emissions and plastic waste disposal by 33% and 46% respectively by 2030 compared to 2020 (and even more by 2040/2050), and for achieving 78% circularity in the European plastics system by 2050 (see Figure 1). The analysis indicates that this scenario requires major shifts in policy, public behaviour change, and an investment of approximately €160-180 billion between 2020 and 2050. Circularity levers are the fastest, most affordable, most effective, and most reliable method of reducing GHGs and waste disposal in the system available to stakeholders today, and most of their benefits can be achieved before 2040. Circularity also has a positive impact on employment levels, although some workforce reskilling may be required. Achieving this scenario requires concurrently scaling up five synergistic system interventions, specifically:

- Elimination[v] of unnecessary plastic, reuse, and other new delivery models have the potential to reduce almost 5 Mt of plastic waste per year by 2030 (current commitments and regulations reduce plastic waste by only 1.5 Mt by 2030).
- Mechanical recycling across all sub-systems, which could grow by 1.8 times to almost 6 Mt by 2030. This will require design for recycling, as well as scaling the entire recycling value chain, including collection and sorting.
- Chemical recycling, which can scale to 3 Mt by 2030, giving rise to a step change in system circularity. Chemical recycling should be used to tackle the hardest to address waste streams, thereby enabling circularity for food packaging that cannot meet the food safety and hygiene requirements for mechanical recycling, and

iv Includes approved regulation at the European level or credibly voluntary commitments made by industry; further details can be found in Chapter 1.
v Elimination refers to practices that reduce packaging that does not serve an essential function while maintaining utility, either through direct elimination at source of unnecessary packaging or through innovative product and packaging design.

making the two interventions complementary. This technology has the potential to address hard-to-recycle waste streams but needs to be implemented correctly, with adequate policy support, to avoid building out plastic-to-fuel routes or increasing the system's GHG emissions.

- Substitution levers, that have the potential to replace 1.5 Mt of plastic by 2030, while accounting for unintended consequences.
- Continued increase of anti-littering efforts and the elimination of exports of plastic waste to countries outside Europe, where littering cannot be controlled, which together could lead to a domestication of plastic waste within an optimized and scaled European waste management system.

Figure 1 shows the fate of plastic waste under the Circularity Scenario, as calculated in this study.

4 In addition to these proven circular economy approaches, there are multiple less mature pathways to develop and deploy innovative technologies and approaches that further decrease GHG emissions and tend to decouple plastic from fossil fuel feedstocks.

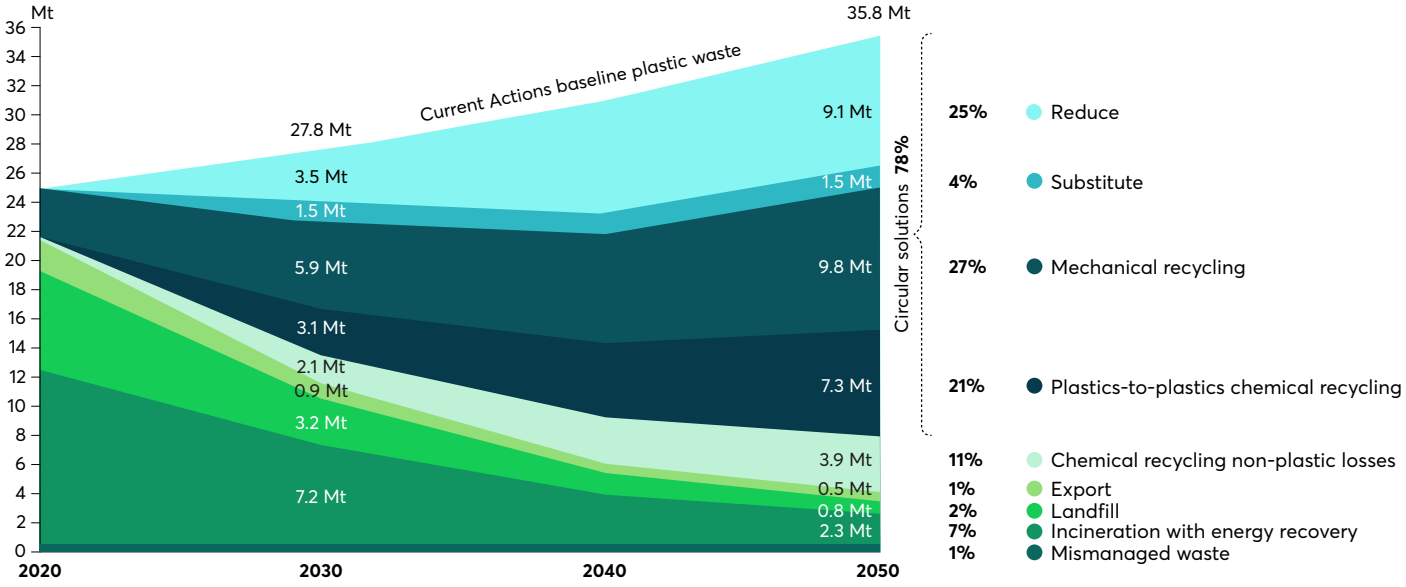
This study models two scenarios that build on the Circularity Scenario and further decrease GHG emissions in the European plastics system in line with the Paris and Glasgow climate agreements. The results are promising, but achieving these scenarios requires radical innovation, ambitious policies, cross-sector partnerships, and significant capital investment, and the analysis is based on many uncertainties.

