Cutting plastics pollution

Financial measures for a more circular value chain

European Investment Bank

European Commission

Cutting plastics pollution

Financial measures for a more circular value chain

European Investment Bank

European Commission

Cutting plastics pollution — Financial measures for a more circular value chain

For further information on the EIB's activities, please consult our website, www.eib.org. You can also contact our InfoDesk, info@eib.org.

European Investment Bank
98-100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-1
info@eib.org
www.eib.org
twitter.com/eib
facebook.com/europeaninvestmentbank
youtube.com/eibtheeubank

Prepared for: European Commission (DG RTD)

By: Innovation & Digital Finance Advisory, European Investment Bank
Authors: Guy Hudson, Paulina Brzezicka, Arnold Verbeek, Roman Samoylov
Analytical support provided by: Rebel and Conversio Market & Strategy

The report was produced with funding from the European Union, under the InnovFin mandate.
Contact: InnovationFinanceAdvisory@eib.org

Published by the European Investment Bank.
Printed on FSC® Paper.

pdf: QH-03-22-156-EN-N ISBN 978-92-861-5405-8 doi 10.2867/123625
eBook: QH-03-22-156-EN-E ISBN 978-92-861-5406-5 doi 10.2867/201865

Table of contents

FOREWORD **5**

EXECUTIVE SUMMARY **6**

Financial Recommendations 8

Policy Recommendations 9

ACRONYMS AND ABBREVIATIONS **11**

GLOSSARY **12**

CONTEXT **13**

Plastics pollution — a complex and growing global issue 13

External costs 14

European policy on plastics 14

Role of the EIB 17

METHODOLOGY **18**

Ecosystem mapping 18

Value chain mapping 18

Expert and stakeholder interviews 19

KEY FINDINGS **22**

1. #NEED FOR MORE FUNDING AND CAPACITY 23
2. #INEFFICIENT VALUE CHAIN 26
3. #DOMINANT ACTORS IDENTIFIABLE ACROSS THE VALUE CHAIN 29
4. #UNFAVOURABLE ECONOMICS OF RECYCLATE 32
5. #TOO MANY PLASTIC TYPES, TOO SHORT A LIFESPAN 34
6. #BRAND OWNERS AND CONSUMERS ARE KEY DECISION-MAKERS 36
7. #CHALLENGING ECONOMICS OF SORTING AND RECYCLING 39
8. #INNOVATION EXISTS, BUT REMAINS TRICKY 44

KEY RECOMMENDATIONS **49**

Key issues 49

Key solutions 50

Financial recommendations 51

Policy recommendations 57

REFERENCES **58**

Table of figures

Figure 1: European policy context 15
Figure 2: Methodology overview 18
Figure 3: Key root causes of inefficiencies in the plastics value chain 20
Figure 4: Key findings 22
Figure 5: Sorting output capacity gap 23
Figure 6: Recycling throughput capacity gap 24
Figure 7: Overview of stakeholders across the plastics value chain 26
Figure 8: Top ten producers in the world (Mt per year) 29
Figure 9: Applications of plastics 30
Figure 10: Total plastics production per region 31
Figure 11: Plastic waste generation per region 31
Figure 12: Dominance of packaging at end-of-life 35
Figure 13: Total managed plastic waste 40
Figure 14: Total unmanaged plastic waste 40
Figure 15: Plastic waste disposal in the EUR27+3 countries 41
Figure 16: Plastic waste treatment in the EU27+3 countries 42
Figure 17: Emerging innovative solutions 45
Figure 18: Key recommendations 51

Spotlights

Spotlight 1: Plastic waste export from Europe 15
Spotlight 2: End-of-life fate of plastic packaging 27
Spotlight 3: Oil and gas price dynamics in the context of plastics 33
Spotlight 4: EPR Systems 37
Spotlight 5: Microplastics 43
Spotlight 6: Quick reference guide — bioplastics 47

Case studies

Case study 1: Borealis 52
Case study 2: Carbios 55
Case study 3: Caribbean Sustainable Water Management and Clean Oceans Programme 56

FOREWORD

Over the past 70 years, plastics have become an indispensable part of our lives and are produced in ever greater types and quantities. Unfortunately, their very usefulness and their ubiquity hides a darker side. Many plastics are too often discarded in the natural environment, where they never degrade. By 2050, it is expected that 12.5 million metric tonnes of plastic waste will either lie in landfills or in the land or marine natural environment, as the enduring legacy of a linear business model and a continuous growth in demand, which have created a plastics pollution crisis.

The circular economy agenda addresses the problem of plastic waste pollution, especially for packaging. Beyond the significant ecological cost of land and marine plastic pollution, the growing volume and the technical specifications of plastics production are at odds with the need to limit the industry's greenhouse gas emissions and carbon footprint. Addressing this is critically important to the European Investment Bank in its role as the EU climate bank and through its commitment to the Paris Agreement.

The issue of plastic waste pollution is attracting global attention and action. Initiatives such as the Global Treaty on Plastics, announced by the UN Environment Programme in Kenya in February 2022, is the first attempt at a global solution to this global problem which requires collective action.

Over the past decade the European Union has played a leading role in fostering a more circular treatment of plastics, based on a mix of incentives and regulatory actions. However, further opportunities exist for pushing towards a more circular economy for plastics, through a smart combination of policy action and dedicated financial instruments.

This report by the European Investment Bank's Innovation and Digital Finance Advisory Division examines the inefficiencies that lead to leakages across the plastics value chain — built up over many decades of exponential growth in both the types and volume of plastics produced — and the potential for directing investment towards solutions to the problem. The Bank is already financing innovative companies and public authorities in the European Union and beyond, and it is prepared to do more under the InvestEU and Global Europe programmes.

I would like to express my sincere thanks to our colleagues at the European Commission for funding this deeper exploration into the challenges of creating a truly circular economy in plastics to the benefit of the natural environment in Europe and across the globe.

Ambroise Fayolle, Vice-President, European Investment Bank

EXECUTIVE SUMMARY

Context

Plastics are an indispensable material in the modern economy, providing durable and cost-effective solutions across many sectors and economic activities. However, over the past 70 years plastics production has grown exponentially in terms of volume and the increased complexity of the underlying compounds. In the absence of a fully circular economy in plastics, the world faces the growing problem of increased plastics production, rapid consumption and discharge into the natural environment — both on land and at sea.

Policy Goals

At the European Union (EU) level, the European Strategy for Plastics has set a plastic packaging recycling target of 50% by 2025 with the aim of generating 10 million tonnes of recycled plastics in new products, across all Member States, by the same year.[1] Furthermore, all plastic packaging on the European market should be reusable or recyclable by 2030, with additional targets proposed by the draft revision of the EU legislation on Packaging and Packaging Waste in November 2022. At the global level, international commitments such as the Global Treaty on Plastics under the auspices of the UN Environment Programme (UNEP) or the recent creation of the Business Coalition for a Global Plastics Treaty (led by the Ellen MacArthur Foundation and the World Wide Fund for Nature, WWF) are clear signs that the time has come to find a durable solution to the growing problem of plastic waste in our natural environment.

Objective

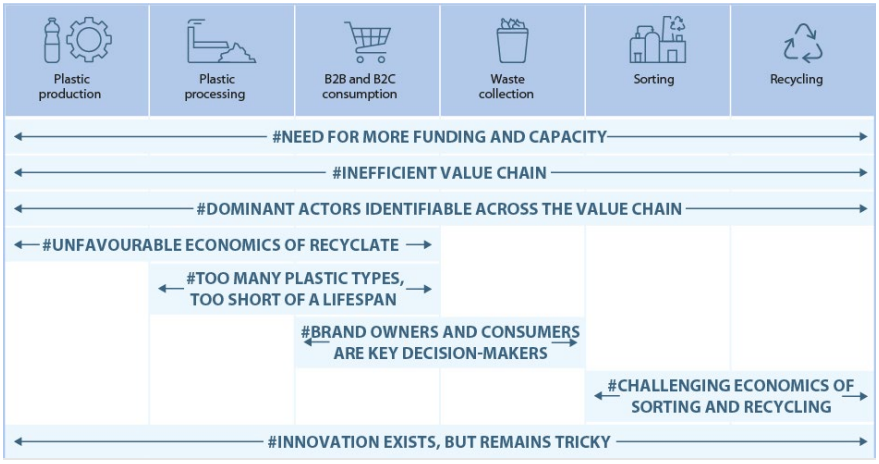
In this report, the European Investment Bank sets out to understand the value chain of plastics to identify investment opportunities and impactful measures that contribute to more efficient and environmentally friendly design, production, use, reuse and recycling of plastics, with the goal of identifying the most impactful opportunities that minimise plastic waste in the European Union and beyond, in line with the EIB's ambitions as Europe's climate bank.

Methodology

This study is based on in-depth desktop research of the functioning of the global plastics industry, a data-driven mapping of the plastics value chain, and 29 expert interviews including with plastics producers, brand owners, investors and lenders active across the value chain. If used, quotes from the interviewees are anonymised in the report. The emphasis of the report is on the European continent while recognising that the problem is a global one and particularly acute in other parts of the world.

[1] European Commission (2018) Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

Key Findings



The report finds that an estimated investment gap of €6.7-8.6 billion must be closed to achieve Europe's recycled content targets by 2025. Achieving these targets requires substantial investment and a reliable end market for the recycled content. This investment would enable the European Union to add 4.2 million metric tonnes (Mt) of annual plastics sorting capacity and 3.8 Mt of annual recycling capacity by 2025 in pursuit of its 10 Mt annual target for recyclate (re)use across the continent.

Looking into the underlying causes of the plastic waste pollution problem, ten key root causes — or inefficiencies — across the circular value chain for plastics are identified. These result in the continuous leakage of all types and sizes of plastics into the environment. By volume and environmental impact, plastic packaging is the biggest contributor to the plastic waste problem. The plastics value chain has several other identifiable focal points, including geographically (the Asia Pacific region being the largest plastics and plastic waste producer) or industrially (such as identifiable global leaders in the plastics business holding dominant market shares).

The economics of a circular, sustainable plastics economy remain challenging compared to the linear status-quo — in terms of the profitability of sorting and recycling as well as the market for recyclate itself. Oil and gas price dynamics, also in the context of the Russia-Ukraine war, are likely to cause spillover effects on plastics producers, although no major shift in the economics of virgin plastics has been observed yet. The lack of homogeneity in plastics, reinforced by brand owners' preference for a variety of shapes, sizes and colours, adds to the challenges of recycling and sorting.

Innovative solutions to the problem of plastic pollution do exist, but they come with their own challenges in terms of impact (such as energy consumption/CO_2 emissions) or implementation (for example, the need for value chain collaboration for packaging tracking). The solution lies in reinforcing circularity by strengthening the links in the plastics value chain. This is only achievable through a powerful combination of regulatory policy innovations (technical standards, minimum recycling rates/content, etc.) and increased capacity and innovation in the collection, sorting and recycling sectors. Such an enabling framework can be created with the support of multilateral financial institutions, for example by providing dedicated financing schemes, in tandem with public-private cooperation for the wider implementation of the circular economy.

In the global context, Europe is performing comparatively well in addressing plastic waste pollution. However, no region can act quickly enough to address the growing amount of single-use plastics in circulation and alleviate the pressure of increasing plastics production and demand. The report concludes that the problem varies across the European continent and that there is thus an important geographical dimension to the solutions.

Key Recommendations

Financial Recommendations

The report concludes with four key financial recommendations that the EIB could implement in order to address the problem of plastic waste pollution both within and outside the European Union:

1. **Plastic production. Large investment programme loans for plastic producers and brand owners in the private sector.** These investment programme loans could be made available to corporate and mid-cap companies involved in the production and conversion of plastics with the explicit objective of improving the circularity and sustainability of these materials. EIB financing could then be channelled towards the most promising and innovative solutions developed by the leading plastics producers.

2. **Plastic sorting and recycling. Framework loans for public sector municipalities or local authorities specifically targeted at scaling up plastic sorting and recycling capacity** in the European Union in order to achieve its objective of having 10 Mt per year of recyclates used in plastic products on the European market by 2025.

    1. The findings of the report indicate gaps in sorting and recycling capacity in more developed EU Member States. However, the largest gaps in sorting and recycling are identified in EU cohesion regions, centred on Central and Eastern Europe and South-East Europe.

3. **Innovation in sorting and recycling technology developed by European SMEs.** It is vital to continue supporting research, development and innovation (RDI) activities by European companies focused on proving new concepts aimed at more circularity in plastics and assisting the adoption of these emerging technologies at scale. Prioritising investments in these technologies could build on the successful model of the Energy Demonstration Project (EDP) facility that continues under the thematic windows of the InvestEU Fund programme (2021-2027). The European Innovation Council Fund could also provide early-stage support to these companies. While this does not provide a "silver bullet" solution to the problem, technical innovation does provide a pathway out of the linear production and consumption model for plastics.

4. **Outside the European Union through EIB Global — Sovereign loans for integrated waste management projects.** EIB sovereign loans to public sector entities, especially those authorities responsible for wastewater collection and treatment, targeting coastal cities (often with substantial ports or harbours) in developing countries.

    1. The initial focus would be on lower income countries in Asia and, to a lesser extent in sub-Saharan Africa, which are the leading sources of plastic waste accumulating in the world's major waterways and oceans. Equally, small Caribbean and Pacific Island states could also benefit from such support where their unique geography aggravates the issue of waste plastics.

    2. As a reflection of the complexity of the problem, this approach would be most effective when combining EIB financing with robust technical assistance to project promoters and blended with appropriate donor grant funding. In this respect, close cooperation by the EIB and the European Commission with multilateral development banks (MDBs) and regional development banks would be essential, alongside the involvement of key European bilateral development actors associated with the EU Clean Ocean Initiative.

3. In terms of support to the private sector in less developed countries, “green” intermediated loan facilities could be extended to local banks seeking to help domestic plastic sorters and recyclers scale up in the face of growing volumes of plastic waste.

Policy Recommendations

Given the complexities of the plastics value chain, many of the necessary improvements require policy measures combined with targeted financial instruments. While these measures fall outside the EIB’s immediate control, they are all essential in contributing to an effective solution. The current set of circular ambitions developed within the European Union demonstrate the clear commitment towards a more circular European economy. Based on deep analysis of the problem, corroborated through expert interviews, this study reveals room for the adoption of additional policy measures specifically designed to:

1. **Incentivise brand owners in their decisions on product design**. Legislative measures could be taken to tackle difficult-to-recycle plastic packaging: for instance, bans on certain single-use plastic products; restrictions on multi-layer plastic packaging; restrictions on composite packaging, such as packaging combining paper and plastics; restrictions on multi-polymer packaging; restrictions on PVC packaging; a ban on opaque PET, which older sorting facilities are not equipped to identify; and measures aimed at reducing the use of too many colours or black colouring.

2. **Encourage producers and brand owners through the introduction or extension of extended producer responsibility (EPR) systems**, thereby incentivising them to make products that are easier to recycle and result in higher value waste streams. EPR systems do not currently exist for most non-packaging plastic products, so there is room for national governments to introduce mandatory ones or collection schemes for specific industrial applications, for instance in the automotive industry, the electrical and electronics (E&E) sector, the agriculture sector and in building and construction.

3. **Introduce price incentives to improve the competitiveness of high recyclate content plastic products**. In order to overcome the historical price disadvantage of these materials against virgin plastic, tax policy could impose financial penalties (taxes, levies) on producers of virgin plastic materials or converters of complex plastic packaging. In terms of positive incentives, high recyclate content plastics could attract a lower rate of tax, thereby offering a lower price to converters and ultimately the consumer, which would ultimately bring the virgin vs. recyclate prices on a par. This “tax wedge” may also have the effect of dampening the effect of oil and gas price volatility on the relative attractiveness of virgin plastic resin (when prices are low) against high recyclate content resin by closing the price differential between these sources of feedstock.

4. **Influence public opinion and consumer demand by educating consumers,** through awareness campaigns. Successful campaigns against the use — and therefore production — of single-use plastics (such as plastic straws, coffee cups, etc.) and adoption of reusable shopping bags provide a template for reducing the number of everyday, readily disposable items that disproportionality contribute to the problem.

5. **Impose quotas on recycling**, by imposing a minimum percentage threshold of recyclates in the feedstock supply, a minimum percentage of recyclates or bio-based material for plastics processors and brand owners, or a minimum percentage recycling quota for specific polymers to compel producers and brand owners to set up dedicated collection, sorting and recycling schemes.

ACRONYMS AND ABBREVIATIONS

ASR	Automotive shredder residue
B2B	Business-to-business
B2C	Business-to-consumer
CEAP	Circular Economy Action Plan
CEE/SEE countries	Central and Eastern European/South-East European countries
EC	European Commission
E&E	Electrical and electronics
EIB	European Investment Bank
EPR	Extended producer responsibility
EU	European Union
GHG	Greenhouse gas
Kt	Thousand metric tonnes
Mt	Million metric tonnes
NCFF	Natural Capital Financing Facility
OECD	Organisation for Economic Cooperation and Development
SDG	Sustainable Development Goal
SUPD	Single-Use Plastics Directive
WWF	World Wide Fund for Nature

Polymers

ABS/SAN	Acrylnitril-Butadien-Styrol, Styrol-Acrylnitril
EPS	Expanded polystyrene
HDPE	High-density polyethylene
LCP	Liquid crystal polymer
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
PA	Polyamide
PBT	Polybutylene terephthalate
PC	Polycarbonate
PE	Polyethylene
PEEK	Polyether ether ketone
PES	Polyethersulfone
PET	Polyethylene terephthalate
PLA	Polylactic acid
PMMA	Polymethylmethacrylate
POM	Polyoxymethylene
PP	Polypropylene
PPA	Polyphtalamide
PS	Polystyrene
PU (foams)	Polyurethane foams
PUR	Polyurethane
PVC	Polyvinylchloride

GLOSSARY

Polymers	Created via polymerisation of many small molecules, known as monomers, to various types of primary macromolecular plastics, chemical fibres and rubber.
Standard plastics	PE, PP, PVC, PS, EPS, PET (bottle grade).
Engineering plastics/Technical thermoplastics	Family of plastics that can be melted when heated and hardened when cooled. These characteristics, which lend the material its name, are reversible such as in the case of ABS, SAN, PA, PC, PBT, POM, PMMA, blends and other high-performance polymers.

CONTEXT

Plastics pollution — a complex and growing global issue

Plastics are among the most ubiquitous and convenient materials in our economy. They are used in a wide range of industries and are part of our daily lives. They are both light and durable, enabling weight and volume efficiency. Plastic products offer a range of benefits: for instance, preserving perishable foods wrapped in plastic packaging much longer.

However, they are also associated with significant environmental externalities, due to their large carbon footprint (greenhouse gas (GHG) emissions) and the polluting effect of plastic waste. One of these externalities is marine plastic pollution, in which microplastics and other forms of plastic waste pollute our waters and harm animal and possibly human health.

