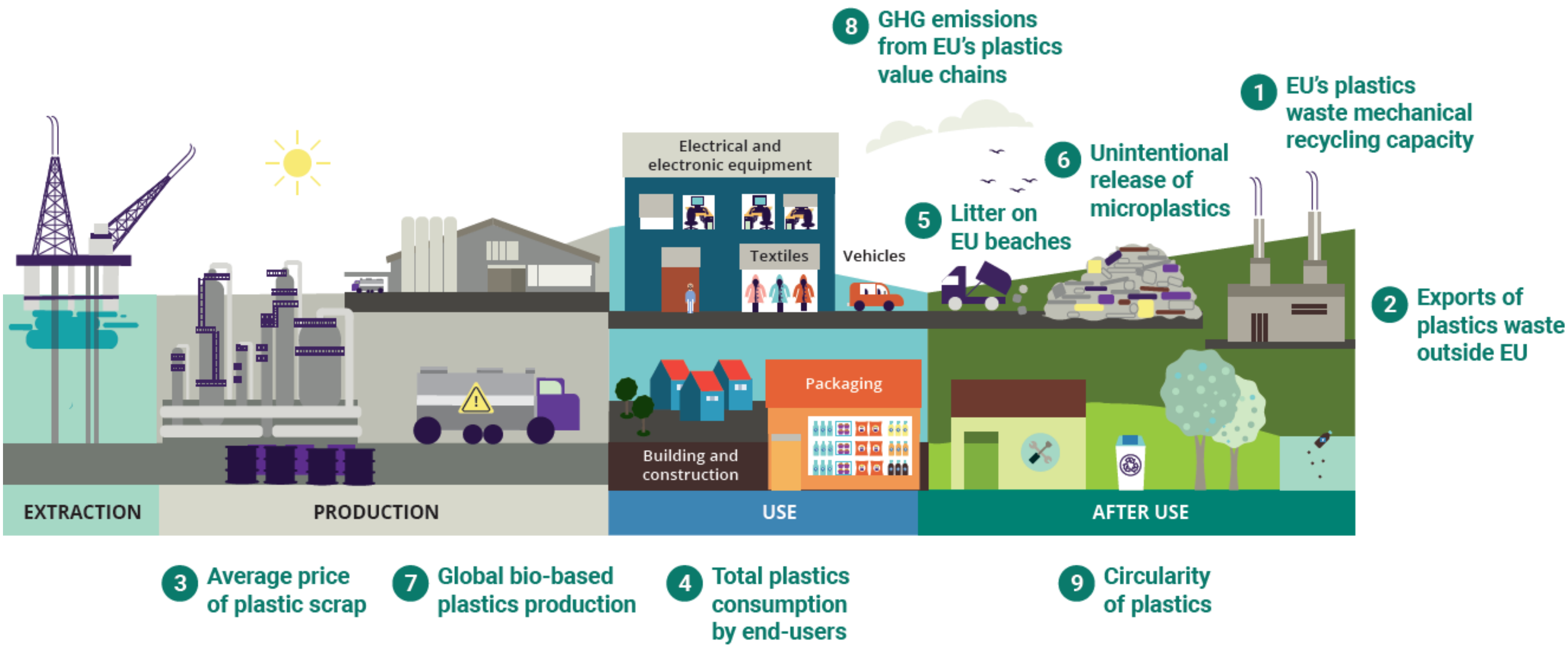
ETC CE Report 2024/6

Measuring Europe's plastics circularity – through the lenses of the EEA Circularity Metrics Lab



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1 Acknowledgements

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2 Description

Plastics continues to be an important agenda, both for the public and policy makers. The unsustainable production, consumption and end-of-life management of plastics have led to significant impacts on the environment and climate. Circular and sustainability practices throughout the lifecycle of plastics can help to reduce greenhouse gas emissions, pollution and waste.

This report is a contribution to EEA's work on plastic and the environment in Europe's circular economy, building on previous reports and briefings. It provides an underpinning report to EEA's briefing on the role of plastics in Europe's circular economy seen through the lenses of the Circularity Metrics Lab (CML). In particular, this publication seeks to develop knowledge on measuring Europe's plastics circularity with a focus on data availability and trends. To do this, the need for reliable data to support measuring plastic circularity is highlighted by presenting nine metrics for measuring plastic circularity in Europe.