- The Retrofit Systems Change Scenario describes a pathway of retrofitting the existing fossil fuel based plastics manufacturing system with GHG reduction technologies. It includes the substitution of carbon intensive fuels (e.g., moving from fossil fuels to green hydrogen in steam crackers) and the capture/storage of carbon dioxide (CO_2) emissions from plastic manufacturing and incineration with energy recovery.

Figure 1

By 2050, the Plastics system could achieve 78% circularity with 30% of waste avoided through reduction and substitution and 48% being recycled, leaving 9% in landfills and incinerators

Physical fate of plastic waste from packaging, household goods, automotive and construction 2020-2050 (Mt)



Source: "ReShaping Plastics" model

This is a capex-efficient method of reducing GHGs while maintaining production from existing assets, but it does not provide a route to net zero emissions by 2050 as 27% of GHG emissions remain.

- The Net Zero Systems Change Scenario describes a potential pathway to a net zero emissions plastics system by 2050. In addition to all the system interventions from previous scenarios, this scenario expands the role of hydrogen and the use of alternative feedstocks from both biological sources and CO_2 capture. Exclusive dependence on biological sources of carbon feedstock is risky, but by expanding the use of captured CO_2 (enabled by a clean hydrogen economy), the plastics system could strategically reposition itself as a carbon sink and enabler of climate change mitigation. This scenario also assumes an increased use of electricity to heat cracker facilities. By 2050, under this scenario, the European plastics system is projected to emit -5 Mt of CO_2e per annum and reduce virgin fossil plastic demand by an estimated 68%, signalling that a partial decoupling from fossil feedstock may be possible. However, this scenario relies on wider developments in industry, for example shifts to renewable energy and the scale-up of green hydrogen production. It requires that approximately 1 in 4 Euros in the plastics system be re-allocated from low risk-return, established business models to higher risk-return, less mature business models. The Net Zero Systems Change Scenario is one of multiple possible scenarios to reach a net zero emissions system, but the only one that this study analyzes in greater depth.

5 The next three to five years are a critical window for action. Long technology maturity cycles and capex lock-in for large infrastructure investments mean that the decisions taken in the early 2020s will determine whether or not the European plastics system will achieve a circular economy and net zero GHG emissions by 2050.

The plastics industry is currently targeting pyrolysis as the dominant pathway for chemical recycling in the 2020s, implying a continued reliance on steam cracker production, the need to further invest in steam cracker capacity, and impacting the implementation of decisions on major decarbonization infrastructure with long-term ramifications. Given the lifespans of these assets, the long technology maturity cycles, and the capital investment required, there are imminent infrastructure lock-in implications. Recycling plants, incinerators, and steam crackers all have lifespans of 20 years or more. That means investment decisions made this decade, and particularly in the next three to five years, will determine what the European plastics system looks like in 2050. Similarly, given the nascence of these technologies and the plastic-to-plastic chemical recycling industry, data shows that it takes an average of 17 years[1] from the concept stage for technology providers to reach growth scale. Capital investments made today will have long term consequences.