A big problem

Humans have produced 8 300 million metric tonnes of virgin plastics[2] — the equivalent of over 1 billion elephants' worth by weight — since large-scale production began in the 1950s, with a 190-fold increase in annual production since 1950. Despite an increased awareness among consumers and businesses in recent years, more plastics continue to be produced every year. In fact, the OECD estimates that global plastic waste will almost triple by 2060, despite efforts to curb it.[3]

The most damaging aspect of this phenomenon in the context of environmental sustainability is that approximately 30% of plastic waste ends up in the natural environment. If current trends in production and waste management continue, roughly 12 500 Mt (million metric tonnes) of plastic waste will have accumulated in landfills or in the natural environment by 2050.[4] The vast majority (~60%) of plastic waste can be traced back to packaging.

A global problem

Plastic recycling is a global industry, with large volumes of plastic waste imported and exported between countries. In recent years, Asian countries such as China have introduced policies aimed at reducing the importation of plastic waste; similar policies have also emerged nearer to Europe (for example, Türkiye).

At the same time, new rules adopted by the European Commission in 2020 now restrict the export of plastic waste from the European Union to countries that are not members of the Organisation for Economic Co-operation and Development (OECD) (except for clean plastic waste sent for recycling), with the aim of ending the export of plastic waste to third countries that are unlikely to have the capacity and standards required to manage said waste sustainably. These developments are expected to result in an increase in plastic waste volumes available for processing within the European Union. If managed improperly, the environmental effects of plastic waste will continue to grow.

A circular problem

There remain many barriers to full circularity across the plastics value chain, with many consumers and manufacturers still unaware of the advantages of circularity.

Plastics pollution is a cross-cutting issue encompassing several environmental and social challenges. For instance, UN Sustainable Development Goal (SDG) 14 (Life below water) is directly related to marine plastic pollution, whereas a circular plastics chain would contribute to SDG 3 (Good health and well-being) and SDG 12 (Responsible consumption and production). Lastly, a circular plastics chain

[2] University of Georgia, 2017

[3] Global plastic waste set to almost triple by 2060, says OECD

[4] Geyer, 2017

relates to climate action, as plastic production emits a significant amount of greenhouse gas emissions and plastic pollution damages the environment.

Making plastics more recyclable and shifting to less carbon-intensive sources in feedstock and energy use in plastics-related activities will contribute to climate action and environmental sustainability, thereby reducing the overall emissions footprint of plastics.

External costs

The economic cost of plastic can be quantified in different ways. One is the market price, which is based on the materials and processes required to produce a plastic product. However, this neither includes nor reflects other costs generated over the course of a product's life cycle, such as natural resource depletion, GHG emissions, health costs and waste management costs. Moreover, the ever-increasing mass of unmanaged waste has a significant impact on the environment. The World Wide Fund for Nature (WWF) estimates that the total cost to society of a single tonne of plastic can be as much as ten times its market price, noting that "the minimum cost that the plastic produced in 2019 will incur over its lifetime is estimated at $3.7 trillion (+/-$1 trillion), with more than 90% of that cost not included in the market price of plastics. This includes the cost of GHG emissions and waste management costs, which society, governments and therefore corporates and citizens have to pay. The lifetime cost of plastic is a huge burden on society."[5] London-based think tank Carbon Tracker estimates the externality cost of plastics to be approximately $1 000 per tonne ($350 billion per year), combining CO_2, health, and collection and pollution costs.[6]

Emissions context

The plastics lifecycle is directly linked to climate change. Plastics are largely derived from fossil fuels leading to GHG emissions during plastics production and waste management. The carbon footprint of the plastics lifecycle is significant. As much as 5 kg of CO_2-equivalent (CO_2e) emissions results from each kg of plastic produced, from feedstock production up to end-of-life treatment. According to UNEP, global emissions related to primary plastics reached 1.8 gigatonnes (Gt) of CO_2e in 2019, contributing 3-4% of global GHG emissions. In the absence of stricter policies, emissions are projected to more than double to 4.3 Gt CO_2e by 2050 and account for 15% of allowed emissions under the goal of limiting global warming to 1.5°C.

European policy on plastics

The European Union's stated ambition is to be the world leader in climate change mitigation, and correspondingly EU policy is increasingly focused on the alarming and growing problem of plastic pollution. The **European Strategy for Plastics** has set a plastic packaging recycling target of 50% by 2025 and aims to see 10 million tonnes of recycled plastics in new products, across all Member States, by the same year.[7] Furthermore, all plastic packaging on the European market should be reusable or recyclable by 2030. European regulations have been developed in pursuit of these targets. The focus of this report is to develop financial recommendations that would address European funding needs along the plastics value chain needed to fulfil the European Union's policy goals.

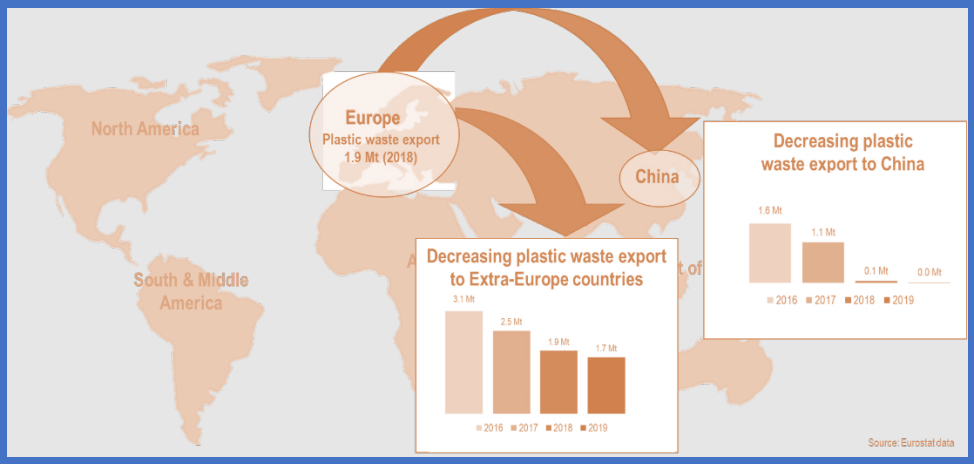
[5] WWF, 2021, p. 15 https://media.wwf.no/assets/attachments/Plastics-the-cost-to-society-the-environment-and-the-economy-WWF-report.pdf

[6] The Future's Not in Plastics - Carbon Tracker Initiative

[7] EU rules on packaging and packaging waste, including design and waste management; https://ec.europa.eu/environment/topics/waste-and-recycling/packaging-waste_en

SPOTLIGHT: Plastic waste export from Europe

In 2020 the European Commission adopted new rules on the export, import and intra-EU shipment of plastic waste. These new rules ban the export of plastic waste from the European Union to non-OECD countries, except for clean plastic waste sent for recycling. This aims to end the export of plastic waste to third countries that may not have the capacity and standards to manage it sustainably.



As part of their campaign against "foreign rubbish," the Chinese government introduced a policy to reduce low-grade solid waste imports. As a result, plastic waste export quantities from EU27+3 countries to China almost completely collapsed in 2018. Other Asian countries followed suit, also introducing restrictions on imported plastic waste. Closed export markets for plastic waste for the EU27+3 and new EU regulations are expected to increase recovery volumes within the European Union.

Spotlight 1: Plastic waste export from Europe

An overview of the issue within the context of European policy is provided in Figure 1.

Figure 1: European policy context

European Union directives

The Packaging Waste Directive[8] was adopted by the European Parliament and the European Council on 20 December 1994. It harmonises the management of packaging and packaging waste in the European Union. The goal was to prevent the production of packaging waste and to reduce the final disposal of such waste by reusing packaging, recycling or other forms of packaging recovery. This directive announced targets on packaging waste recovery and recycling to be attained by Member States in the following five to ten years (thus, until 2004); nonetheless, it remains the most applicable directive on packaging waste.

In November 2022, the European Commission announced a draft revision of the EU legislation on packaging and packaging waste,[9] and the new framework is now being considered by the European Parliament and Council. The proposed targets include making all packaging in the European Union recyclable by 2030, a 15% packaging waste reduction per Member State per capita by 2040 and mandatory rates for recycled content in new plastic packaging. The proposed legislation also clarifies the taxonomy around bio-based, biodegradable and compostable plastics. Biomass used to produce bio-based plastics must be sustainably sourced. Biodegradable and industrially compostable plastics must be approached with caution, directed to specific applications where their environmental benefits are proven.

The **Plastic Bags Directive**[10] was adopted in 2015 and aims to reduce the consumption of lightweight plastic carrier bags whereas the **Single-Use Plastics Directive (SUPD)**[11] was introduced in 2019 to limit the circulation of plastic products that are used only once before being discarded. Both directives focus on the upstream stage of a plastic product's life cycle by limiting production in the first place. The reasoning here is that reducing the production of lightweight plastic carrier bags and single-use plastics — which are among the most common forms of marine waste — reduces plastic pollution as a whole.

Circular Economy Action Plan

The **European Green Deal** was adopted in December 2019 and aims to reduce European CO_2 emissions by 55% by 2030 ("Fit for 55"), compared to 1990 levels. To achieve this, the second **Circular Economy Action Plan (CEAP)** was released in 2020, setting out measures for building a future-oriented economy based on circular economy principles. Among other value chains, the CEAP prioritises: reducing and redesigning packaging; regulatory measures for labelling; source sorting and safe recycling; and microplastics. The CEAP also aims for a more sustainable use of plastic by setting mandatory requirements on recycled plastic content in certain new plastic products. The objective of the CEAP regarding packaging is to "ensure that all packaging on the EU market is reusable or recyclable in an economically viable way by 2030." The European Commission's intention to "lead efforts at international level to reach a global agreement on plastics is also formulated in the CEAP."[12]

Two additional proposals regarding EU policy on plastics have been implemented since January 2021. First, as an addition to the **Regulation on waste shipments**,[13] the definition of hazardous waste was broadened to reduce the volume of plastic waste being imported into and exported out of Europe.[14] This reduces the volume of harmful plastics transported to countries where plastic waste is typically dumped rather than recycled. Second, a **levy on non-recycled plastic packaging waste** (€800 per

[8] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31994L0062
[9] European Green Deal: Putting an end to wasteful packaging (europa.eu)
[10] Directive (EU) 2015/720
[11] EUR-Lex - 32019L0904 - EN - EUR-Lex (europa.eu)
[12] New Circular Economy Action Plan 2020; https://ec.europa.eu/environment/pdf/circular-economy/new_circular_economy_action_plan.pdf
[13] Regulation (EC) No 1013/2006
[14] Regulation (EU) 2020/2174

tonne) was applied.[15] This provides an economic incentive for countries to improve recycling technology and capacity, which reduces the rate of leakage into the natural environment.

Sustainable Products Initiative[16]

On 30 March 2022, the European Commission presented its approach and ambitions on making sustainable products the norm through the **Sustainable Products Initiative**. It proposes designing more sustainable circular and energy-efficient products and the standardisation of digital product passports that provide information on the environmental sustainability of products, such as information on energy use, recycled content, presence of substances of concern, durability, reparability and recyclability. The Sustainable Products Initiative also includes measures to prevent and stop the destruction of unsold consumer goods, which should be in line with the waste hierarchy. Until the broadened framework is in place (endorsements by the European Parliament and the European Council are expected), the European Commission will continue its work under the existing **Ecodesign Directive**.

Ecodesign Directive[17]

This framework for the setting of ecodesign requirements for energy-related products (meaning any good that has an impact on energy consumption) was adopted by the European Parliament and the European Council on 21 October 2009. This directive contributes to increased energy efficiency, protection of the environment and safety of energy supply by establishing requirements for energy-related products to be placed on the market and/or put into service, such as the ease for reuse and recycling through, among others, the marking of plastic parts in accordance with ISO standards. EU Member States are responsible for market surveillance, so they should, among other things, organise appropriate checks on product compliance and ensure that consumers and other interested parties can submit observations on product compliance to the competent authorities.

Role of the EIB

As Europe's climate bank, the EIB has a special responsibility as the European Commission's key implementing partner in addressing the financial challenges of maintaining and improving the quality of the living environment on land, at sea and in the air. For this reason, the EIB continues to play a leading role in boosting the circular economy in Europe, supporting solutions to major environmental threats ranging from excess greenhouse gas emissions to growing levels of plastic waste pollution in the natural environment. Improving circularity across the European plastics sector by helping the development of more sustainable business models across the industry is part of the Bank's mandate (Climate Bank Roadmap) and aligned with EU strategy (CEAP). It has also assumed a leading role, alongside key European and international financial institution partners, in addressing the problem beyond the European Union's shores under the Clean Oceans Initiative which is intended to mobilise €4 billion of financing to remedy ocean-based waste by 2025.

The Clean Oceans Initiative is the largest common initiative dedicated to funding projects aimed at reducing plastic pollution at sea. Since 2019, the initiative has already provided € 1.6 billion in long-term financing for public and private sector projects that reduce the discharge of plastics, microplastics and other litter into the oceans through improved management of solid waste, wastewater and stormwater.

Through its financial instruments and advice to project promoters, the EIB can support the transition towards a more efficient, sustainable economy in pursuit of the Sustainable Development Goals.[18]

[15] Council Decision (EU, Euratom) 2020/2053
[16] IMMC.COM%282022%29140%20final.ENG.xhtml.1_EN_ACT_part1_v9.docx (europa.eu)
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009L0125&from=EN
[18] EIB Impact Report 2020

METHODOLOGY

The purpose of this study is to analyse the plastic ecosystem, value chain and stakeholder views to identify specific points in the plastics value chain with the greatest potential for reducing plastic waste pollution and its environmental impact, and how these could be addressed by the EIB either in Europe or beyond (through EIB Global).

The study consists of (i) in-depth desktop research aimed at describing and analysing the functioning of the plastics industry ecosystem, (ii) data-driven mapping of the plastics value chain, and (iii) 29 expert and stakeholder interviews validating the findings of the desk research (Figure2). Key findings and recommendations derived from the analysis of these three elements are then put forward at the end of this report.

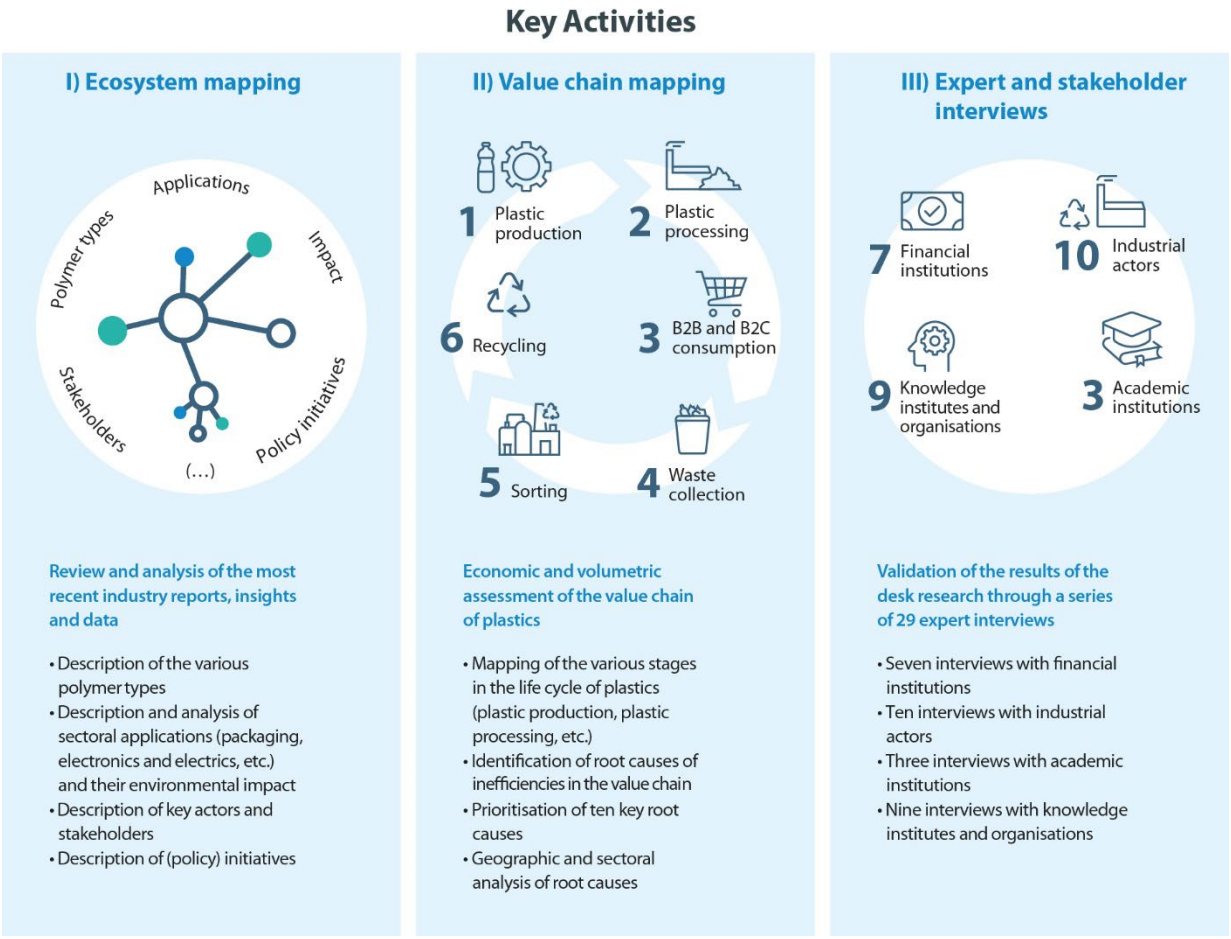


Figure 2: Methodology overview

Ecosystem mapping

The first exercise involves a review and analysis of the most recent reports, insights and data. The objective was to map the various plastic types, their applications and their environmental impact, as well as the role and position of the relevant industries' key actors, stakeholders and policy initiatives.

Value chain mapping

This analysis includes an economic and volumetric assessment of the value chain of plastics. The subjects of the assessment are the various stages in the life cycle of plastics, such as the production of polymers, waste collection systems in Europe, and sorting and recycling methods. The various sectoral applications of plastics (such as packaging) are also included in the analysis. The objective is to obtain a clear picture of why certain plastics are not reused or recycled and, as a result, end up in the

environment unless properly managed. The findings help identify solutions that contribute to more efficient and environmentally friendly design, production, use and recycling of plastics.

The stages in the plastics value chain are: (1) plastic production (from both virgin material and second hand recyclates), (2) plastic processing, (3) business-to-business use and business-to-consumer consumption, (4) waste collection, (5) sorting, and (6) recycling.

The study identifies ten key root causes of inefficiencies in the plastics value chain that contribute to plastic waste pollution. Their intensity varies both by geography and by economic sector. Also identified are the actors engaged in each link of the value chain.

Expert and stakeholder interviews

The results of the desktop research are validated through 29 expert interviews with knowledge institutes, industrial actors (including integrated oil/gas/petrochemical companies), financial actors (banks, private equity investors) and individual project promoters. The identified root causes are presented to the interviewees for their assessment.