The division of the metrics of the plastics module follow the same structure as the general Circularity Metrics Lab into the categories of (1) the enabling framework (2) business (3) consumption, and (4) materials and waste:

Metrics for 'Enablers'

- EU's plastics waste mechanical recycling capacity

Metrics for 'Business'

- Exports of plastics waste outside the EU
- Average price of plastic scrap

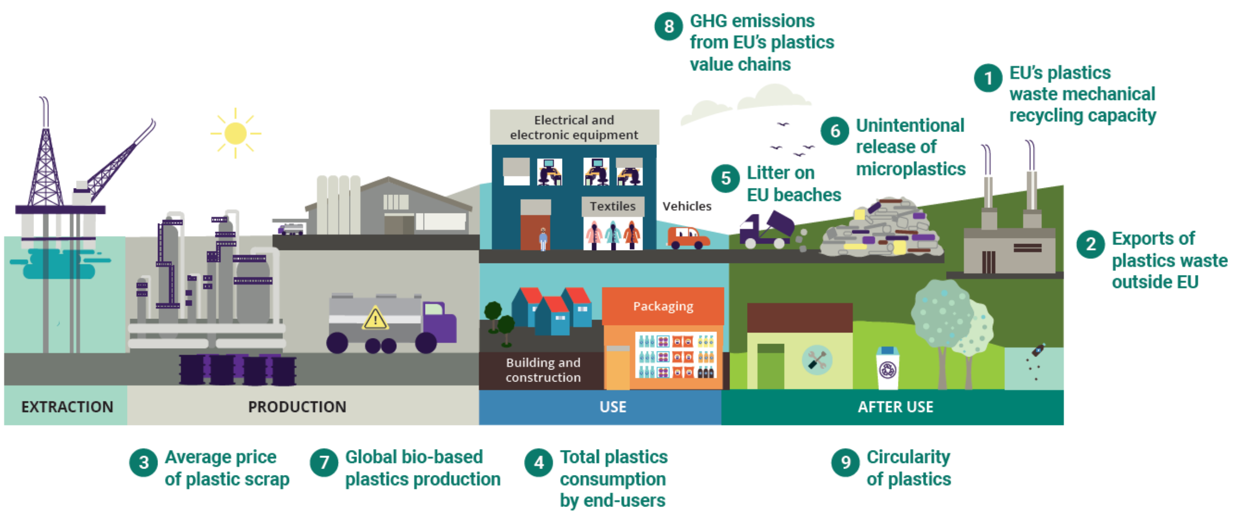
Metrics for 'Consumption'

- Total plastics consumption by end-users in the EU
- Plastic litter found on European beaches
- Microplastics unintentionally released into the environment in the EU

Metrics for 'Materials and waste'

- Global bio-based plastics production
- GHG emissions from EU's plastics value chains
- EU circularity of plastic materials

Figure 2.1 The nine metrics of the circularity metrics lab plastics module



3 Introduction

This report aims to contribute to filling knowledge gaps by identifying key plastics topics and developing and identifying metrics that enable assessing the circularity of the European plastic systems from a global perspective. The work is based on the CML framework, creating a plastics module to the CML, that aims at contributing to monitoring and analysing the circular economy of plastics in the EU. This work takes a deep dive into the world of plastics, to support monitoring and analysing the European circular plastics economy in a global context and to test the CML applicability on a specific value chain (plastics).

3.1 Background

Growing concerns about the environmental and climate impacts associated with the production, consumption, and disposal of plastics have prompted a shift from a linear to a circular economy for plastics in Europe. The European plastics value chains are dependent on variable sources of crude oil and natural gas supplies, that come from many different countries across the world, having different production practices. The refining of oil leads to direct pollutant emissions (drilling, flaring, etc.), as well as indirect emissions, for example through energy production. Further environmental hazards are linked to wastewater with dispersed oil, hazardous substances and chemicals as well as to possible oil and chemical spills. Throughout the manufacturing stages, environmental pressures are caused by different pollutants being generated (particles, NO_x, SO_x), as well as emissions from the energy used. During production and use phase, micro- and nanoplastics may be formed and released into the environment causing different environmental and health concerns. At the end-of-life, environmental issues come from leaked and littered plastic waste, as well as direct emissions from combustion and energy use in recycling. (Vanderreydt et al., 2021)

The European Commission aims to achieve carbon neutrality by 2050 (European Commission, 2019a), and the EU 2020 Circular Economy Action Plan (European Commission, 2020) highlights the need for measures to enhance circularity and mitigate the environmental effects of plastics. The European Commission's Strategy for Plastics in a Circular Economy emphasises the vital role of plastics in economy and the daily lives of EU citizens, while stressing the urgency of addressing environmental challenges (European Commission, 2018a). Despite the escalating global demand for plastic, there is an anticipation that the industry will continue to rely on virgin fossil resources. However, recyclates are crucial for transitioning from a linear to a circular plastics system, achieving carbon-neutral solutions within the plastics value chain (Tenhunen-Lunkka et al., 2022). Despite this strong political attention on plastics in recent years, both in the EU and at the global level, there are still large monitoring, data and indicator gaps. And the state of the European circular plastic economy, as well as its drivers, pressures and responses, remain difficult to assess.