Despite the prominence of plastic as a pillar of European industry, and the growing attention paid to circular economy solutions, there are significant data gaps that will need to be resolved to enable a circular economy and mitigate climate and environmental risks. An estimated 43% of the plastic put on the market in Europe is unaccounted for in waste statistics (approximately 22 Mt per year). Some of this plastic is entering a growing "stock" contained in buildings, cars, and consumer products (or being exported in finished goods), but some may be ending up as unclassified materials in mixed waste streams going to landfill or incineration. This data gap presents a major challenge to our understanding of the environmental and climate impacts of the industry, and to our efforts to design and implement circular economy solutions. It is also a limitation of this study, which uses published data statistics and may be under-representing the end-of-life impacts of plastic in Europe.

Achieving the ambitious outcomes modelled in this study requires substantial changes in the business models of firms producing and using plastics and their substitutes; overhauls to the recycling and waste disposal industries; new investment models and criteria; and the modification of consumer behaviour at scale. These are unlikely to materialize unless government policies create significant incentives and mechanisms for circular business models such as recycled materials or reused products. To remain competitive with linear, emissions-intensive plastics systems around the globe, targeted policies and support for the European plastics industry may be needed, as well as greater transparency of carbon and environmental footprints of all products placed on the EU market. At the same

time, industry should ensure that all plastic put on the market is recyclable, invest in material and business model innovations, and join with governments to help finance and scale advanced collection, sorting and recycling systems.

Further research, dialogue and collaboration between industry, government and civil society will be essential to ensure a stable investment climate and effective policy enablers for a circular, net zero emissions European plastics system. Delivering the systems transformation needed will very likely require a system-level coordination body, active innovation, and the implementation of upstream and downstream circularity and GHG reduction projects by industry, accompanied by major financing for an innovation agenda and infrastructure expansion. Data transparency and definition consistency also are critical ingredients to enable the necessary trust and collaboration between parties.

Fortunately, there are promising emerging efforts to build on. In addition to existing EU initiatives, the Circular Plastics Alliance is a unique multistakeholder collaboration at the European level aimed at helping plastic value chains boost the EU market for recycled plastic. The Ellen MacArthur Foundation's New Plastics Economy initiative has already united more than 1,000 organizations behind a vision for a circular economy under a global commitment for plastic that is a good first step towards pursuing the systemic changes identified in this report. Early discussions are also underway regarding establishing a new international agreement on plastic pollution that may help provide a global policy framework for united government action and ensure that the European plastics system is competitive.

This report focuses on the best-case scenario to transform the system. How close the system comes to achieving it will depend on the level of ambition and leadership shown by key decision makers across industry, policy, and civil society in the coming few years. A circular, net zero plastics system in Europe is within reach, but it will require enhanced ambitions and bold decisions.