Figure 3 depicts the ten root causes. Those marked in bold are issues that, according to the analysis of this study, offer the best opportunity for private sector investment. These are (i) the influence of retailer and brand owner design requirements on sorting and recyclability, (ii) the presence of an efficient recycling sector, and (iii) the presence, capacity and standards of the sorting sector. This analysis is validated in the expert interviews. The percentages in Figure 3 indicate the share of interviewees who identify a root cause as a key issue contributing to the plastic waste problem.

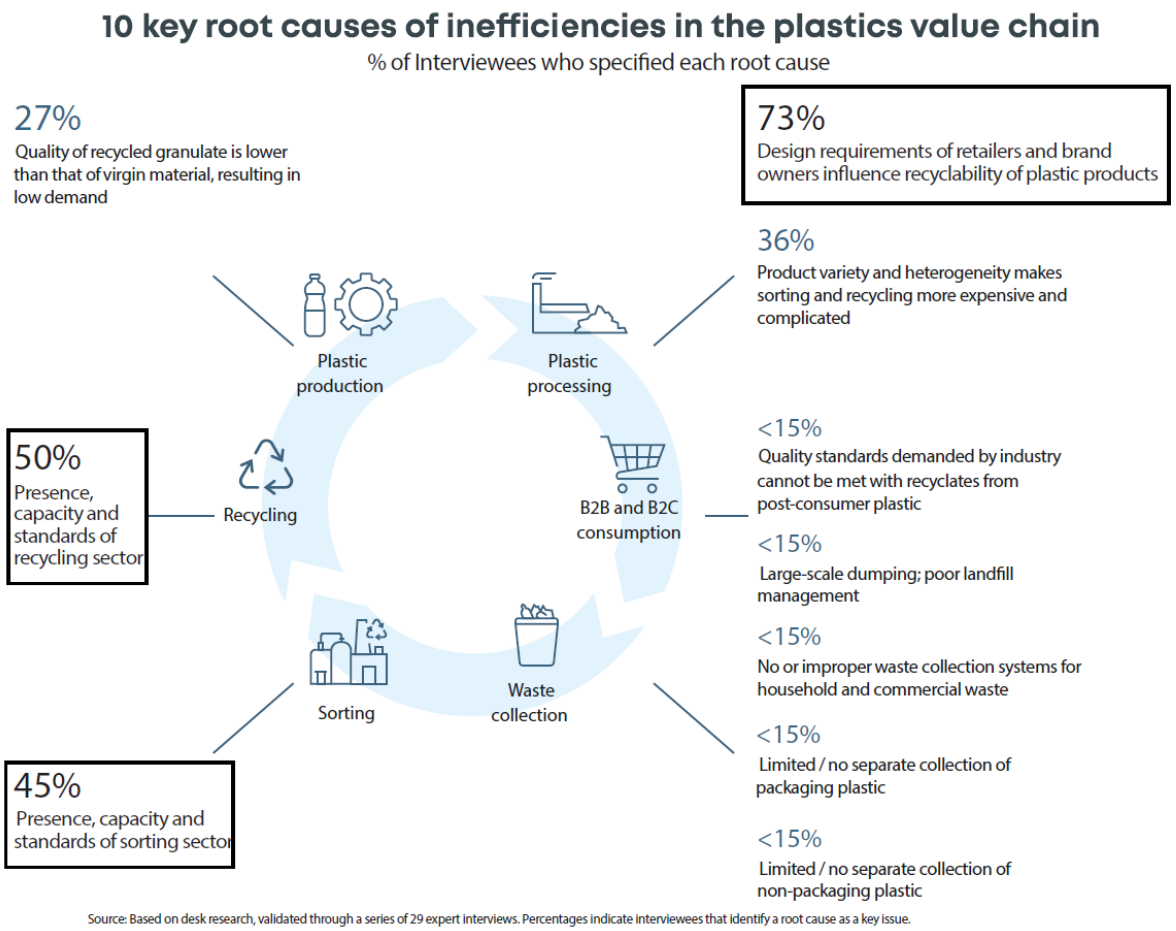


Figure 3: Key root causes of inefficiencies in the plastics value chain

Root Cause #1: Design requirements of retailers and brand owners influence the recyclability of plastic products.	
Occurs in:	**Causes inefficiencies in:**
Plastic processing/converting; and Retailers and brand owners →	→ Production → Plastic processing → Waste collection → Sorting → Recycling

Packaging materials are designed with the primary goal of enhancing product positioning and marketing, as well as meeting logistical and safety needs. Including optimised material recovery in product design is still rarely considered in the product development process. If they followed basic sustainable design principles, much of the plastic packaging material used today could already be waived by retail and brand owners. However, the emphasis on product positioning and marketing is causing packaging material to be highly heterogeneous in terms of colour, material, format, and delivery model (including labels and printing). Although these packaging types are desired for their functionality, they do not have viable reuse or recycling pathways (Ellen MacArthur Foundation, 2017).

Root Cause #2: Presence, capacity and quality of the recycling sector	
Occurs in:	**Causes inefficiencies in:**
Recycling →	→ Recycling
Root Cause #3: Presence, capacity and quality of the sorting industry	
Occurs in:	**Causes inefficiencies in:**
Sorting →	→ Sorting

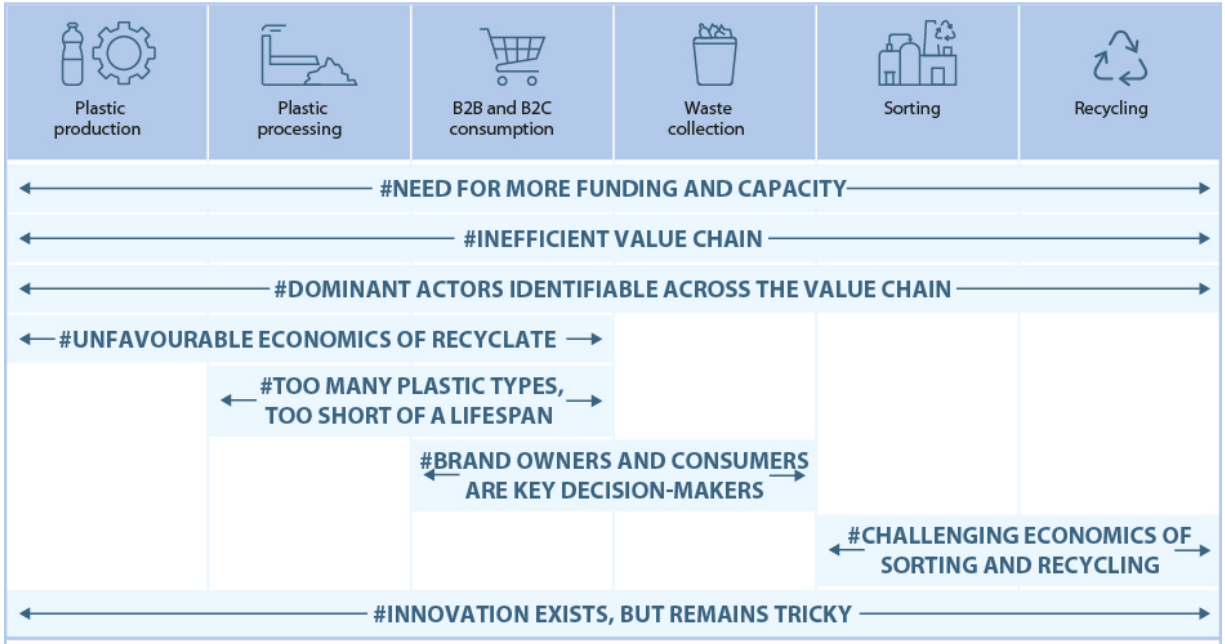
The limited capacity of existing facilities or lack of quality hinders sorting and recycling. Europe lacks sorting plants that can supply the recycling industry adequately.

Specialised sorting facilities for separate collection of lightweight packaging (such as the coloured bins for separate collection) — aimed at adequately sorting polymer types into well-sorted plastic fractions — are mainly concentrated in Germany, Netherlands, northern Italy, Spain and the Scandinavian countries. Many other European countries lack sorting facilities with good quality standards.

Only 20% of sorting facilities specifically sort separately collected plastic waste to supply the recycling industry with sorted plastic waste fractions. Some 80% of the sorting facilities in Europe sort mixed waste streams with varying output quality — often only of limited use for the recycling industry and showing high input material loss during the sorting process.

This 20% of sorting facilities still have high material loss rates. Many sorting facilities have a backlog demand for innovative sorting technologies. Many facilities still operate with non-automated (that is, manual) sorting methods. New smart sorting lines are often only economically viable on a large scale with higher throughputs. Today, most sorting facilities are designed for low throughput volumes.

KEY FINDINGS



#NEED FOR MORE FUNDING AND CAPACITY

Improvements in the plastics value chain increase recycling potential. To exploit this potential, sorting and recycling capacity needs to be increased. To achieve the EU goal of 10 Mt of recyclates in products and packaging placed on the European market each year by 2025, a gap of 4.2 Mt in sorting capacity output and 3.8 Mt in recycling throughput capacity must be closed.

#INEFFICIENT VALUE CHAIN

Plastic pollution is a negative externality resulting from the activities of many players operating in the plastics value chain. In many cases, stakeholders operating at the early stages of the plastics value chain are not directly confronted with the external effects of inefficiencies caused by their decisions. Understanding the different stages in the life cycle of plastics and how they are related is crucial to improving the entire system.

#DOMINANT ACTORS IDENTIFIABLE ACROSS THE VALUE CHAIN

There is a high degree of concentration of stakeholders and industries, as well as geographic concentration, at specific points in the plastics value chain. Packaging constitutes the largest application sector for plastics, with a 41% share of all processed plastics (160 Mt in 2018).

The Asia Pacific region accounts for the highest share of plastic production (50%) and processing volume (60%), and for the largest contribution to global plastic waste by volume (46%).

#UNFAVOURABLE ECONOMICS OF RECYCLATE

Investing to improve performance is hindered by the fact that prices for recycled content are high relative to virgin material. Consequently, alternative disposal methods (such as landfilling) remain in use.

#TOO MANY PLASTIC TYPES, TOO SHORT OF A LIFESPAN

There is a large variety of plastics used in the manufacture of products and packaging of all kinds, most plastic packaging being single-use. Thus, most of these products are quickly discarded, creating challenges in collection, sorting and recycling.

#BRAND OWNERS AND CONSUMERS ARE KEY DECISION-MAKERS

Brand owners and private consumers are key decision drivers in the reduction of the amount and types of plastic used in the plastics value chain. They have a role to play in reducing the potential amount that ends up in the environment.

#CHALLENGING ECONOMICS OF SORTING AND RECYCLING

Europe's sorting and recycling industry receives large volumes of plastic waste comprising a great variety of plastic types, some of which are quite difficult to process. At the same time, low virgin resin pricing and uncertainties regarding platic offsetting are making their output streams less competitive.

Moreover, this well-established industry does not operate everywhere within the European Union. There is much room for (capacity) improvement in CEE/SEE countries and in countries with low recycling rates.

#INNOVATION EXISTS, BUT REMAINS TRICKY

Innovative solutions to the problem of plastic pollution already exist. A survey of promising projects and companies in Europe reveals an abundance of innovative solutions along the length of the value chain. However, innovation alone is not enough.

Figure 4: Key findings

#HOT TOPICS

This section presents key insights into the plastics value chain. Together, they provide an overview of the total ecosystem associated with plastic and the resulting pollution problem. Understanding these elements aids understanding of the context within which this study reaches its key recommendations. Each key insight is prefixed by a hash sign (#), indicating their topicality.

1. #NEED FOR MORE FUNDING AND CAPACITY

ADDITIONAL FINANCING AND IMPROVED END-MARKET CONDITIONS ARE NEEDED TO BRIDGE THE SORTING AND RECYLING CAPACITY GAPS

Finding 1: An estimated investment gap of €6.7-€8.6 billion must be closed to achieve Europe's recycled content targets by 2025. Achieving these targets requires substantial investment and a reliable end market for the recycled content.

Improvements in the plastics value chain increase recycling potential. To exploit this potential, sorting capacity and recycling capacity both need to be increased.

Secondary finding 1.1 — THE SORTING INVESTMENT GAP: To achieve the EU goal of using 10 Mt of recyclates in products and packaging on the European market each year by 2025, a gap of 4.2 Mt in annual sorting output capacity must be closed.

In December 2018, the European Commission launched the Circular Plastics Alliance (CPA). The objective of the CPA is to support the European Union's goal to have 10 Mt of recyclates in products and packaging placed on the European market each year by 2025.[19]

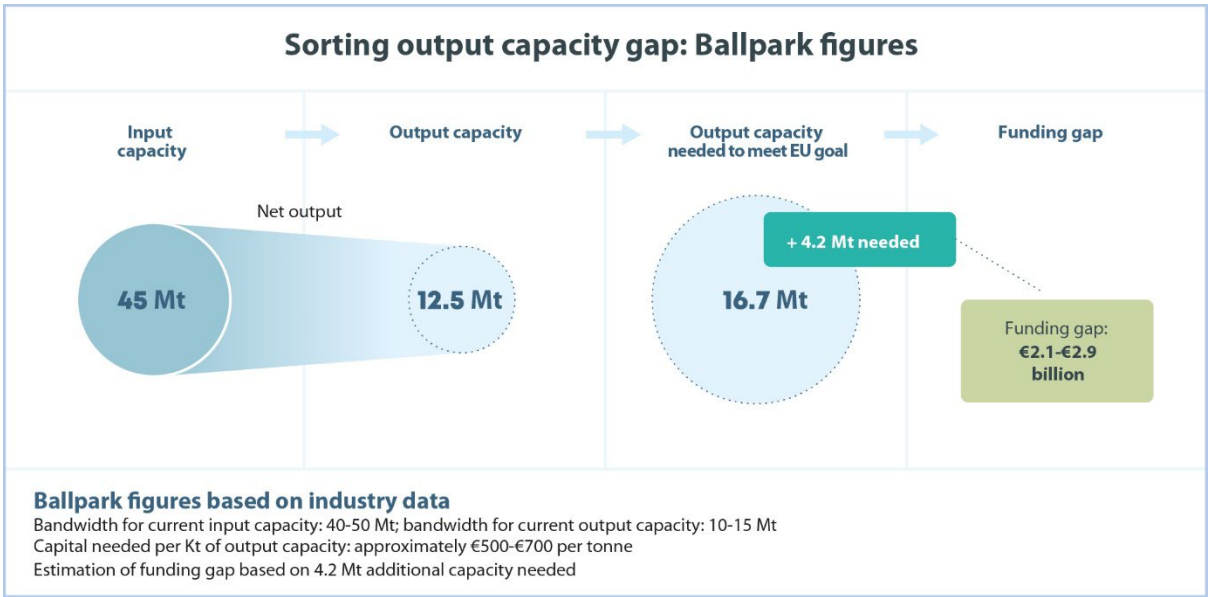


Figure 5: Sorting output capacity gap

[19] The CPA covers the entire plastics value chain and currently includes over 290 organisations representing industry, research organisations and public authorities, while its membership continues to grow. The Report "Circular Plastics Alliance – Roadmap to 10 Mt recycled content by 2025" provides an overview of how the CPA aims to achieve the 10 Mt target by 2025. (Circular Plastics Alliance, 2021, p. 17).

The **sorting industry output capacity** required to meet the EU objective — taking into account the material losses involved in downstream recycling processes — is estimated at approximately 16.7 Mt per year.[20] Currently, Europe's 1 200 sorting plants have a combined annual input capacity of 45 Mt [21] and an annual output capacity of 12.5 Mt.[22] In order to reach the 16.7 Mt output capacity target, an additional 4.2 Mt of sorting output capacity is required. When estimating the capital expenditure needed to close this gap, it is important to recognise significant differences in the design of sorting plants, process configurations, size, operating availability and costs of labour, and regulatory constraints across Europe. However, based on industry data, the capital expenditure per Kt of additional annual output capacity is estimated to be between €500 and €700 per tonne.[23] On this basis, **the investment required to scale up Europe's sorting industry capacity by 4.2 Mt to the 16.7 Mt target falls within the range of €2.1–2.9 billion (Figure 5).**

Secondary finding 1.2 — THE RECYCLING INVESTMENT GAP: To achieve the EU goal of using 10 Mt of recyclates in products and packaging on the European market each year by 2025, a gap of 3.8 Mt in annual recycling throughput capacity must be closed.

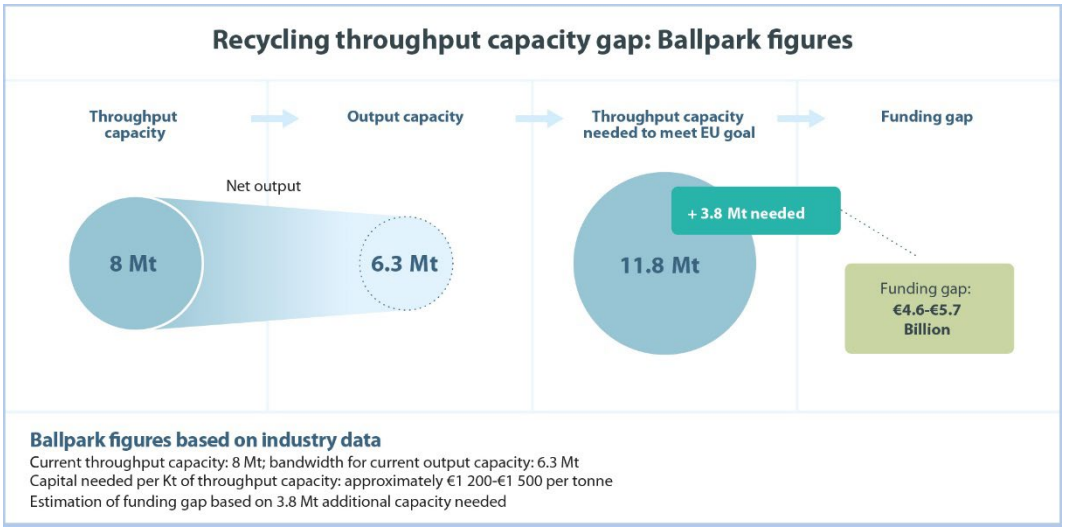


Figure 6: Recycling throughput capacity gap

Europe's total installed plastic **recycling capacity** (throughput) is estimated at 8 Mt per year[24] spread across over 650 recycling plants, equivalent to an annual output capacity of 6.3 Mt.[25] Based on recent data, Europe produces 5 Mt of plastic recyclates.[26] To reach the EU goal of 10 Mt of recyclates in products and packaging placed on the European market each year by 2025, it is estimated that 11.8 Mt of throughput capacity will be needed, therefore a gap of 3.8 Mt of additional recycling (throughput) capacity must be closed. Capital expenditure (CAPEX) per kilotonne of installed throughput capacity can be estimated at €1 200 – €1 500 per tonne.[27] Based on these estimates, **the**

[20] Circular Plastics Alliance, 2021, p. 17.
[21] Based on Conversio industry data.
[22] Circular Plastics Alliance, 2021, p. 17.
[23] Circular Plastics Alliance, 2021, p. 17.
[24] Based on Conversio industry data.
[25] Circular Plastics Alliance, 2021, p. 17.
[26] Based on Conversio industry data.
[27] Circular Plastics Alliance, 2021, p. 17.

investment required to scale up Europe's recycling industry capacity by 3.8 Mt to total annual throughput capacity of 11.8 Mt falls in the range of €4.6–5.7 billion (Figure 6).