Lately, there has been a shift in policy attention from waste management to secondary raw materials when promoting circularity. The *Directive 2019/904/EU on the reduction of the impact of certain plastic products on the environment* states a binding target for the introduction of recycled PET in beverage bottles. The Proposal for the *packaging and packaging waste Regulation* (COM/2022/677) presents binding targets for recycled content in beverage bottles and other packaging, including a target for recycled content recovered from post-consumer waste. The draft *Regulation on circularity requirements for vehicle design and on management of end-of-life vehicles* (COM/2023/451) states targets that at least 25 % of plastics in a vehicle should come from recycling, of which 25 % must originate from ELV recycling (European Commission, 2019b, 2022e, 2023a).

Furthermore, in the United Nations International Negotiating Committee (INC) to develop an international legally binding instrument on plastic pollution, including in the marine environment[1], data and knowledge

[1] https://www.unep.org/inc-plastic-pollution

on plastics, its impacts and circularity is crucial both for the negotiations and for the monitoring of the future agreement. More insights into the circularity of plastics and key challenges and opportunities around this, are therefore essential.

3.2 EEA's work on plastics

In a previous EEA report (EEA Report No 18/2020), three pathways to ensure a long-term move towards a sustainable and circular plastics production and consumption system were presented. The three pathways are (i) smarter use; (ii) increased circularity; and (iii) renewable material, addressing different stages of the plastics value chain, as well as different environmental and climate impacts. (Fogh Mortensen et al., 2020; European Environment Agency, 2023b)

The Eionet Report ETC/WMGE 2021/3 studied the European plastic value chain from a lifecycle perspective: from extraction of raw materials through production and use, to the end-of-life waste treatment of plastics. The aim was to reinforce the understanding of the links between (the circularity of) plastics and climate change and to provide insights to inform future discussions on the potential (and limitations) of circular plastics and the corresponding impacts on climate and natural capital. The total greenhouse gas emissions caused by the plastics value chain, for the plastics volume converted in the European Union (EU) in 2018, is estimated at 208 million tonnes (Mt) of carbon dioxide equivalent (CO_2-eq). The report shows that the majority (63 %) of the greenhouse gas emissions in the EU plastics value chain are caused by its production. Converting these polymers into products accounts for 22 %, and plastic waste treatment at end-of-life adds another 15 %, mainly due to incineration. (Vanderreydt et al., 2021)

EEA and ETC reports that deal with plastic waste-related trade include the recent ETC CE Report 2/2023, which focuses on changes in trends in plastic waste trade, potentially resulting from policies, trade bans and other drivers, as well as the possible 'fate' of exported plastic waste in destination countries. Previous reports on plastic waste trade that adopt a similar approach and focus on plastic waste trade include an EEA Briefing on plastic waste trade (European Environment Agency, 2019), based on the ETC/WMGE Report 5/2019. The issue of plastic waste trade is also covered in the already mentioned EEA Report 18/2020, which is, however, more general in scope, focusing on the challenges and opportunities related to the circular economy transition. (D'Amato et al., 2023, 2019; Fogh Mortensen et al., 2020)

Recent ETC/ICM reports (1/2021; 5/2022; 6/2022) on marine litter highlight the share of plastics found on European beaches. Specifically plastic packaging and other small plastic waste, together with fishery-related items, represent the largest fraction of litter found on European beaches, and display an increasing trend. In total, plastics represent 85 % of total marine litter items found on European beaches. Marine litter originates from a multitude of sources, mainly from mismanaged waste. The effective implementation of the EU legislation on single use plastics and fisheries is vital for decreasing levels of plastic litter in the marine environment. (Kideys et al., 2021; Veiga et al., 2022; Aytan et al., 2022)

A previous ETC CE report (7/2022) on non-packaging plastics highlights that non-packaging applications represent the majority of European plastic consumption, but only a few policies target plastic in non-packaging applications. Data on non-packaging plastic flows is limited, both at national and EU levels. Improved data could support better management of these materials by informing new policies to target non-packaging plastics, which in turn would help achieve Europe's circular plastic ambitions and reduce environmental impacts. (zu Castell-Rüdenhausen et al., 2022a)