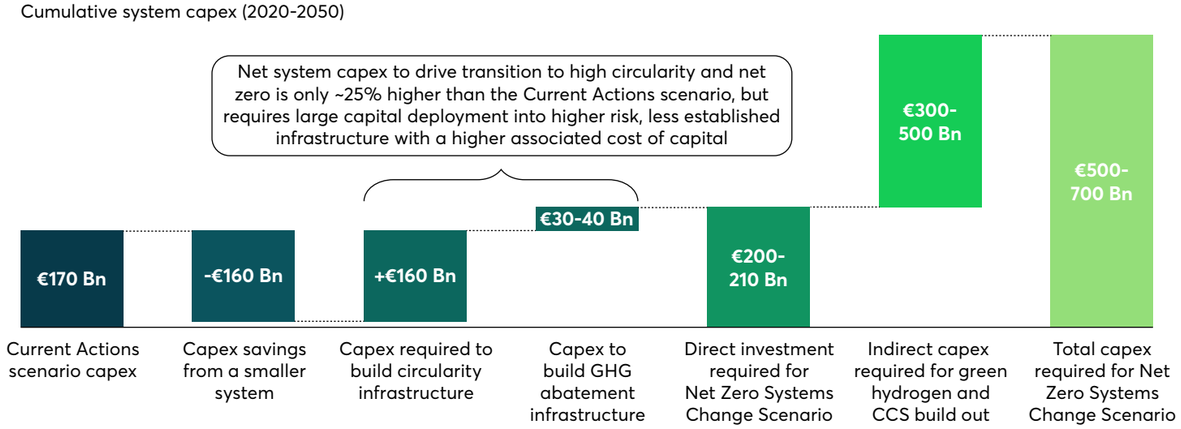
"While many stakeholders want to take meaningful action, the economic, fiscal, environmental, and social implications of different pathways are often unclear, making it difficult to determine which actions should be prioritized for different plastic applications, or to understand the synergies between different solutions. "ReShaping Plastics" attempts to fill that gap."

ReShaping the European Plastics System

Scenario	Scenario description	Key Assumptions
Current Actions Scenario	All major commitments already made by the public and private sectors until 2020 are implemented and enforced These include European regulation and voluntary industry commitments	• Current regulation (as of April 2021) is implemented and enforced • No additional regulation is put in place • Voluntary commitments are met in full • Basel convention strengthens and international waste trade is increasingly controlled and regulated
Reduction & Substitution Scenario	Reduction of plastic use through elimination, ambitious introduction of reuse and new delivery models, and plastic substitutions where it makes sense	• Strong policy intervention to incentivize reuse, new delivery models and DRS • Investment into reuse and new delivery models infrastructure, including reverse logistics, and technological improvements • Wide consumer and business adoption of these models • Performance & cost improvements of compostables and other substitutes
Recycling Scenario	Ambitious expansion and investment into collection for recycling, sorting, mechanical recycling, and chemical recycling infrastructure	• All plastic packaging is designed for recycling • Supportive policy incentives including minimum recycled content, recycling targets, EPR and more • Financial investment into recycling investment and R&D • Chemical recycling scales across Europe from its low base today
Circularity Scenario	All circularity levers are applied concurrently and ambitiously, including both upstream (see Reduction & Substitution Scenario) and downstream (see Recycling Scenario)	• All "Recycling Scenario" and "Reduction & Substitution Scenario" conditions are met concurrently • Consumers are educated, engaged and change behaviours regarding consumption and waste management
Retrofit System Change Scenario	On top of Circularity Scenario, assumes the substitution of carbon intensive fuels with low-carbon hydrogen and the capture and storage of CO_2 emissions from plastic manufacturing and incineration	• Affordable and abundant low-carbon hydrogen is available at ~€2/kg • CCS technologies scale and are affordable in multiple geographies • Methanol to olefins capabilities are available (commercially) to upgrade steam cracking off-gasses • Chemical recycling can improve its carbon profile
Net-Zero System Change Scenario	On top of Retrofit Scenario, assumes expansion of the role of hydrogen, the use of alternative feedstocks from both biological sources and CO_2 capture, and electrification of some steam crackers	• Carbon usage technologies reach maturity and affordability • Sufficient quantities of sustainable biomass is available for plastics • Electrification of steam cracking technical barriers can be overcome • GHG reduction can be applied to chemical recycling

THE COST OF NET-ZERO & HIGH CIRCULARITY

Cumulative system capex (2020-2050)



2050 ENDSTATE Scenario	Circularity (%)	GHG Emissions ($MtCO_2e$)	Virgin Fossil Plastic Use (Mt)
Base Case (Current System)	14%	112	44
Current Actions Scenario	33%	92	37
Reduction & Substitution Scenario	52%	68	29
Recycling Scenario	69%	41	24
Circularity Scenario	78%	33	20
Retrofit System Change Scenario	78%	25	20
Net-Zero System Change Scenario	78%	~0	11

1 Defined as the share of plastic utility that is either reduced, substituted by circular materials, or recycled mechanically or chemically excluding plastic entering stock.
2 Cumulative capital investments 2020-2050. Excludes cost of decommissioning legacy assets; some scenarios may have higher operating costs not shown in this table.
3 Includes direct investment into the Plastics system (e.g., recycling facilities, new delivery models, etc) and indirect capex not made directly by the Plastics system (e.g., carbon capture and storage or green hydrogen) but paid by plastics industry in long-term offtake contracts to suppliers of GHG reduction infrastructure. Does not include opex efficiency savings in production from upstream circularity levers.