It is important to recognise that it will only be possible to raise the financing required for these additional investments in both sorting and recycling capacity if there is a robust market for the recycled output.

Secondary finding 1.3 — MARKET: Without properly functioning circular business models, capacity building remains a challenge.

There seems to be sufficient private capital available in the market (for sectors such as the petrochemical industry) and several new investment funds have been established aimed at investments in the circular economy (for example, the €425 million ABN AMRO Sustainable Impact Fund). However, investors and financial institutions interviewed for this study still observe several financing barriers to capacity building and to investment in other forms of innovation aimed at a more circular plastics value chain:

1. **Financing barrier 1:** Circular business cases are often more difficult to close than linear, fossil-based ones. This is primarily due to the economics (especially price fluctuations for recyclates) or the lower price of virgin materials derived from oil and gas.

2. **Financing barrier 2:** Investments in the scale-up phase are often riskier, which make them less appealing to investors. This has to do with uncertainty about how a technology will perform on a larger scale, but also on the commercialisation potential of a project (the "Commercialisation Valley of Death").

3. **Financing barrier 3:** Investors need certainty regarding the stability of supply and quality of feedstock of a project. In other words, investors need to know whether the inputs for a project they seek to invest in will be available over the medium to long-term, and whether potential quality fluctuations of the inputs will affect the process and thus the output of a project. It is often difficult for project owners to provide such certainty.

4. **Financing barrier 4:** Investors also require certainty about the stability of the end market for recycled content. In a market still under development, such certainty is difficult to obtain. For many plastic polymers, recyclers face the problem of low demand from converters. While new technology would produce recycled material of the quality required by the market, they would still face stiff price competition from producers of virgin material. Thus, market conditions would still be unequal.

5. **Financing barrier 5:** Investors are reluctant to invest in recycling solutions for certain polymers, such as polystyrene, as the corresponding business models require the establishment of substantial logistical infrastructure for feedstock supply (for example, investment in upstream sorting and collection). For the most common standard polymers used in the packaging industry such as PE, PP and PET, there are well-established waste streams with corresponding value chains and sorting technologies. The key challenge here is to increase sorting yield and quality, which investors are reluctant to invest in.

2. #INEFFICIENT VALUE CHAIN

IMPROVING CIRCULARITY REQUIRES STAKEHOLDERS TO IMPROVE COLLABORATION

Finding 2: Plastic pollution in this study is approached as a negative externality resulting from the activities of the many players operating in the plastics value chain, combined with the absence of suitable waste management systems. Some of these players operate on a global scale, others only on a regional scale. In many cases, stakeholders operating at the early stages of the plastics value chain are not directly confronted with the external effects of inefficiencies caused by their decisions. Understanding the different stages in the life cycle of plastics and how they are related is crucial to improving the entire system.

Secondary finding 2.1: Improving circularity requires all stakeholders to work together at the various stages of the plastics value chain.

The six stages of the plastics value chain — production, processing, consumption, waste collection, sorting and recycling — all have stakeholders of their own. These are presented in Figure 7. Plastic producers are easily identifiable as the first actors in the plastics value chain and as the prime decision-makers in what gets brought to market. However, it would be wrong to focus solely on this particular stakeholder. All require attention as they each have a role to play in tackling the issue of plastic pollution.

Figure 7: Overview of stakeholders across the plastics value chain

"All stakeholders along the plastic value chain think differently and have different interests. Brand owners and retailers? They only think as far as the point of sales. Plastic producers? Their objectives are purely scientific. And recyclers? They're left to deal with products that weren't designed for recycling and suboptimal business models." — NGO

"To get to a circular chain, more innovation in packaging is needed. Packaging should be designed in such a way that it causes fewer problems in sorting and recycling." — Knowledge institute

Spotlight: End-of-life fate of plastic packaging

Nearly 60% (148 Mt) of the total plastic waste generated globally is packaging material. PE (all densities), PP and PET collectively make up 85% of all packaging materials (Plastics Europe and Conversio, 2020).

According to the Ellen MacArthur Foundation, 98% of plastic packaging is produced from virgin feedstock (Ellen MacArthur Foundation et al., 2016). Based on the values generated by the Ellen MacArthur Foundation et al. (2016), of the 78 Mt of annual plastic packaging material production, the end-of-life fate is as follows:

1.	Collected for recycling	14%
	Process losses	4%
	Cascaded recycling	8%
	Closed-loop recycling	2%
2.	Incineration and/or energy recovery	14%
3.	Landfilling	40%

Spotlight 2: End-of-life fate of plastic packaging

Secondary finding 2.2: No accountability upstream in the value chain.

Plastic flows clockwise in the plastics value chain: producers send their raw materials to the processing company, while manufacturers and brand owners sell their products to the public and to businesses. At their end of life, these products are collected, sorted and — ideally — recycled. For all these services provided by the many stakeholders, payments are made.

In many cases, stakeholders operating at the early stages of the plastics value chain are not directly confronted with the external effects of inefficiencies caused by their decisions. If brand owners and designers choose to use different types of plastic in a single product, or to use plastics that are difficult to recycle, this will affect the business case of the recycler at the very end of the chain. However, these brand owners will remain unaccountable for using such plastics so long as they satisfy the demand and preferences of their immediate consumers. Consequently, there is no economic incentive for them to change their behaviour.

Secondary finding 2.3: Plastics become waste and pollution mostly following the end of life of products in which they are used. The temptation might therefore be to focus solely on effective waste collection and processing. However, decisions made during the upstream processes (production, processing) also contribute enormously to the problem of plastic pollution.

Given that physical losses of material from the plastics value chain (and thus the environmental impact) are most visible following the end of life of plastic products during waste collection, sorting and recycling, the temptation might be to focus solely on these activities. For instance, plastic pollution may in some cases be avoided by improving or expanding waste collection systems. And improvements in sorting and recycling technologies and capacity may improve the recyclability of waste streams and reduce the likelihood of plastics ending up in the environment. However, upstream processes of production, processing and consumption are just as important in finding solutions and improving the entire system. Decisions taken at the early stages of product development may determine the recyclability and therefore the monetary value of waste streams.

Therefore, a holistic view understanding the different stages and their relationship in the plastics value chain is necessary to improve the entire system.

Secondary finding 2.4: The plastic waste material received by sorters and recyclers comprises a great variety of plastics, some easy to handle, others quite difficult. The performance of these sorters and recyclers could be improved if the material received is standardised and/or is of higher quality, or if their processes are upgraded.

According to the experts interviewed, one of the key challenges for Europe is increasing the circularity of plastic by supporting the market for recovered plastics. For this, both inputs and outputs of recyclers need to improve.

The quality of recycling input is affected by all players operating upstream of the plastics value chain, and is therefore a collective responsibility. Plastic converters and brand designers need to make the right decisions (tackle the "too many, too short" issues) combined with collection systems that allow for separate collection and the sorting of waste streams into homogenous batches for recycling.

In addition, technological improvements need to be made in the sorting industry. Most sorting facilities are currently designed to handle low throughput rates. New innovative sorting lines are often only economically viable when operated on a large scale and processing higher volumes of waste. At the moment, only 20% of Europe's sorting facilities specifically sort separately collected plastic waste for the purpose of supplying the recycling industry with sorted plastic waste fractions. These plants should be upscaled and/or expanded. The remaining 80% sort mixed waste streams with outputs of varying quality, which are often of limited use to the recycling industry and involve a high loss of input material during the sorting process. These facilities should be revamped with up-to-date technologies.

Recycling output is not only affected by the quality of the input streams, but also by the performance and capacity of the recycling industry itself. Wherever this is wanting, investment is needed.

"Littering and dumping are bad but are not an impediment to developing a circular model. It is more important to have a market." — Asset manager

3. #DOMINANT ACTORS IDENTIFIABLE ACROSS THE VALUE CHAIN

CONCENTRATION IN PLASTIC PRODUCTION, WASTE AND GEOGRAPHY

Finding 3: There is a high degree of concentration of stakeholders and industries, as well as geographic concentration, at specific points in the plastics value chain.

Secondary finding 3.1 — PRODUCTION: The production of plastics is dominated by large multinationals: 25 companies are responsible for half of the world's polymer production. These polymers are used by converting companies — numbering roughly 50 000 in Europe — in making products of all kinds.

Plastic producers are producers of raw materials who distribute moulding compounds (powder, granulates, basic materials such as PUR) made by polymerisation to plastic processors. They include both manufacturing companies of pure plastic resin materials and manufacturers of compounds and masterbatches. There are more than 500 plastic producing companies worldwide, but 25 companies dominate the market, with a market share of 50% of total global plastics production (Figure 8). Many of these are multinationals with production facilities spread across the globe.

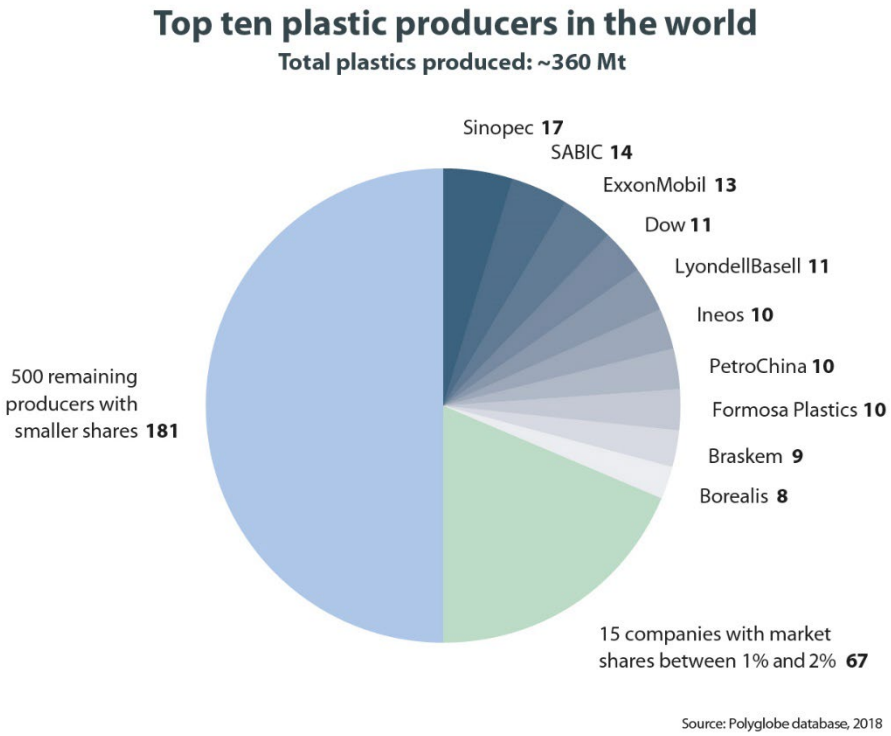


Figure 8: Top ten producers in the world (Mt per year)

Secondary finding 3.2 — WASTE: Packaging constitutes the largest application sector for plastics, with a 41% share of all processed plastics (160 Mt in 2018). In terms of plastic waste, packaging material accounts for 60% of the global total.

Plastic is used in almost every industry. Processing companies use it to make everything from toothbrushes and building pipes to fruit boxes and car interiors. But the largest application sector of all is the packaging industry, accounting for over 41% of all plastic products on the market (160 Mt in 2018). Other major sectors of industrial application are building and construction (~20%), the automotive industry (~10%), the electrical and electronics industry (~6%), agriculture (~3%), household, and leisure and sports goods (~4%) (Figure 9).

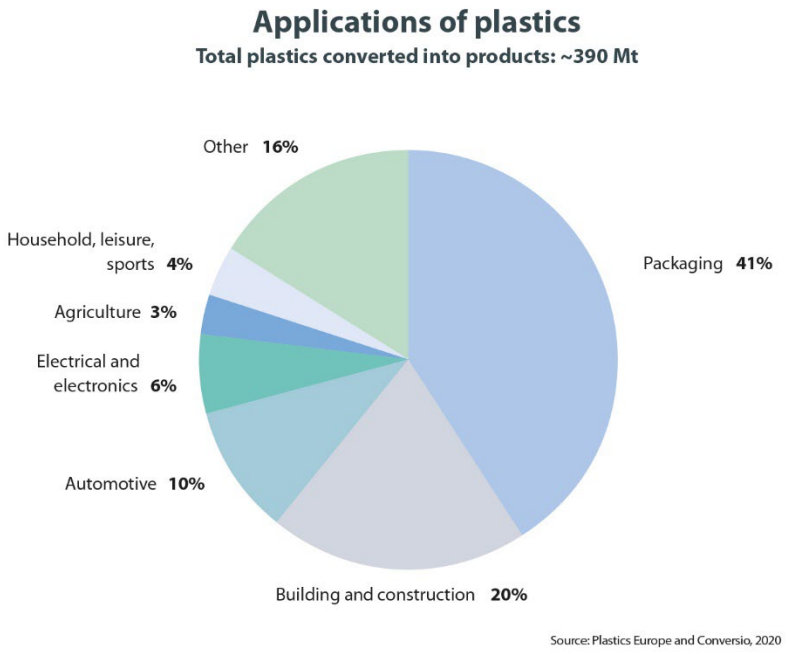


Figure 9: Applications of plastics

The packaging industry is also dominant in terms of its contribution to plastic waste and pollution: packaging accounts for nearly 60% of all plastic waste per year (250 Mt). Most of this waste consists of single-use products, which become waste within 12 months of their manufacture. According to the Ellen MacArthur Foundation, 32% of the annual production of plastic packaging ends up in the environment.[28]

Secondary finding 3.3 — GEOGRAPHY: The Asia Pacific region accounts for the highest share of plastic production (50%) and processing volume (60%), and for the largest contribution to global plastic waste by volume (46%).

Asia is the largest plastic producing region in the world (230 Mt), with China the leading single country in terms of annual production (23%; 84 Mt). By comparison, North America and Europe each account for just 16% of total production (Figure 10). China dominates in the production of most polymer types besides PE-LD, which the United States produces slightly more of (19%) than China (16%).

[28] Ellen MacArthur Foundation et al., 2016

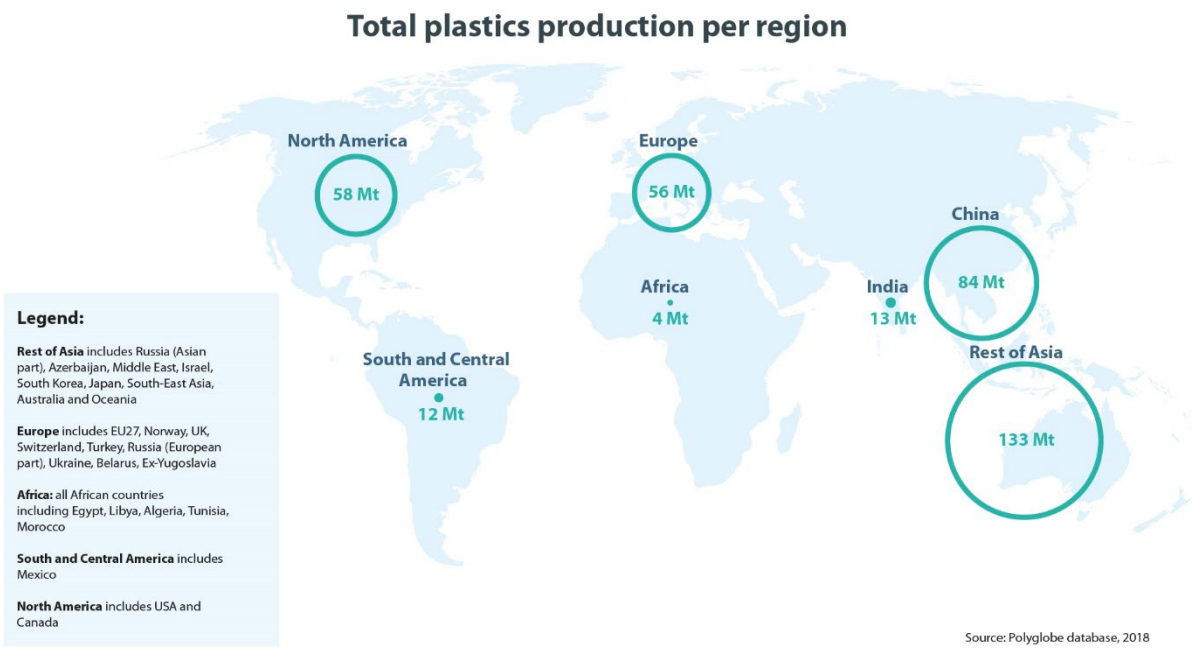


Figure 10: Total plastics production per region

Asia also leads in terms of annual plastic waste generation (114 Mt or 46% of the 250 Mt of plastic waste generated worldwide in 2018), followed by Europe (45 Mt; 18%), North America (38 Mt; 15%), South and Central America (27 Mt; 11%) and Africa (26 Mt; 10%). (Figure 11).