3.3 EEA indicators and the CML

EEA indicators generally aim to simplify complex systems by focusing on certain aspects which are regarded relevant and for which data are available. However, the real significance of an indicator is in the message the indicator conveys regarding the complex system. The aim of indicators is to communicate critical or typical aspects of the complex interrelation between components of the system. Environmental indicators may be used as a powerful tool to raise public awareness on environmental issues and to support policy-making by supplying information on environmental problems and enabling measuring their seriousness, prioritization, and monitoring policy response. EEA indicators are designed to support all phases of environmental policy making, telling the reader about the trend (or status) of the phenomenon being investigated over a given period of time. It also specifies whether or not associated policy objectives are being met and quantitative targets reached.

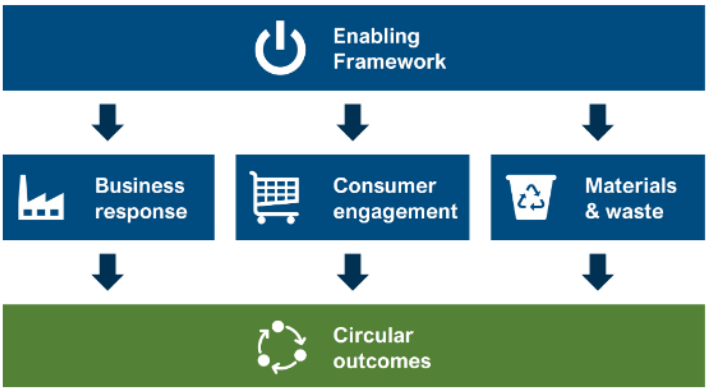
The EEA's CML is intended to complement other circularity monitoring frameworks, specifically the official EEA indicators, by presenting additional evidence on circularity, including metrics focused on the implementation of circular principles and practices. Some elements of circular economy, however, are less well covered in existing monitoring approaches, often because the data flows to understand them are fragmented or non-existent. By providing additional information on the growth of the circular economy from novel sources and across a wide range of perspectives, the CML complements these other frameworks by compiling responsive data on the the circular economy.

The 'Lab' aspect of the CML refers to the intention to not only rely on well-established data, but also giving space to those important aspects to be measured that do not have fully reliable data from a long time series available. A key purpose is to gather a diverse group of metrics to inform on the status and trends towards a circular economy. Since data availability and reliability is of essence, the metrics are characterised into three categories based on data availability: (1) *indicators*, which are well-established and EU-wide datasets with a sufficient time series, datasets e.g. provided by Eurostat; (2) s*ignals* are such that, although they are informative, there is less reliable and/or complete data available – data may include scientific studies, surveys, and country-level datasets; and (3) *potentials*, which would be highly informative and key to measuring circularity but lack data for formation of trends or assessment of current status. These are often presented in the form of single data spots.

Figure 3.1 presents the logic and structure used in the CML. The circularity metrics are grouped in four categories:

(1) ***The enabling framework*** presenting the political and economic momentum in Europe, including possible growth in financing for circularity projects. The development and growth of a circular economy requires a framework of enabling factors to be in place, including policy, innovation, and financing.
(2) ***Business***, presenting signs of adopting circular approaches in European business models. The development of the circular economy requires a transformation in the operating models of companies to provide goods and services with reduced resource consumption.
(3) ***Consumption***, presenting signs of consumers' and producers' readiness to embrace more circularity in the products and services they consume or produce. Consumption patterns play a crucial role in moving towards the circular economy, related to organizations and individuals making sustainable choices when purchasing and using products and services.
(4) ***Materials and waste***, presenting waste generation and management trends, as well as measures to reduce the use of virgin raw materials by keeping products in use for longer.