FAST FACTS

ReShaping Plastics in numbers

State of Play Today

24.5 million tonnes of **plastic waste generated** in 2020

14% of **plastic waste were recycled**, providing 3.5 Mt of recyclates in 2020

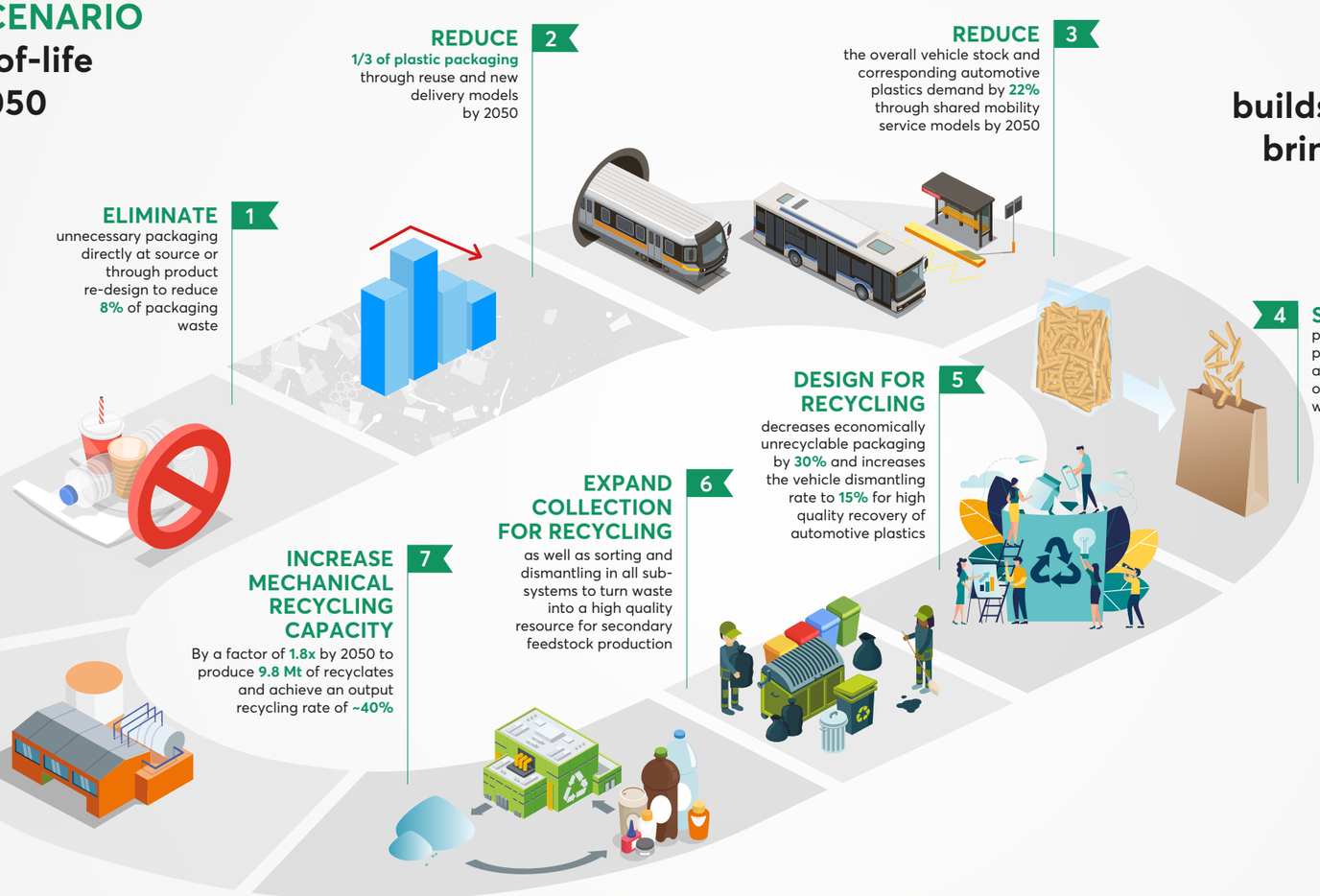
50% of today's European plastic waste is **incinerated for energy recovery**