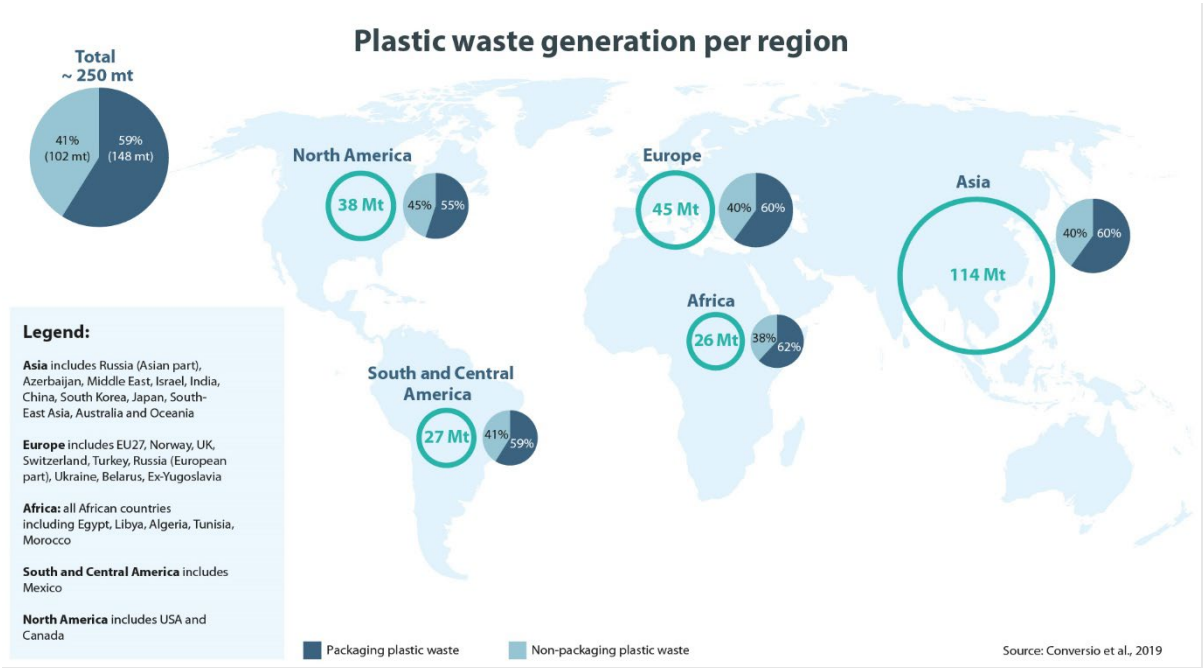


Figure 11: Plastic waste generation per region

4. #UNFAVOURABLE ECONOMICS OF RECYCLATE

PLASTICS DERIVED FROM WASTE HAVE A PRICE DISADVANTAGE WHEN COMPENSATORY INCENTIVES ARE NOT IN PLACE

Secondary finding 4.1: Investing to improve performance is hindered by the fact that prices for recycled content are high relative to virgin material. Consequently, alternative disposal methods such as landfilling remain in use.

According to the Ellen MacArthur Foundation, 98% of plastic packaging is produced from virgin feedstock (Ellen MacArthur Foundation et al., 2016). A functioning market for recycled granulate remains largely non-existent, and stakeholders at the later stages of the plastics value chain are unable to "correct" dysfunctions that occur at earlier stages in the value chain. Collection companies and sorters either have cheaper ways to dispose of plastic, or technology is lacking for recyclers to produce granulate of sufficiently high quality, and/or there is no market for such granulate as virgin material derived from oil or gas is cheaper.

To unlock investments in recycling, plants need to secure feedstock supply of appropriate plastic waste. However, investors remain hesitant because the market for recycled granulate is yet to mature. This is to be expected, given that for a recycling market to thrive and expand, it needs both the production of granulate of high quality and a steady demand for recycled granulate.

It is precisely here that we find a mismatch, right where the end of the plastics value chain (recycling) meets the beginning of the chain (production) and where the business models of producers and plastic converters are mainly driven by issues of quality and price.

In terms of the quality of granulate, industries such as healthcare or pharmaceuticals operate according to standards that effectively preclude the use of recyclates from post-consumer plastic waste. Furthermore, the quality of recyclates is often below that of virgin material, which also affects the functionality of whatever it is used to produce. While there are exceptions to this rule — for instance, PET plastic bottles can be recycled multiple times for the production of new bottles that perform just as well as the originals — achieving product performance parity with items produced with virgin material is, for most applications of plastic, prevented by factors such as colour, odour, contamination or content of legacy additives (such as lead stabilisers in PVC profiles, phthalates in flexible PVC products, flame retardants, etc.).

In terms of price, the volatility of oil prices may encourage the use of virgin material in plastic production whenever prices are lower than that of recycled granulates. This negatively affects the demand for recyclates and thus affects the business case for waste collection, sorting and recycling. Recycled plastic prices declined between 2012 and 2015 but were relatively stable in 2021.[29]

[29] KIWEB, 2021

Spotlight: Oil and gas price dynamics in the context of plastics

The authors of this report acknowledge the impact of oil and gas price volatilities in the current geopolitical and macroeconomic context (2023) on the economics of plastics.

According to Moody's Investor Service, spillover effects from the Russia-Ukraine military conflict on commodity prices and global supply chains will put pressure on European non-paper packaging manufacturers' margins.

It is noted that an analysis of the virgin plastic cost component in the overall demand-supply dynamics of the plastics industry does not form part of this report. However, while beyond the scope of this report, a further investigation of price shocks' impact on virgin versus recycled plastics' demand and supply dynamics warrants consideration.

For further information, please refer to publicly available industry analysis, for example:

OECD[1], 2022, "Global Plastics Outlook: Economic drivers, environmental impacts and policy options"
Moody's[1], 2022, "Soaring commodity prices will pressure packaging makers' profitability in 2022", Donatella Maso, Ambra Cortesi, Ivan Palacios.

Spotlight 3: Oil and gas price dynamics in the context of plastics

5. #TOO MANY PLASTIC TYPES, TOO SHORT A LIFESPAN

TOO MANY DIFFERENT TYPES OF PLASTIC PRODUCED WITH EXCESSIVELY SHORT USEFUL LIFESPANS

Finding 5: The plastics industry produces a variety of plastics used in the manufacture of all kinds of products and packaging. This, in combination with the fact that most plastic packaging is single-use, means that most of these products are quickly discarded, creating challenges in collection, sorting and recycling.

Secondary finding 5.1: The plastics industry produces too many types of plastics. Consequently, there is an urgent need for harmonisation, especially in the area of packaging.

Consumers of plastic products exert influence on producers through demand. High demand for products offering convenience and ease of use often means lower rates of recyclability. At the same time, however, retailers and brand owners have a responsibility to offer recyclable and/or reusable alternatives.

At the moment, the first objective of packaging design is to enhance product positioning, bolster the marketing message and convey product information. Other objectives, such as meeting logistical or safety requirements, are relegated to second place, while considerations for material recovery rarely feature in the product development process. Much of the plastic packaging used today could be done away with by retailers and brand owners if they were to adopt some basic principles of sustainable design. But the focus on product positioning, marketing and product information is driving design, resulting in the maximisation of variety in terms of colour, materials, format and delivery method (including labels and printing). And while such variety in packaging types serves a functional purpose, it also constitutes a barrier to the possibility of a viable reuse or recycling pathway.[30]

From a technical standpoint, solutions exist for the separate collection and sorting of most packaging materials. The problem is that operating sorting plants when the waste stream volume is low simply isn't economically viable. Heterogeneity of input (plastic waste varying in form, material, colour, etc.) slows down the sorting process and causes inefficiencies, which increases costs. Manual sorting, for instance, is easy to perform with large and readily identifiable items. But sorting what remains by hand is difficult, which can result in a 30% loss of input material. The greater the distribution, fragmentation and heterogeneity of material, the higher the sorting cost. To successfully collect and sort all the material in a waste stream, sorting plants would have to work at a snail's pace, with detrimental effects on efficiency and cost. Consequently, packaging material making up a small share of total waste streams (such as expanded polystyrene, EPS) often enters the mixed residual stream for energy generation (by incineration/energy recovery).

Secondary finding 5.2: The bulk of plastic packaging has a very short lifespan in use/application, and much of it is used just once. This, in combination with low recyclability, creates major problems for waste collection, sorting and recycling capacity.

"End-of-life fate" refers to the life cycle of plastics once they have been used and discarded. It starts when a product is discarded and ends when the product is returned to nature as a waste product or enters another product's life cycle (as a recycled input). The leakage of plastics into the environment

[30] Ellen MacArthur Foundation, 2017

occurs predominantly during the end-of-life phase/fate, therefore understanding what happens during this period is critical in addressing the impact of plastic pollution.

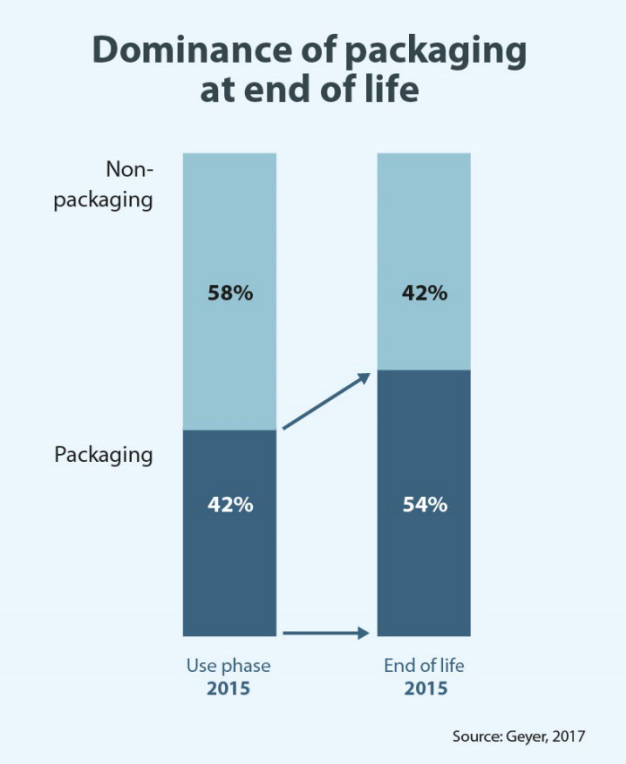


Figure 12: Dominance of packaging at end-of-life

Single-use products, such as plastic packaging for items with a short shelf life, become waste within 12 months of their manufacture. This is especially the case with food and beverages. Most non-packaging plastic products are durables with medium to long life cycles, and typically only become waste after several years of use. This contrast in duration of use greatly affects end-of-life figures. For example, 42% of primary non-fibre-reinforced plastics produced in 2015 entered the use phase as packaging (Figure 13). In the same year, non-fibre-reinforced plastic leaving the use phase comprised no less than 54% of packaging material.[31] Owing to its short lifespan, packaging material constitutes the bulk of plastic waste at the end-of-life stage.

Interview highlights

"We need to develop a better design for recycling packaging products. For example, development of mono-material packaging, which enables easier sorting and recycling in downstream processes." — Innovative packaging company

"Training to brand owners and retailers about better design for recycling would be necessary to improve sorting." — Private startup company

"Design for circularity is mainly in the hands of brand owners. The design choice leads to a more efficient way to have the product recycled. In the end, the whole value chain is important. We can have proper designs, but this needs to go hand in hand with the adopted waste management solutions." — International NGO

[31] Geyer, 2017

6. #BRAND OWNERS AND CONSUMERS ARE KEY DECISION-MAKERS

DRIVING DECISIONS ON QUANTITIES AND TYPES OF PLASTICS

Finding 6: Brand owners and private consumers are key decision drivers in the reduction of the amount and types of plastic used in the plastics value chain. They have a role to play in preventing plastic from entering the value chain in the first place, thereby reducing the potential amount that ends up in the environment.

Secondary finding 6.1: Brand owners can, through their decisions, reduce the amount of plastic or change the types of plastics that enter the market. They can be encouraged to do so by extended producer responsibility (EPR) systems. However, these are not yet present everywhere in Europe.

The EPR system is a unique form of private sector participation. In an EPR system, the cost for the final recycling or disposal of materials is borne by the goods' producer. Producers may pay the municipality or waste management company directly for the cost of collection and disposal, or develop a system for private individuals to return the product after use. In either case, producers will typically include the cost of disposal in the sale price, thereby shifting the burden of the additional cost to consumers. Producers and consumers thereby split the financial and logistic responsibilities for their resource usage. EPR systems ultimately reduce government costs, divert waste from disposal facilities (and thereby reduce the space needed for disposal operations), and encourage environmentally-friendly consumption.[32] In addition, EPR systems may encourage converters and brand owners to choose different types of plastic or reduce the amount of material in their products, thereby reducing the total amount of plastic in circulation.

The European Union has incorporated EPR principles in its policies over the past 25 years. The EPR landscape in Europe encompasses a wide variety of schemes with different financial and technical configurations, and there are EPR systems for different types of waste. The ones for plastic waste mainly concern lightweight packaging. Some countries have additional EPR systems for items such as agricultural films and foils, commercial and industrial packaging, and window frames. There are large discrepancies across Europe regarding the degree to which EPR systems are implemented and how they perform.

[32] Kaza et al., 2018

SPOTLIGHT: EPR Systems

The EPR system is a unique form of private sector participation. Under an EPR system, the costs for the final recycling or disposal of materials are borne by the goods' producer. Producers may pay the municipality directly for the cost of collection and disposal or develop a system for citizens to return the product. In either case, producers will often price the removal cost into the product so that consumers ultimately bear the disposal cost. Therefore, producers and consumers are jointly responsible, both financially and logistically, for their resource usage. The European Union has been integrating EPR principles into its policies for more than 25 years. The EPR landscape in the European Union encompasses a large variety of schemes with different financial and technical configurations. Under the European Union's EPR framework, producers may choose between a collective compliance scheme or an individual scheme.

- Under a **collective scheme**, individual legal obligations are outsourced to umbrella-type organisations, such as producer responsibility organisations (PROs). PROs are created to support producers in handling the technical, financial and policy aspects of managing product life cycles. PROs receive financial contributions from industry and members and use these proceeds to recycle goods, manage data, conduct operations, facilitate contracting, and communicate with stakeholders.
- Under an **individual scheme**, producers that cater to a specific geography or generate most of their waste close to the production site will manage waste directly, such as through a take-back programme. Consumers can return used materials to the distributor.

EPR systems exist for many types of waste. EPR systems, mainly for lightweight packaging products, have been successfully established for plastic waste. In some European countries, other EPR systems exist, such as for agricultural films and foils, commercial and industrial packaging materials, window framing, etc.

The success of an EPR system depends on four criteria (Deloitte, 2014):

1. Clearly defined and distributed responsibilities across stakeholders: Role and contracting, who is responsible for recovery, and waste management.
2. Recovery of actual costs: EPR schemes must account for the costs of source segregation, collection, treatment, enforcement and operation of the EPR programme.
3. Fair competition: A robust EPR system allows competition between PROs and waste management operators. The competition encourages efficiency improvements and reduces monopolies. Service operators should be procured using transparent procedures and competitive open tenders.
4. Transparency and monitoring: Monitoring the performance of an EPR system requires clear performance metrics such as unit costs and the impact of the design on recycling activities. Metrics allow governments to compare the performance of different EPR schemes and support the replicability of good practices. EPR systems must also be monitored to reduce corruption, prevent lack of action, ensure that all waste is fully reported, optimise collection and treatment operations, and stay attuned to PRO activities and compliance.

Spotlight 4: EPR Systems

Secondary finding 6.2: Private individuals are doing their utmost to prevent household waste from leaking into the environment. However, greater efforts need to be made in this area given the amount of waste that still ends up in the environment. Everyone in Europe has a role to play in the solution.

Private individuals and households use 64% of all plastic products, while 36% of plastics are used in commercial and industrial applications.[33] Through their demand, private individuals and households can influence the total amount of plastic products produced. They also have a say in brand owners' design decisions. If public awareness reaches a point at which consumers refuse to buy products that come in certain types of packaging, producers and brand owners will be forced to change their habits immediately. If the public remains indifferent, it will have the opposite effect.

Private individuals and households can also help prevent plastics from ending up in the environment by handling their waste correctly and disposing of their rubbish responsibly. There are roughly three ways in which authorities can help here: awareness-raising and other educational public service campaigns (such as anti-littering campaigns and public service campaigns about how long it takes plastic to degrade in nature); clean-up campaigns (clean-up days organised by local authorities or EPR organisations); and prevention through legislation (for example, requiring producers to keep bottle caps attached to their bottles) or by placing waste bins in litter prone locations.

[33] Plastics Europe and Conversio, 2020

7. #CHALLENGING ECONOMICS OF SORTING AND RECYCLING

CHALLENGING INPUT AND OUTPUT MARKETS FOR SORTERS AND RECYCLERS

"The ugly truth is that the economics of sorting and recycling do not work. Economics need to work first before you can make an investment." — Renowned international charity

Finding 7: Europe's sorting industry and recycling industry, though highly developed, face several challenges in reaching the objective of handling all the continent's collected plastic waste. The industry has to deal with large volumes of mixed plastic waste that are difficult to process.

At the same time, low virgin resin prices and regulatory uncertainties around the timing and level of minimum recycled content requirements are making recycled output streams less competitive. This undermines the targeted shift towards the greater circular reuse of plastics. Certain targeted incentives, such as lower tax on high recyclate content plastics, combined with higher taxes/levies on virgin plastics, could help boost the competitiveness of the former against the latter.

Secondary finding 7.1: Europe's sorting and recycling industry is highly developed and operates reasonably well.

Whether plastics that are not reused or recycled end up in the environment or not depends strongly on the existence of functioning and efficient waste disposal, sorting and recycling infrastructure. The interviews found that most countries in Europe boast large commercial entities with the capacity to combine collection, sorting and recycling activities.

The **sorting** of plastic waste is an essential upstream process for mechanical or feedstock recycling, and is predominantly operated and managed by the private sector. Without the pre-sorting of waste streams, efficient material recycling is virtually impossible. About 50 Mt of plastic waste is sorted for recycling across the globe each year. This figure refers to the input stream to recycling companies.

Recycling largely comes in two forms: mechanical and chemical. Mechanical recycling is currently the main method for producing recyclates. The mechanical recycling industry is highly fragmented. Europe alone is home to more than 600 plastic recycling companies, representing over 8.5 Mt of installed capacity.[34] Chemical recycling on the other hand has a market share of less than 1% globally.

Sorting and recycling systems in Europe are quite advanced and generally operate well. As a result, Europe boasts a high share of the global total of properly managed plastic waste (via recycling, energy recovery and managed landfills) and a low share of waste that is not managed, or is managed improperly resulting in leakage into the environment (Figure 13 and Figure 14).

[34] Plastics Recyclers Europe, 2021

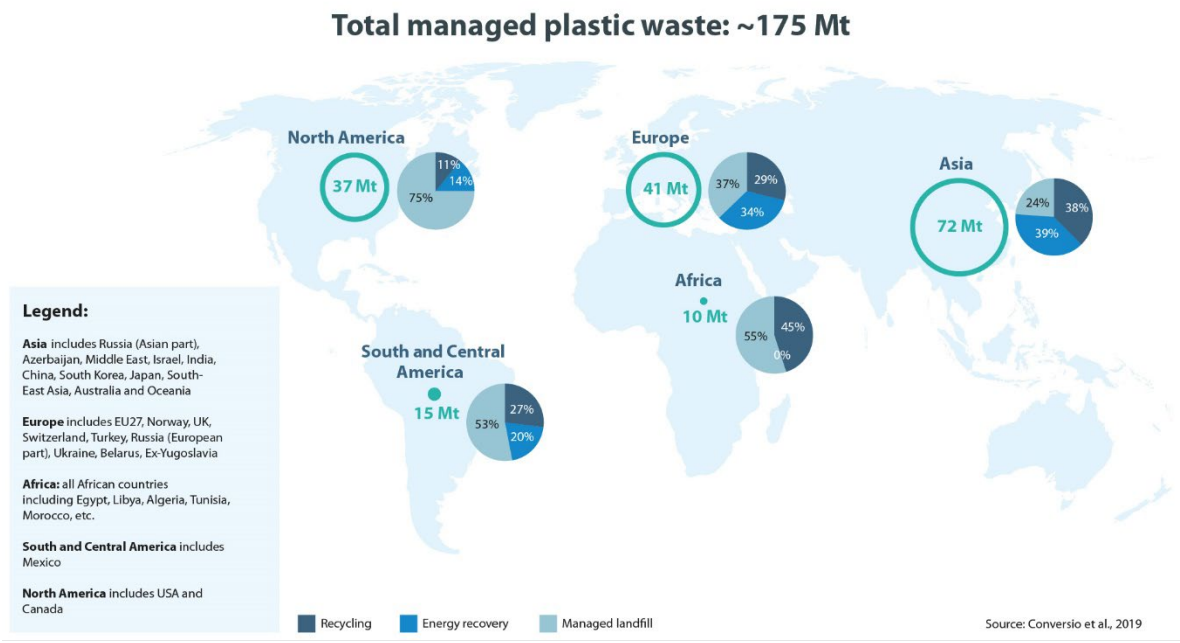


Figure 13: Total managed plastic waste

Figure 14: Total unmanaged plastic waste

In recent years, more emphasis has been put on the recycling of plastic packaging waste. This effort is reflected in the sharp rise in recycling volume, resulting from improved collection systems and the clear strategic orientation of EPR towards recycling in the packaging industry in particular. Europe's share of global packaging recycling currently stands at about 42%.