95 million tonnes of **CO_2e are emitted per year** in 2020, one-third is caused by incineration

8-15 million tonnes of **unaccounted for plastic** as a result of gaps in waste data

The CIRCULARITY SCENARIO reduces 80% of end-of-life plastic disposal by 2050 compared to today,

effectively reducing system CO_2 emissions by 65% through the immediate implementation of 8 complementary system intervention levers in the plastics value chain



1 ELIMINATE
unnecessary packaging directly at source or through product re-design to reduce **8%** of packaging waste

2 REDUCE
1/3 of plastic packaging through reuse and new delivery models by 2050

3 REDUCE
the overall vehicle stock and corresponding automotive plastics demand by **22%** through shared mobility service models by 2050

4 SUBSTITUTE
plastic packaging with paper and compostables alternative to switch **8%** of projected plastic waste by 2050

5 DESIGN FOR RECYCLING
decreases economically unrecyclable packaging by **30%** and increases the vehicle dismantling rate to **15%** for high quality recovery of automotive plastics

6 EXPAND COLLECTION FOR RECYCLING
as well as sorting and dismantling in all sub-systems to turn waste into a high quality resource for secondary feedstock production

7 INCREASE MECHANICAL RECYCLING CAPACITY
By a factor of **1.8x** by 2050 to produce **9.8 Mt** of recyclates and achieve an output recycling rate of **~40%**

8 SCALE UP CHEMICAL RECYCLING
for hard-to-recycle plastics to produce **7.3 Mt** of secondary feedstock by 2050

The NET ZERO SYSTEMS CHANGE SCENARIO builds on the Circularity Scenario and brings the European Plastics system on a net zero pathway through 4 methods of GHG reduction:

A
CHANGE THE FEEDSTOCK CARBON SOURCE
to provide 1/4 of feedstock by 2050 via sustainable bio-based materials or captured carbon and hydrogen

B
APPLY BLUE AND GREEN HYDROGEN
as fuel and feedstock to reduce production emissions

C
ELECTRIFY HEAT SOURCES
for steam crackers with cumulative production capacity of 1.5 million tonnes by 2050

D
CAPTURE PRODUCTION AND END-OF-LIFE EMISSIONS
through applying CCS to steam crackers or CCU/S to waste-to-energy plants

The NET ZERO SYSTEMS CHANGE SCENARIO achieves environmental and economic benefits

Target State 2050

-60% (255 Mt) less waste incinerated between 2020-2050

>70% less virgin plastic produced from fossil fuels

1.6 Gigatonnes cumulative CO_2 emissions saved between 2020-2050

+160,000 jobs from circularity levers

1 in 4€ to be redeployed to innovative low carbon technologies and circular business models

"ReShaping Plastics: Pathways to a Circular, Climate Neutral Plastics System in Europe" presents an evidence-based roadmap for a paradigm shift in the European Plastics system. Following the approach developed in *Breaking the Plastic Wave*, it quantifies the economic, environmental, and social indicators for six possible scenarios to achieve plastic circularity while significantly reducing greenhouse gas emissions in Europe.

A Steering Committee comprising 13 senior leaders from public policy, civil society and industry provided strategic guidance for this work, while a panel of 10 experts ensured the scientific accuracy of the study.

The aim of this report is to help guide policymakers, industry executives, investors, and civil society leaders as they seek to understand the trade-offs and navigate through a highly contested and complex terrain towards a circular Europe plastics system.

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