Secondary finding 7.2: A well-established sorting and recycling industry does not exist everywhere in the European Union. There is much room for improvement in CEE/SEE countries and in other countries with low recycling rates (such as France).

Dedicated sorting facilities for the separate collection of lightweight packaging (facilities with the capacity to sort multiple polymer types into plastic fractions) exist in most European countries, but with a higher concentration in Germany, the Netherlands, northern Italy, Spain, Belgium, the Czech

Republic and the Scandinavian countries. The technological capacity of sorting facilities in most other European countries needs improving. The limitations of existing facilities means that the sorting industry in these regions cannot serve the recycling industry adequately — further proof of the interdependencies around the circular value chain.

As of 2019, 14 of the 27 EU countries were still sending more than 40% of their plastic waste to landfills, with the highest percentages recorded in South-East Europe (Figure 15 and Figure 16). As a result, 3 Mt of packaging waste was sent to landfills in 2018. If managed improperly, this waste may end up in the environment.

"In countries with less advanced waste infrastructure (such as Hungary), investments in waste collection systems are of high importance." — International think tank focused on the circular economy

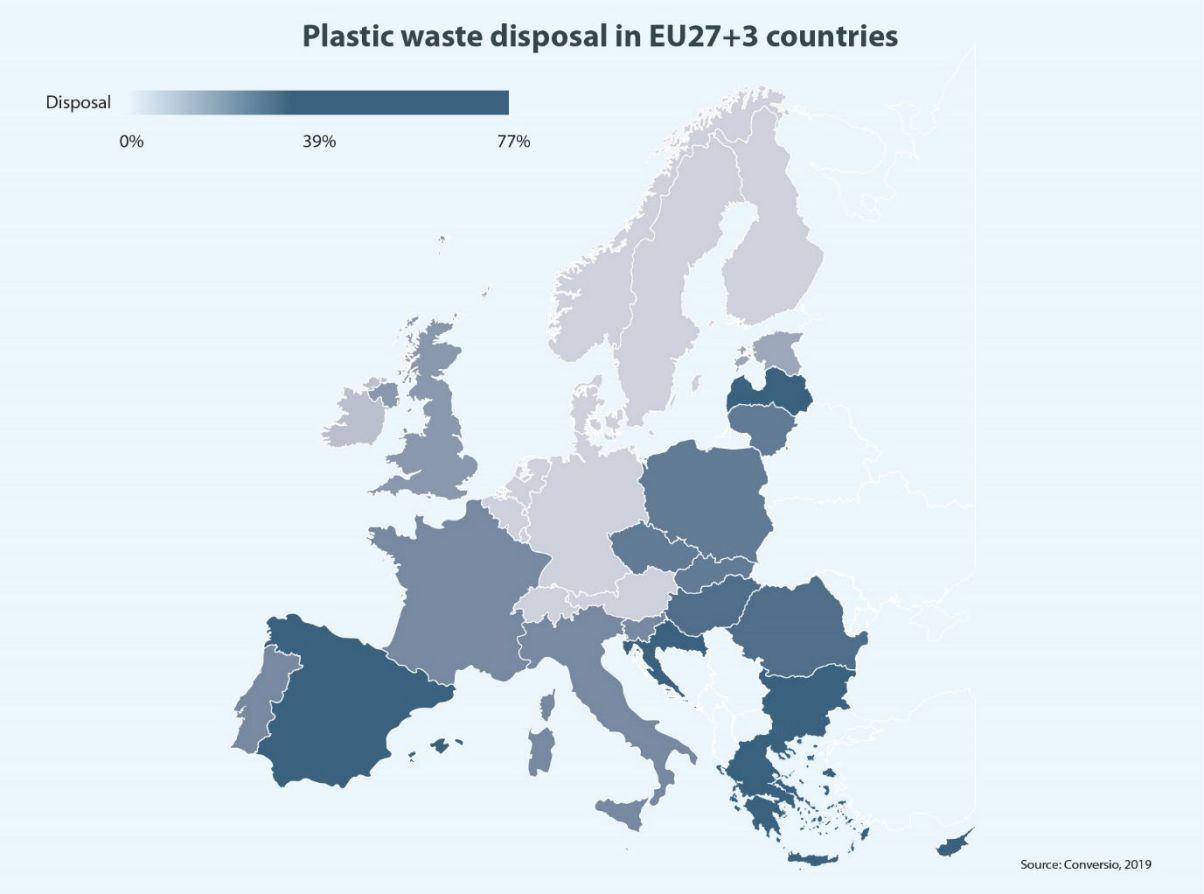


Figure 15: Plastic waste disposal in the EUR27+3 countries

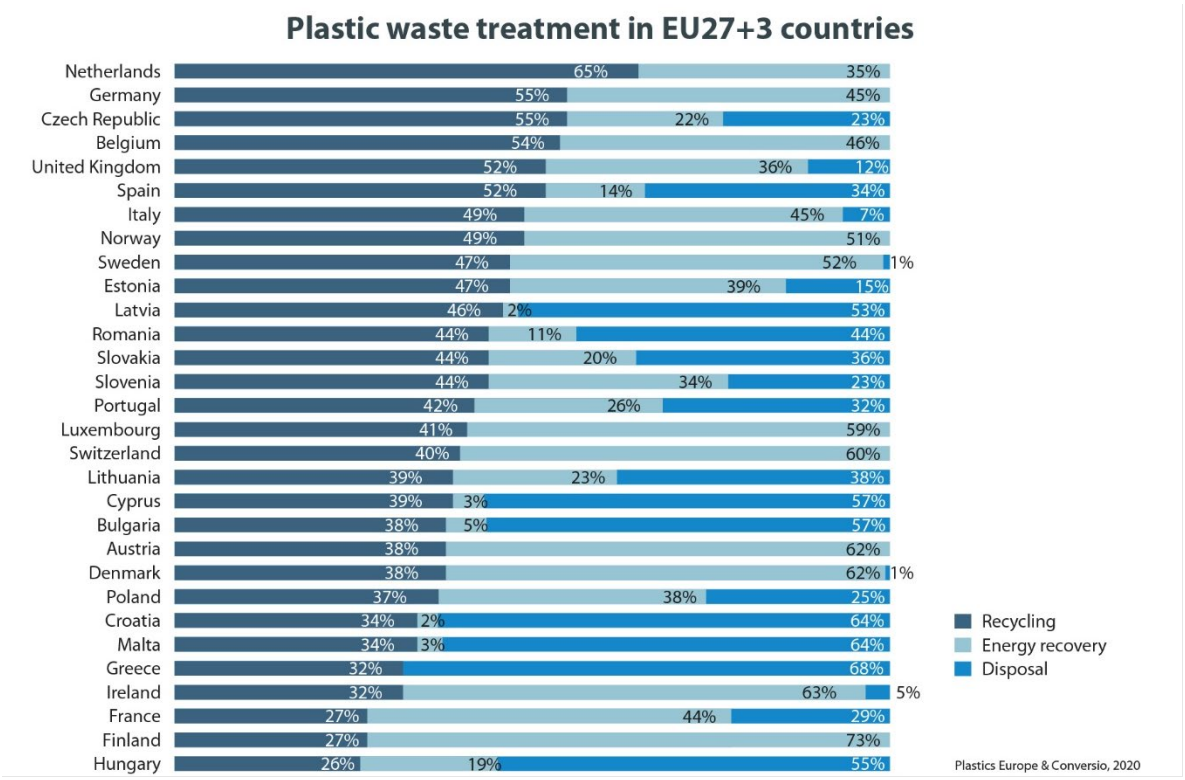


Figure 16: Plastic waste treatment in the EU27+3 countries

SPOTLIGHT: Microplastics

It is estimated that 98% of primary microplastic leakage into the marine environment is generated from land-based activities (Conversio, 2022). The International Union for Conservation of Nature (IUCN)[1] estimates that the global release of primary microplastics into the ocean amounts to 1.5 Mt per year. Microplastics have an impact on both terrestrial and marine environments, although the effects of microplastics, especially on terrestrial ecosystems, remain largely understudied.

The main sources of primary microplastics are vehicle-type dust (from abrasion of tyres while driving), pellet spills, textiles (from abrasion of synthetic materials during washing), personal care products/cosmetics and paint. About half of the microplastic loss is trapped in soils when wastewater treatment sludge is used as fertiliser and/or when particulates are washed from the road pavement.[1]

In countries where adequate wastewater treatment exists, filters capture some of the primary microplastics, such as those created during the laundering of synthetic clothing items. Sludge from these treatment plants is contaminated with microplastics. Therefore, the use of the sludge as fertiliser on agricultural land constitutes a risk (Henry et al., 2018). The same study finds that the application of sludge with representative values of microplastics is shown to affect the survival and fitness of earthworms (Henry et al., 2018).

In marine environments, "aquatic flora and fauna have been found to be affected in different ways when coming into contact with microplastics" (Prinz and Korez, 2020). Ingestion of microplastics is found to have a negative physiological effect on aquatic creatures. In addition, microplastics can harm organisms by carrying pathogens into their tissue (Prinz and Korez, 2020). Tissue damage, through cellular uptake or chemical contamination of leachates from the microplastics, is among the adverse effects of microplastics in organisms. However, these effects are often sublethal, resulting in "reduced primary productivity, compromised energy allocation, reduced growth, changed feeding efficiency or altered predatory performance. Combined with other environmental stressors, this can alter the ecological function of a species in the ecosystem" (Prinz and Korez, 2020).

Moreover, the impact of microplastics on human health is discussed widely. There is particular concern around the transfer of ingested microplastics across trophic levels of the food web. There is clear evidence that fish and other seafood consumed by humans contain microplastics (Prinz and Korez, 2020). Recently, microplastics were found in human placenta (Ragusa et al., 2021). The study that made the discovery attributed the transplacental passage of microplastics to different factors. One of the hypotheses around the phenomenon was ingestion via food (Ragusa et al., 2021). However, while possible adverse consequences on pregnancy outcomes are a concern, evidence demonstrating the human health impact of microplastics is still lacking (UNEP, 201; Ragusa et al., 2021).

Spotlight 5: Microplastics

8. #INNOVATION EXISTS, BUT REMAINS TRICKY

INNOVATION IS HAPPENING, BUT THAT ALONE WILL NOT SOLVE THE PROBLEM ("NO SILVER BULLET")

Finding 8: Innovative solutions to the problem of plastic pollution already exist, but these alone will not solve the problem. Furthermore, innovation comes with its own challenges.

Secondary finding 8.1: The industry is currently working on a whole range of ideas for improving the circularity of plastics. A survey of promising projects and companies in Europe reveals an abundance of innovative solutions spanning the entire value chain.

The industry is developing innovative solutions aimed at addressing problems across the length of the plastics value chain. Several plastics producers and converters are working on innovations aimed at making their materials and products more recyclable, while others are training their efforts on minimising the environmental impact of their products. Sorting companies are developing new ways to improve sorting efficiency — some through optimisation of traditional sorting methods, others by using digital tools (such as artificial intelligence and blockchain technology) to trace plastics along the value chain. In the recycling industry, substantial developments are under way in both mechanical (PET tray recycling) and chemical recycling techniques (for example, pyrolysis, depolymerisation). An overview of innovations noted during this study is provided in Figure 17.

Figure 17: Emerging innovative solutions

Secondary finding 8.2: Chemical recycling is a promising alternative recycling technology, but it poses challenges related to its greenhouse gas emissions and high energy consumption.

Chemical recycling is a term used for describing a range of emerging technologies that turn plastic waste into base chemicals or chemical feedstock. Different technologies target different plastics. At the moment, the efficiency of chemical recycling technologies varies widely. Purification and hydrothermal treatment are new technologies, and scale-up efforts are under way to make them commercially viable. Depolymerisation is currently in use for PET, but its application on other polymers

is still under development. Pyrolysis and gasification have been commercialised; however, their efficiency remains low. In summary, there is as yet no standard or proven technology in chemical recycling.

Nevertheless, much effort is currently being undertaken by large petrochemical and plastics-producing industry actors to develop a technical recycling solution which enables the industry to establish a better circular economy for plastics. There is growing momentum for chemical recycling projects worldwide, including recent announcements of large new facilities by multinational corporations such as ExxonMobil, Shell Chemical, Chevron Phillips and the Eastman Chemical Company. For instance, between mid-2017 and 2021, 66 recycling projects valued at $5.5 billion were announced in the United States — including $4.3 billion for chemical recycling.[35] In Europe, plastics manufacturers recently announced plans to invest €7.2 billion in chemical recycling between now and 2030.[36]

Interviewee opinions on chemical recycling vary, with some regarding it as a beneficial innovation and others voicing doubts around the environmental impact and circularity of the technology. High energy consumption and the greenhouse gas emission balance of the process are key issues under discussion.

For chemical recycling technology to flourish, several regulatory and supply chain issues need to be resolved. On the regulatory front, mass balance certification for chemical recycling needs to match that of mechanical recycling.

"Mechanical recycling has its limitations by the nature of the life and use cycle. Moreover, for all non-packaging plastic applications, mechanical recycling is not a proper solution. For those materials, solutions are required to improve their recycling by chemical means, instead of just incinerating them in waste-to-energy plants." — An academic

"Politicians focus too much on the opportunities and promises made by the chemical recycling industry. However, if chemical recycling is treated similarly to mechanical recycling by law, it will discourage efforts at mechanical recycling. Mechanical recycling technology is now highly advanced, and just needs to be implemented on a large scale across the industry." — Brand owner

Secondary finding 8.3: Substituting plastics with bio-based and/or biodegradable plastics is generally not regarded as a widely applicable solution. Proponents suggest that materials and products that are bio-based, biodegradable and recyclable should be prioritised for investment.

Substituting plastics with bio-based and/or biodegradable plastics is generally not regarded as a widely applicable solution. For instance, non-recyclable biodegradable plastics move the economy away from circularity as they decompose. In addition, some biodegradable plastics require specific conditions for their total degradation, which may be highly energy-intensive. These conditions cannot be provided in traditional waste management facilities. Certain bio-based plastics may cause additional environmental problems, for example those that degrade into small particles (microplastics) but never fully biodegrade.

Proponents of bioplastics suggest that — if investing in bioplastics — materials and products that are bio-based, biodegradable and recyclable should be prioritised for investment. It is also preferable if these materials/products are made from by-products of the forestry and agriculture industries, so as to avoid additional shifts in land use. Compostable plastics that can be broken down into biomass at their end of life are the second-best option.

[35] The Year of Advanced Plastics Recycling (And Watch the Video) — Advancing Circular Packaging.
[36] European plastics manufacturers plan 7.2 billion euros of investment in chemical recycling – Plastics Europe.

In addition, a great majority of bio-based plastics are produced from annual crops. Therefore, environmental and social risks related to the growing demand for bio-based plastics need to be adequately evaluated before investing further in bio-based or biodegradable plastics.

"Investment in plastic substitutes is not a good contribution to solving the problem of plastic pollution. Bioplastics can, in certain instances, even make the situation worse. Biodegradable plastic is by its nature a non-circular concept." — International think tank focused on the circular economy

"We can't substitute our way out." — Renowned international charity

SPOTLIGHT: QUICK REFERENCE GUIDE — BIOPLASTICS

"Bio-based" refers to a material or product derived from biomass. Currently, bio-based materials are produced predominantly from annual crops, such as corn and sugar beet, or perennial cultures, such as cassava and sugar cane). However, the use of non-food crops, such as cellulose, in the production of bio-based products is being researched (European Bioplastics — EUBP, 2021).

However, there is a distinction between bio-based plastics and bioplastics. Bioplastics could refer to bio-based plastics, biodegradable or both. Bioplastics can be divided into three categories:

Bio-based and biodegradable

For example, polylactic acid (PLA), polyhydroxyalkanoates (PHA), polybutylene succinate (PBS), and starch blends.

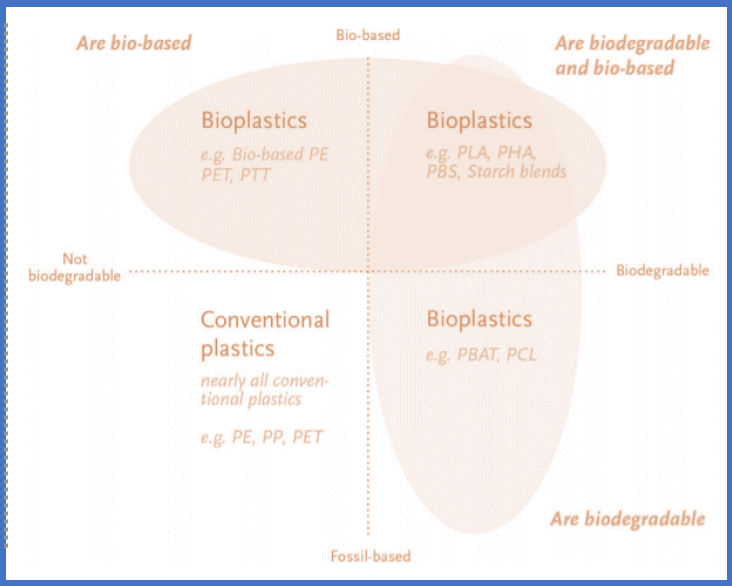
Bio-based and non-biodegradable

For example, bio-polyethene (bio-PE) and bio-polypropylene (bio-PP).

Fossil-based and biodegradable

For example, polybutyrate adipate terephthalate (PBAT).

The figure on the right depicts the material coordinate system of bioplastics (EUBP, 2021).



In scientific terms, biodegradation is a "chemical process in which materials, with the help of microorganisms, are metabolised to water, carbon dioxide and biomass. When materials biodegrade under conditions and within a timeframe defined by the European standard for industrial composting EN 13432, they can be certified and labelled as industrially compostable" (EUBP, 2021).

Bio-based plastics can be durable products that can be reused, mechanically recycled and eventually incinerated. When bio-based products are also biodegradable, they can be organically recycled (industrial composting and anaerobic digestion) at the end of a product's life cycle (if certified accordingly) (EUBP, 2021).

Today, there is a bioplastic alternative for several conventional plastic materials and application that offers the same or, in some cases, even better properties and functionalities (EUBP, 2021). Current application trends of bio-based plastics show some differences compared to fossil-based plastics.

Spotlight 6: Quick reference guide — bioplastics

Secondary finding 8.4: While plastic packaging is receiving a lot of attention, innovation is also needed in waste systems for engineering plastics and in a variety of application industries, such as the automotive industry and in the electrical and electronics (E&E) sector.

Many of the established waste management systems focus on the collection, sorting and recycling of plastic packaging. Industries generating other types of plastic waste show little in the way of end-of-life processing activities, such as sorting systems for PVC in the construction industry or sorting and recycling systems for agricultural plastics. While the packaging industry is responsible for the bulk of plastic production and waste, other sources should not be overlooked. Engineering plastics[37], in particular, require sustainable solutions. Such plastics are in use in the automotive industry and E&E.

Electrical and electronic products are responsible for 6% (15 Mt) of the global total of plastic waste generated each year, and account for about 2 Mt of the waste collected in the EU27+3 countries.[38] Only about 24% of this 2 Mt was recycled in 2018, with large disparities seen between EU countries. Waste streams in the E&E sector often contain a variety of substances that pose considerable risks to the environment and are therefore required to be treated accordingly. But they also contain valuable materials, making them an important resource for recycling operations. Most operations currently only focus on the recovery of metals. However, many more valuable secondary materials, including plastics, could be obtained if collection, sorting and recycling systems were to be improved.

The automotive industry is responsible for 5% (13 Mt) of global plastic waste. In the EU27+3 countries, the total amount of plastic waste collected in 2018 was around 1 Mt.[39] The treatment of automotive shredder residue (ASR) with post-shredder technologies is yet to be established on a large scale in Europe for the recycling of plastics. Only 19% of ASR was sent for recycling in 2018.

The construction industry is another sector with untapped potential. For instance, plastic material installed years ago may contain harmful substances that are no longer permitted for use in buildings, such as hexabromocyclododecane (HBCD, a flame retardant) in EPS insulation. If these materials were to be stripped from buildings today, this waste would be contaminated with those hazardous substances. Poor recovery would result in environmental pollution. While this particular application currently accounts for a relatively small share of total annual waste, the long lifespan of these plastics could mean larger waste streams in the future. Pre-emptive action is thus required, particularly given the presence of harmful substances in these streams.

Secondary finding 8.5: However, innovation alone will not solve the problem. Additional steps are needed throughout the value chain to achieve full circularity.

While there is an abundance of innovations in the pipeline aimed at minimising material usage and improving the recyclability of plastic waste streams, additional steps are needed to achieve full circularity. For innovations to work and be adopted on a wider scale, the systemic issues previously described must be resolved. A mature market for both feedstock and recycled granulate needs to exist for investing in sorting and recycling innovations to become attractive. For plastic producers to use recyclates instead of virgin materials, the choice must be economically appealing. For brand owners and designers to choose materials and products that can be recycled, they need clear economic incentives, such as changing consumer demand (the carrot) or regulatory requirements (the stick). To

[37] ABS, SAN, PA, PC, PBT, POM, PMMA, blends, others including high-performance polymers.
[38] Plastics Europe and Conversio, 2019.
[39] Plastics Europe and Conversio, 2019.

ensure that end-of-life plastics, if not reused or recycled are at least properly managed, comprehensive and effective waste disposal systems must be in place. Innovation alone will not bring this about.

KEY RECOMMENDATIONS

Reducing plastic waste pollution is a key ambition of the European Union, as reflected in its support for a comprehensive global solution to the problem through UNEP's proposed Global Treaty on Plastics. It is therefore natural that the EIB, the European Union's lending arm, looks at ways finance can help address the challenge of supporting a more circular business model across the plastics value chain. In this report, the focus has been on the key issues within the plastics value chain that contribute to the problem of plastic pollution, as well as on solutions to overcoming them.

The plastics value chain hosts a variety of interdependent stakeholders, who all have a role to play in moving Europe and the world towards a circular economy. It is the complex nature of these underlying interdependencies that make the problem so hard to resolve. Decisions made by one stakeholder affect the processes of another, with knock-on effects throughout the value chain. For instance, stakeholders operating at the early stages of the chain in production and processing can, through their design decisions and choice of materials, influence the recyclability of waste streams later in the chain (sorting and recycling). However, when these decisions worsen the recyclability of the waste streams, these players are not directly confronted with the external effects of the inefficiencies they cause.

Key issues

As stated in this report, three key issues lie at the core of the problem.

First, decisions to use specific types of plastics in the manufacture of products and packaging are based more on functionality, marketing and other such priorities than on reuse or recycling potential. Thus, an excessive variety of plastics are currently being introduced into the plastics value chain. In the packaging sector, the bulk of these plastics consists of single-use products. Consequently, most of these items are quickly discarded, creating challenges in collection, sorting and recycling. While the packaging industry is responsible for the bulk of plastic production and waste, other sources cannot be overlooked. In particular, technical or engineering plastics, commonly used in the automotive industry and electrical and electronics sector, require more sustainable solutions.

Second, as a consequence of the first issue, the sorting and recycling industry receives large volumes of plastic waste comprising many different types of plastic, some of which are difficult to recycle. The quality of sorting and recycling input is affected by all upstream players in the plastics value chain, and therefore constitutes a collective responsibility that is difficult for sorters and recyclers to manage on their own. At the same time, low virgin resin pricing and uncertainties regarding plastic offsetting (that is, quotas for minimum recycled content in new plastics) are making recyclers' output streams less competitive. For the recycling market to thrive and expand, it needs both the production of granulate of high quality and a steady demand for recycled granulate.

Sorting and recycling systems in Europe are advanced and generally operate well. As a result, Europe boasts a high share of the global total of properly managed plastic waste (via recycling, energy recovery and managed landfills) and a low share of waste that is either not managed or managed improperly. However, the sorting and recycling industry does not operate equally well across the EU Member States. There is much room for capacity improvement in regions that still rely heavily on landfills (CEE/SEE countries) and in other countries with low recycling rates (such as France).

The third issue is access to finance for those seeking to address the problem of plastic waste pollution. On the one hand, there are the public authorities who face the ultimate responsibility for the collection, sorting, recycling or disposal of ever greater volumes and variety of plastic waste and are confronted with the challenge of financing the value chain. On the other hand, there are innovative

companies working on more circular solutions to the plastic waste problem that require patient, risk-bearing capital to reach a sufficient level of maturity and overcome the startup "valley of death".

Key solutions

This report highlights an estimated investment gap of €6.7-€8.6 billion that must be closed in order to meet Europe's recycled content targets by 2025. Achieving these targets requires both substantial investments in sorting and recycling capacity and the creation of a reliable end market for the recycled content. Four key solutions to the problems can be identified:

1. Rein in the variety of plastics. Brand owners are key decision-makers regarding the types of plastics used in their products, and their decisions are largely driven by consumer demand. Since more homogeneity in plastic types increases the ease of recycling and thus increases the value of waste streams later in the chain, restricting the variety of plastics that enter the market will help the sorting and recycling industry operate more effectively. As a result, brand owners need to be given incentives to make this a reality. Furthermore, they need support for the shift to designing and using packaging materials that are more recyclable. It is likely that this effort will require both raising public awareness so that consumers become less tolerant of problematic plastics if they can be avoided and stricter regulations to avoid them altogether and support alternative solutions.

2. Remove financing barriers that hinder innovation. The private sector is developing innovative solutions aimed at addressing problems along the length of the plastics value chain. Such innovations need to be championed and facilitated. For example, clear gaps exist in new recycling solutions for technical products (in use across the automotive industry and the electrical and electronics sector) which need to be developed and implemented.

Digital sorting technologies to increase the speed and accuracy of separating mixed plastics waste streams are another underdeveloped area of innovation. Innovation in the use and type of plastics employed in the agricultural and food processing sectors is another opportunity to address the problem at a meaningful scale. However, there are significant barriers that keep investors away. For instance, investors require certainty regarding the stability of supply and quality of feedstock of a project (supply and offtake arrangements).

Project owners are often unable to provide such assurances due to market uncertainty or because of technological and commercial challenges in the scale-up phase of their operations. To accelerate innovation, financial support in the form of patient, risk-bearing capital is needed for projects that come with these uncertainties or challenges.

3. Build a market. To create sufficient and stable demand for recycled content, prices must become more stable and competitive relative to virgin material. This is not often the case. The volatility of oil prices may encourage the use of virgin material in plastic production whenever prices are lower than that of recycled granulates. This negatively affects the demand for recyclates and thus puts the sorting and recycling sector in a tight spot. Uncertainty regarding plastic offsetting needs to be reduced.

4. Build capacity. If improvements in the plastics value chain are made and market conditions are stabilised, this will increase the amount of available recyclable material. To take advantage of this, both sorting and recycling capacity needs to be increased.

The four solutions are complementary and would need to be pursued in parallel to improve the plastics value chain and reduce plastic waste pollution. The remainder of this section offers measures in pursuit of this objective, split into policy recommendations and financial recommendations (Figure 18).

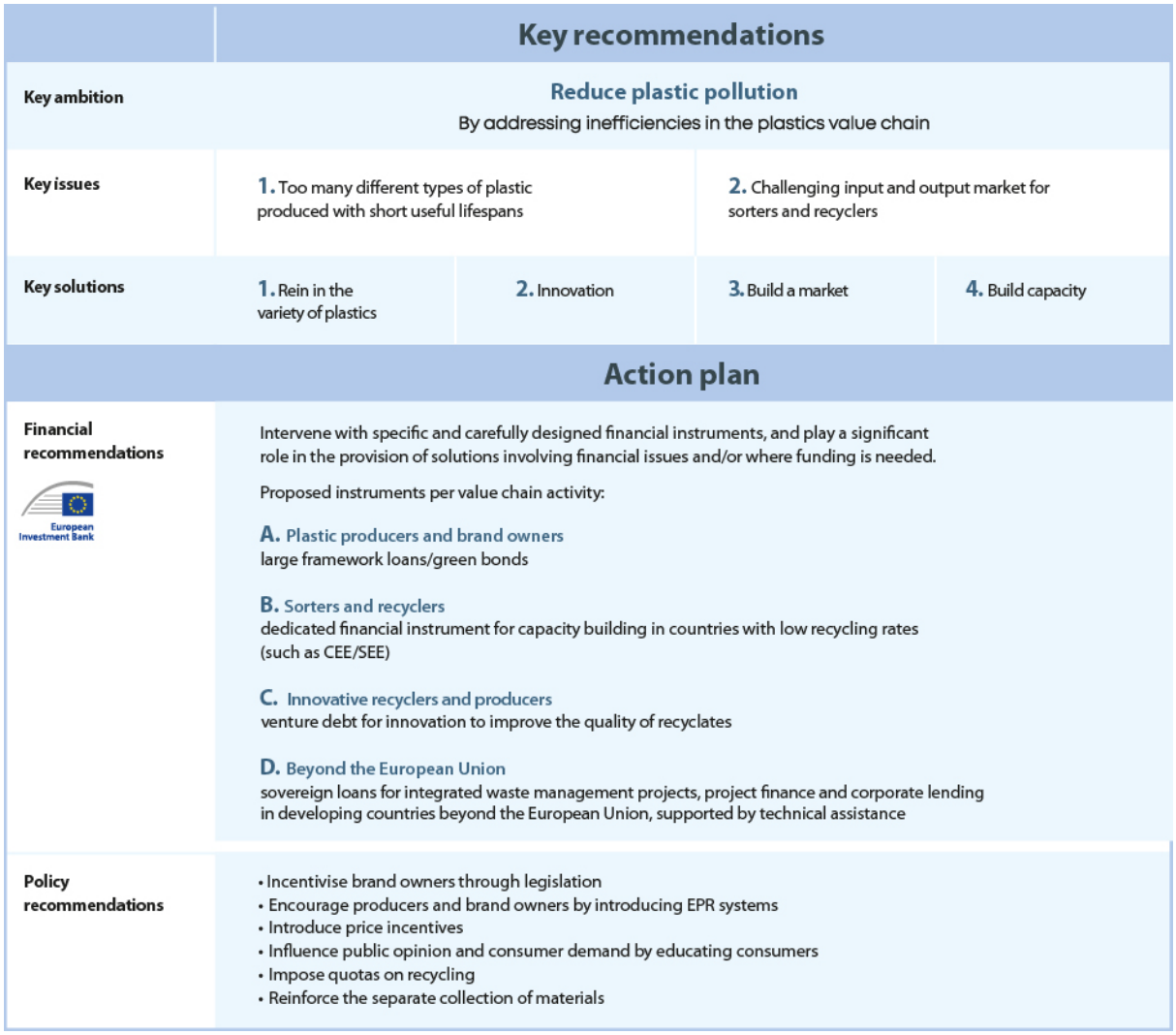


Figure 18: Key recommendations

Financial recommendations

This report concludes that there is an estimated investment gap of €6.7-€8.6 billion in the plastics sorting and recycling sectors that needs to be addressed in order to meet Europe's recycled content targets by 2025. Achieving these targets requires substantial investment in sorting and recycling capacity (assuming there is sufficient collection capability) and a reliable end market for the recycled content. The EIB is a natural partner for the European Commission in addressing the problem of plastic waste pollution by building an enabling environment for public authorities, entrepreneurs, financiers and investors. The creation of a functioning end market for plastic waste and recyclate is a necessary condition for private sector investment in support of a more circular economy in plastics. However, legislative change to introduce these positive incentives into the value chain takes time. However, the EIB can and is intervening with specific, well-designed financial instruments to support scalable solutions. Moreover, EIB advisory services can help innovative European companies understand and meet EU objectives and assist them in navigating the available financing options.

The financial recommendations presented in this section are actionable steps the EIB can take to contribute to solving the issue of plastic waste pollution both inside and outside the European Union, accompanied by a selection of active EIB-financed projects to illustrate the Bank's commitment to a more circular economy in plastics.

Given the existing plastics value chain and the nature of the players operating at each stage, four main recommendations are put forward.

1. Plastic producers and brand owners: large investment programmes and green bonds for corporates.

This study identified a concentration of large companies producing plastics and plastic products at the beginning of the plastics value chain. Many of these companies have the capacity to innovate (for example, in their packaging and/or use of materials) and thereby create higher waste stream value at later stages of the value chain. Some of them, in fact, already have R&D departments and significant budgets to undertake and develop sustainable activities.

The EIB could serve this market by providing large investment programme loans for plastic producers and brand owners in the private sector with the explicit objective of improving circularity and sustainability. EIB financing could then be channelled towards the most promising and innovative solutions developed by the leading plastics producers. The InvestEU mandate (2022-2027), through the InvestEU Advisory Hub, provides a focal point for the EIB's financial and technical advice in support of emerging, higher-risk and innovative sectors in the European Union.

Case study: Borealis

Amount: €250 million

Instrument: Ordinary investment loan in support of multiple projects, financed by EIB own resources

Tenor: Ten years

Geography: Austria, Sweden, Finland

Description: The loan supports Borealis's multi-year R&D investment programme in the area of plastics circularity.

Borealis is one of the world's leading providers of advanced and circular polyolefin solutions and a European market leader in base chemicals, fertilisers and the mechanical recycling of plastics.

Borealis employee working at the large compounding line in Linz, Austria

Case study 1: Borealis

The EIB can stimulate these types of activities by either issuing large **investment programme loans** or acquiring the issuance of **green bonds** (as a loan substitute) from large players in the market, specifically designed to fund — and thereby support — such sustainable activities. In this way, the EIB would address inefficiencies originating at the beginning of the plastics value chain.

1. **Investment programme loans** are flexible loans designed to finance large investment programmes. They usually consist of multiple smaller and medium-sized loans for projects within a company or investment programme, which can be issued flexibly for the duration of the framework loan. Framework loans usually start from €100 million, with the different projects within the loan varying between €1 and €50 million.

2. **Green bonds** are fixed-income instruments that are issued by projects or companies with a specified objective, for instance combating climate change through mitigation or adaptation. As an issuer, the EIB was the pioneer of green bonds through its climate awareness bond (CAB) issued in 2007. The EIB then allocated the proceeds of the issue to CAB-eligible projects. In the context of plastics, the EIB could be the purchaser of such issuances by larger private companies, so broadening the capital markets to the circular economy.

2. Sorters and recyclers: framework loans for municipalities and regions to build recycling and sorting capacity in countries that still rely heavily on landfills (CEE/SEE countries) and in other countries with low recycling rates (such as France).

Further downstream in the plastics value chain are the sorters and recyclers, and the EIB can play a role in their capacity building. It is recommended that the Bank **expand on a proven financial instrument such as the energy demonstration projects (EDP) facility** for this purpose, offering small to medium-sized investment tickets to sorters and recyclers with proven and scalable technology. The InvestEU Fund provides such an opportunity through its thematic financing facilities. In broadening this instrument, thought should be given to understanding why existing plants have difficulty obtaining funding and why equity players have been reluctant to invest in these companies. One of the findings of this study is that investors need certainty regarding the supply and quality of feedstock — which is often absent. The same applies to certainty about the stability of the end market for recycled content.

Plastic sorting and recycling. Framework loans for public sector municipalities or local authorities specifically targeted at scaling up the plastic sorting and recycling capacity in the European Union to achieve its objective of having 10 Mt per year of recyclates used in plastic products on the European market by 2025.

The findings of the report indicate gaps in sorting and recycling capacity in some more developed EU Member States. However, the largest gaps in sorting and recycling are identified in EU cohesion regions, centred on Central and Eastern Europe and South-Eastern Europe.

It is estimated that the investment required to close this gap across the European Union amounts to up to €6.7–8.6 billion, split between additional sorting capacity (€2.1–2.9 billion) and new recycling capacity (€4.6–5.7 billion). This investment would enable the European Union to add 4.2 million metric tonnes (Mt) of annual plastics sorting capacity and 3.8 Mt of annual recycling capacity by 2025 in pursuit of its 10 Mt annual target for recyclate (re)use across the continent.

3. Innovative recyclers: venture debt for innovation to improve the quality of recyclates.

It is essential to continue supporting research, development and innovation (RDI) activities by European companies focused on proving new concepts aimed at more circularity in plastics and assisting the adoption of emerging technology solutions at scale. While this does not provide a "silver bullet" to the problem, technical innovation does provide a pathway out of the present linear production and consumption models for plastics.

For conventional recyclable plastics, the output of recyclers is recycled material, otherwise known as granulate or recyclate. For the more complex, difficult-to-recycle plastics (such as composites), the output is a by-product that can be used further down the value chain as raw material for other processes. Substantial developments are already under way in both mechanical (PET tray recycling) and chemical recycling techniques (for example, pyrolysis, depolymerisation). Please refer to Figure 17 for an overview of innovations noted in this study.

The EIB can accelerate innovation by supporting business models that improve recyclers' feedstock (such as sorting innovations), output quality (recycling innovations) and innovative uses of the by-products (new uses and alternatives), addressing the needs of all recycling types.

Particularly in the cases of less mature, innovative technologies, the Bank may absorb the related technology risk by investing in R&D and commercial demonstration projects with a higher risk-bearing instrument, **venture debt**.

1. **Venture debt** is a form of debt financing with equity features, designed specifically for innovative companies in the early development stages. The EIB currently provides venture debt financing specifically for investments in R&D and commercial demonstration, for a period of up to eight years. With this type of financing, the EIB complements existing venture capital financing (typically after round B financing) and covers up to a maximum of 50% of the total investment costs. The current minimum commitment under the venture debt programme is €7.5 million. At the EU level, there are potential synergies with the European Innovation Council (EIC)'s fund which, as an explicitly pathfinding, accelerator-type financial instrument, would typically invest at an earlier stage than the EIB's venture debt product.

2. Within the EIB's existing range of financing instruments for larger and later-stage projects, two recent and replicable operations illustrate that dedicated financing at scale is available to innovative sorters and recyclers. The Innovation Programme Loan — Western Europe (€500 million) and the Thematic Green Finance (InvestEU Venture Debt) and Debt Programme Loan (€500 million) are two dedicated financing envelopes for this purpose, the former on the Bank's own resources and the latter under the European Union's flagship InvestEU Fund. Individual loans under these programmes can range between €25 million and €75 million.

The innovative companies assessed and interviewed in the course of this study are further evidence of an emerging segment of innovative companies seeking to address the problem of plastic waste. An example of such a transaction is the EIB's financing of the French company Carbios. In December 2021 and with the support of the European Commission, the EIB signed a €30 million loan agreement with the company which developed an enzymatic recycling technology to support the circular economy.[40]

[40] https://www.eib.org/en/press/all/2021-476-the-eib-with-the-support-of-the-european-commission-is-financing-a-eur30m-loan-for-carbios-enzymatic-recycling-technology-to-support-the-circular-economy

Case study: Carbios

Amount: €30 million

Instrument: InnovFin Energy Demonstration Projects

Tenor: Eight years

Geography: France

Description: The quasi-equity financing funds the strategic industrial and commercial development of Carbios technology in France.

Carbios developed an enzymatic recycling technology that deconstructs any type of PET plastic waste into its basic components, which can then be reused to produce new PET plastics of a quality equivalent to virgin plastics.

Carbios PET bio-recycling demo plant (EDP)

Case study 2: Carbios

For counterparties with strong credit ratings, traditional **corporate lending**, as shown in detail in item #1, remains a cheaper financing alternative. EIB intervention could be restricted to the specific process put in place for the recycling or treatment of these plastics (for example, wind turbine blade recycling factories).

4. EIB Global — Sovereign loans for integrated waste management projects and tailored lending in lower-income countries outside the European Union (in Asia, sub-Saharan Africa and small Caribbean and Pacific Island States) supported by technical assistance.

As most of the plastic pollution occurs in emerging markets, or less developed countries, the EIB can also play a role in mitigating its negative effects closer to where it is originated.

1. **EIB Global — Sovereign loans for integrated waste management projects.** EIB sovereign loans to public sector entities, especially those public entities responsible for wastewater collection and treatment, targeting coastal cities (often with substantial ports or harbours), in developing countries.

The initial focus would be on lower income countries in Asia and, to a lesser extent in sub-Saharan Africa, that are the leading sources of plastic waste accumulating in the world's major waterways and oceans. Equally, small Caribbean and Pacific Island states could also benefit from such support where their unique geography aggravates the issue of waste collection and management.

As a reflection of the complexity of the problem, this approach would be most effective when combining EIB financing with robust technical assistance to project promoters — an essential component to maximise the impact of the Bank's financing — and blended with appropriate donor grant funding. In this respect, close cooperation by the EIB and the European Commission with multilateral development banks (MDBs) and regional development banks would be essential, alongside the involvement of key European bilateral development actors associated with the EU Clean Ocean Initiatives.

2. **EIB Global — Project Finance and Corporate Lending.** As the plastic waste treatment market outside the European Union has evolved away from traditional delivery by the public sector and towards public-private partnerships (PPPs) based on granting concessions to private sector entities, the EIB can play a key role in supporting the development of this market.

The EIB is well placed to offer both corporate loans and non-recourse project finance to project companies awarded long-term plastic waste management concessions. Considering the findings of this report, the initial focus could centre on developing countries in Asia and Latin America where the Bank operates under a mandate to develop the private sector and for whom the EIB is an attractive provider of competitive, long-term financing, and in local currency if required.

Some niche market segments too small and granular for direct EIB lending could benefit from "green" intermediated loan facilities whereby EIB credit is extended to local banks seeking to help domestic plastic sorters and recyclers scale up in the face of growing volumes of plastic waste. These intermediated operations can also benefit from robust technical assistance (TA) to promote the transfer of best international practices and ensure adequate project management and monitoring.

Case study: Caribbean Sustainable Water Management and Clean Oceans Programme

Amount: €150 million

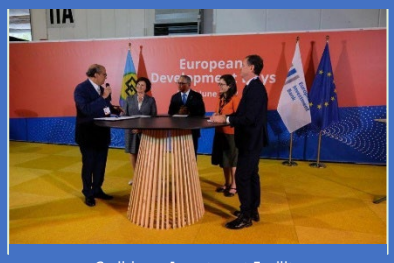
Instrument: Thematic loan, supported by the NDICI mandate

Tenor: 25 years

Geography: Caribbean countries

Description: The loan aims to provide financing primarily to sovereign and sovereign-guaranteed public sector counterparties in the Caribbean.

The Caribbean Sustainable Water Management and Clean Oceans Programme is dedicated to improving climate resilience and healthy oceans through new investments in security of water supply, wastewater treatment, solid waste and stormwater management across the region.



Caribbean Investment Facility

Case study 3: Caribbean Sustainable Water Management and Clean Oceans Programme

Policy recommendations

Given the complexities of the plastics value chain, many of the necessary improvements require policy measures, to be combined with the financial instruments described above. While these measures fall outside the EIB's immediate control, they are all essential in contributing to an effective solution. The current set of circular ambitions (as set out in the European Strategy for Plastics and the European Green Deal) and existing directives (such as the Plastic Bags Directive, the Single-Use Plastics Directive and the EU Taxonomy for Sustainable Activities[41]) developed within the European Union demonstrate the clear commitment towards a more circular European economy.

However, the analyses and expert interviews conducted for this study revealed room for adjustment to existing policies and the adoption of additional policy measures specifically designed to:

1. **Incentivise brand owners in their decisions on product design**. Legislative measures could be introduced to tackle difficult-to-recycle plastic packaging: for instance, bans on certain single-use plastic products; incentives against the use of multi-layer plastic packaging, composite packaging (such as packaging combining paper and plastics), multi-polymer packaging or PVC packaging; a ban on opaque PET (which older sorting facilities are not equipped to identify); and measures aimed at reducing the use of too many colours or black colouring.
2. **Encourage producers and brand owners through the introduction or extension of EPR systems**, thereby incentivising them to make products that are easier to recycle and result in higher value waste streams. EPR systems do not currently exist for most non-packaging plastic products, so there is room for national governments to introduce mandatory ones or collection schemes for specific industrial applications, for instance in the automotive industry, the electrical and electronics sector, the agriculture sector and in building and construction.
3. **Introduce price incentives to improve the competitiveness of high recyclate content plastic products**. In order to overcome the historical price disadvantage of these materials against virgin plastic materials, tax policy could be made so as to impose financial penalties (taxes, levies) on producers of virgin plastic materials or converters of complex plastic packaging. In terms of positive incentives, high recyclate content plastics could attract a lower rate of tax, thereby offering a lower price to converters and ultimately the consumer. As with EPR systems, this would serve to create additional revenue streams that could support additional investments across the value chain. This "tax wedge" may also have the effect of dampening the effect of oil and gas price volatility on the relative attractiveness of virgin plastic resin (when prices are low) versus high recyclate content resin by closing the price differential between these sources of feedstock.
4. **Influence public opinion and consumer demand by educating consumers,** through awareness campaigns. Successful campaigns against the use — and therefore production — of single-use plastics (such as plastic straws, coffee cups) and adoption of reusable shopping bags provide a template for reducing the number of everyday, readily disposable items that disproportionality contribute to the problem.
5. **Impose quotas on recycling**, by imposing a minimum percentage threshold of recyclates in the feedstock supply, a minimum percentage of recyclates or bio-based material for plastics processors and brand owners, or a minimum percentage recycling quota for specific polymers to compel producers and brand owners to set up dedicated collection, sorting and recycling schemes.

[41] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32020R0852&from=EN

REFERENCES

Air Pollution, 2021. What is Acid Rain? http://www.air-quality.org.uk/01.php

ASTM, 2020a. D7611 / D7611M-20, Standard Practice for Coding Plastic Manufactured Articles for Resin Identification, ASTM International, West Conshohocken, PA. Accessed on 30 May 2021 via http://www.astm.org/cgi-bin/resolver.cgi?D7611D7611M

ASTM, 2020b. ASTM D7611 Standard Practice For Coding Plastic Manufactured Articles For Resin Identification. Accessed on 30 May 2021 https://www.astm.org/COMMIT/d7611.pdf

BASF and Conversio, 2019. Waste generation, waste streams and recycling potentials of HBCD-containing EPS/XPS waste in Europe and forecast model up to 2050. https://polystyreneloop.eu/wp-content/uploads/2021/01/Conversio-study.pdf

Bio by Deloitte, 2014. Development of Guidance on Extended Producer Responsibility (EPR). Final Report. Report prepared for the European Commission. Neuilly-sur-Seine.

Boucher, J. and Friot D. (2017). Primary Microplastics in the Oceans: A Global Evaluation of Sources. Gland, Switzerland: IUCN. 43pp.

British Plastics Federation (2021). Chemical Recycling 101. Accessed on 15 December 2021 via https://www.bpf.co.uk/plastipedia/chemical-recycling-101.aspx

CE Delft, 2018. Environmental Prices Handbook: EU28 version. https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_7N54_Environmental_Prices_Handbook_EU28_version_Def_VS2020.pdf

Circular Plastics Alliance, 2021. Roadmap to 10 Mt recycled content by 2025. Accessed via https://ec.europa.eu/docsroom/documents/46956

Ellen MacArthur Foundation, 2021. UN Treaty. https://www.newplasticseconomy.org/projects/un-treaty

Ellen MacArthur Foundation, World Economic Forum, McKinsey Center for Business and Environment, 2016. The New Plastics Economy: Rethinking the Future of Plastics. Accessed on 30 May 2021 via https://www.ellenmacarthurfoundation.org/explore/plastics-and-the-circular-economy

Environment Protection Authority (EPA), 2004. Photochemical smog – what it means for us. Accessed on 1 June 2021 via https://www.epa.sa.gov.au/files/8238_info_photosmog.pdf

EUBP, 2021. Frequently Asked Questions On Bioplastics. Accessed on 30 May 2021 https://docs.european-bioplastics.org/publications/EUBP_FAQ_on_bioplastics.pdf

European Commission, 2000. Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles. Accessed via https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32000L0053

European Commission, 2012. Directive 2012/19/EU on waste electrical and electronic equipment (WEEE). Accessed via https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:en:PDF

European Commission. European Circular Economy Stakeholder Platform. Accessed via https://circulareconomy.europa.eu/platform/en/commitments/pledges

European Commission, 2013. Final Product Environment Footprint and Organisation Environmental Footprint methods. Accessed on 30 May 2021 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013H0179

European Commission, 2018a. A European Strategy for Plastics in a Circular Economy. Accessed on 15 May 2021. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A28%3AFIN

European Commission, 2018b. Press Release: Commission reviews implementation of EU waste rules, proposes actions to help 14 Member States meet recycling targets. Accessed on 30 May 2021 https://ec.europa.eu/info/news/commission-reviews-implementation-eu-waste-rules-proposes-actions-help-14-member-states-meet-recycling-targets-2018-sep-24_en

European Commission, 2019a. European strategy for plastics - voluntary pledges. Accessed on 15 May 2021 https://ec.europa.eu/growth/content/european-strategy-plastics-voluntary-pledges_en

European Commission, 2019b. The European Green Deal. Accessed on 15 May 2021 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52019DC0640&from=EN

European Commission, 2020a. A new Circular Economy Action Plan. Accessed on 15 May 2021 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1583933814386&uri=COM:2020:98:FIN

European Commission, 2020b. Summary of: Directive 94/62/EC on packaging and packaging waste. Accessed on 30 May 2021 via https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l21207

European Commission, 2020c. Summary of: Directive 2008/98/EC on waste and repealing certain Directives. Accessed on 30 May 2021 via https://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32008L0098

European Commission, 2020d. Reducing packaging waste – review of rules. Accessed on 30 May 2021 via https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12263-Reducing-packaging-waste-review-of-rules_en

European Commission, 2020e. Waste shipments – revision of EU rules. Accessed on 30 May 2021 via https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/7567584-Waste-shipments-revision-of-EU-rules_en

European Commission, 2021a. Circular economy action plan. Accessed on 30 May 2021 via https://ec.europa.eu/environment/strategy/circular-economy-action-plan_de

European Commission, 2021b. EU launches Global Alliance on Circular Economy and Resource Efficiency. Accessed on 30 May 2021 via https://ec.europa.eu/environment/news/eu-launches-global-alliance-circular-economy-and-resource-efficiency-2021-02-22_en; https://ec.europa.eu/environment/international_issues/gacere.html

Geyer, R., Jambeck, J. R., & Law, K. L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 3(7). Accessed on 1 May 2021 via https://advances.sciencemag.org/content/3/7/e1700782/tab-pdf

Henry, B.; Laitala, K.; Klepp, I. G.; 2018. Microfibres from apparel and home textiles: Prospects for including Microplastics in environmental sustainability assessment, Science of The Total Environment, Volume 652, 2019, Pages 483-494, ISSN 0048-9697, Accessed on 1 June 2021 via https://www.sciencedirect.com/science/article/pii/S004896971834049X

HTP 2017. Recycling und Recyclingfähigkeit bei Verpackungen - Das neue VerpackG in der Praxis.

Jambeck, J.; Geyer, R.; Wilcox, C.; Siegler, T.; Perryman, M.; Andrady, A.; Narayan, R.; Law Lavender, K., 2015. Plastic waste inputs from land into the ocean. Science, 347(6223), 768-771, accessed data via https://ourworldindata.org/grapher/mismanaged-plastic-waste-by-region-2010

Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Urban Development. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/30317

Kunststoff Information Database (2021). Kunststoff Information Preisreport Westeuropa. Accessed via: https://www.kiweb.de/

Moody's Investors Service, 18 May 2022. Soaring commodity prices will pressure packaging makers' profitability in 2022. Donatella Maso, Ambra Cortesi, Ivan Palacios

OECD, 2022. Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options, OECD Publishing, Paris, https://doi.org/10.1787/de747aef-en .

PEW Charitable Trust and Systemiq. 2020. Breaking the Plastic Wave, a Comprehensive Assessment of Pathways Towards stopping Ocean Plastic Pollution. https://www.pewtrusts.org/en/research-and-analysis/articles/2020/07/23/breaking-the-plastic-wave-top-findings

Plastic Pollution Treaty, 2020. Manifesto: The Business Call For A UN Treaty On Plastic Pollution. Accessed via https://www.plasticpollutiontreaty.org/

Plastics Recyclers Europe, 2021. Who we are. Accessed on 15 December 2021 via: https://www.plasticsrecyclers.eu/who-we-are

Plastic Soup Foundation, 2021. Global Sustainability Goals And Plastic Soup. Accessed via https://www.plasticsoupfoundation.org/en/2018/08/global-sustainability-goals-and-plastic-soup/

Polyglobe Database, 2018. Polyglobe; Worldwide polymer producers, plants, capacities. Accessed via: https://www.polyglobe.net/

Prinz, N., Korez Š., 2020. Understanding How Microplastics Affect Marine Biota on the Cellular Level Is Important for Assessing Ecosystem Function: A Review. In: Jungblut S., Liebich V., Bode-Dalby M., (eds) YOUMARES 9 - The Oceans: Our Research, Our Future. Springer, Cham. https://doi.org/10.1007/978-3-030-20389-4_6

PROBLUE, 2020. PROBLUE 2020 Annual Report. http://documents1.worldbank.org/curated/en/564401603456030829/pdf/PROBLUE-2020-Annual-Report.pdf

Sciencing, 2021. Effect of Photochemical Smog. Accessed on 1 June 2021 via https://sciencing.com/effect-of-photochemical-smog-12328963.html

Plastics Europe and Conversio, 2020. Plastics - the Facts 2020. An analysis of European plastics production, demand and waste data, accessed on 6 June 2021. https://www.plasticseurope.org/de/resources/publications/4312-plastics-facts-2020

Plastics Europe and Conversio, 2019. Circular Economy of Plastics 2018 EU28+2.

UNEP, 2021. Fifth session of the United Nations Environment Assembly. https://www.unep.org/environmentassembly/

UN Environment, 2017. Marine Litter Socio Economic Study, United Nations Environment Programme, Nairobi. Kenya.

United Nations Environment Assembly of the United Nations Environment Programme (UNEA of the UNEP), 2021. Proceedings of the United Nations Environment Assembly at its fifth session. UNEP/EA.5/25. https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/35932/Proceedings%20of%20the%20United%20Nations%20Environment%20Assembly%20at%20its%20fifth%20session.pdf?sequence=2&isAllowed=y

University of Georgia, 2017. 8.3 billion metric tons: Scientists calculate total amount of plastics ever produced. Accessed on 30 May 2021. https://phys.org/news/2017-07-billion-metric-tons-scientists-total.html

Vanderreydt, I.; Rommens, T., 2021. Greenhouse gas emissions and natural capital implications of plastics (including biobased plastics). European Environmental Agency, European Topic Centre on Waste and Materials in a Green Economy. Accessed on 15 May 2021. https://www.eionet.europa.eu/etcs/etc-wmge/products/greenhouse-gas-emissions-and-natural-capital-implications-of-plastics-including-biobased-plastics

World Wide Fund for Nature, the Ellen MacArthur Foundation and BCG, 2020. The business case for a UN treaty on plastic pollution.

World Wide Fund for Nature, 2021. Plastics: The Costs to Society, The Environment And The Economy. https://wwfint.awsassets.panda.org/downloads/wwf_pctsee_report_english.pdf

Cutting plastics pollution

Financial measures for a more circular value chain

European Investment Bank

European Commission

InnoVFin Advisory

European Investment Bank
98 -100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-22000
www.eib.org – info@eib.org

pdf: ISBN 978-92-861-5405-8
eBook: ISBN 978-92-861-5406-5