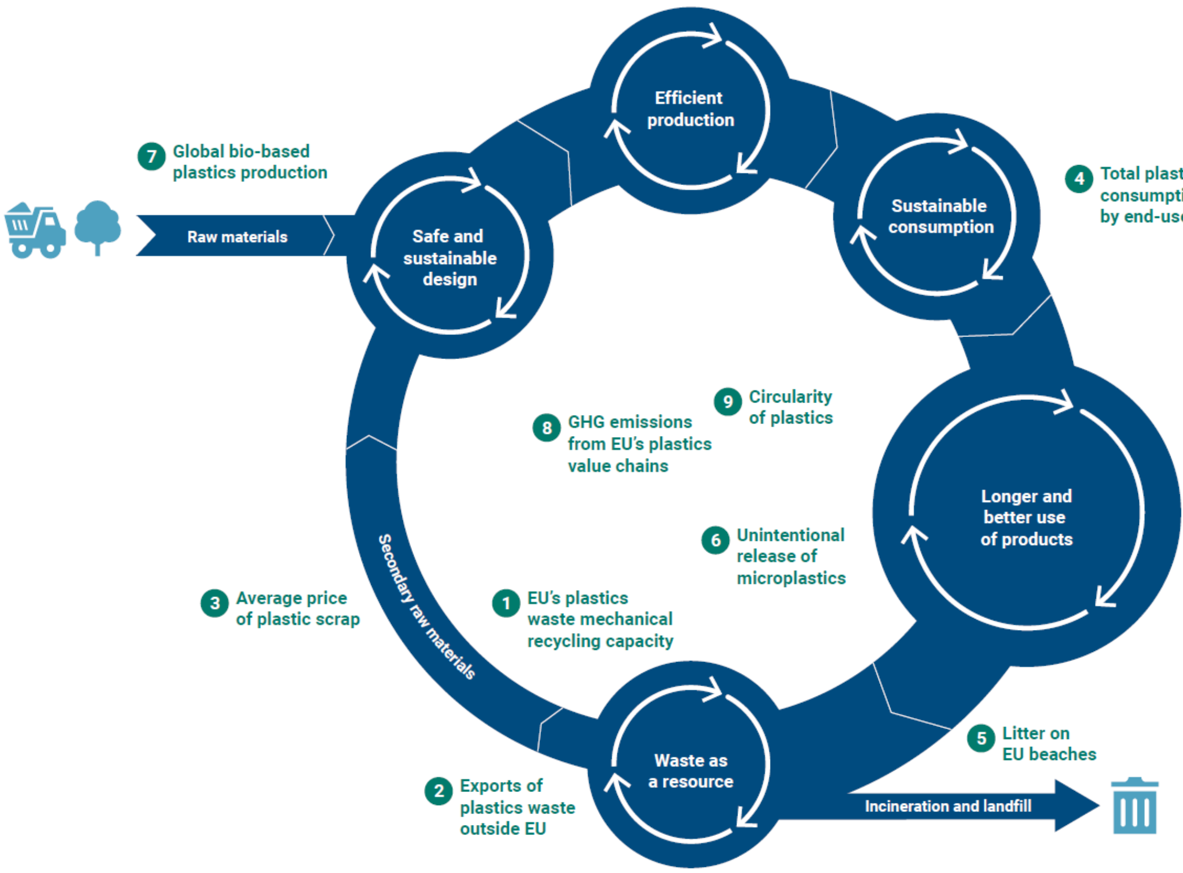
Figure 3.1 The logic and structure used in the CML



3.4 The plastic module of the CML

There are no official EEA indicators on plastics and therefore the plastics module of the CML can be seen as the key method for EEA to measure plastics' circularity in Europe. Figure 3.2 presents the metrics of the CML plastics module implemented into the EEA's Circular economy concept. The plastics module is planned to form a screenshot of a specific topic, where data reliability is seen as a challenge and can be used as a complement to other work monitoring the circularity of plastics. Similar to the general CML, also the plastics module groups the metrics based on data reliability, where the metrics are divided into indicators, signals and potentials. The plastic module of CML is available here Plastics (europa.eu)

Figure 3.2 The metrics of the CML plastics module implemented into the EEA's Circular economy concept



4 Methodology

The process for developing the CML Plastics module, was initiated through the careful selection of metrics based on available data, reports and knowledge. This process was divided into two phases, where the first part aimed at collecting a long list of potential metrics. For this, the CML was explored to find potential metrics that could be directly transposed into a plastics metric. Other indicator sets were explored globally and in Europe to find available indicators with existing data, literature sources to find high quality data were explored with a specific focus on EEA and ETC reports from previous years that presented high quality data on plastics. The result from this process was a list of initially 82 (partially overlapping) suggestions for metrics to measure plastics circularity.

This long list was first narrowed down to 22 (partially overlapping) metrics that were considered to be key for measuring Europe's plastic circularity and that were considered potentially having available data. The next step of the process was to ensure no overlaps and dive deeper into data availability. Finally, after screening for potential data sources, the topics for 10 metrics were chosen for the data mining. During the data mining process, the metrics were further refined to fit best for presenting easily understandable data and, when needed, to answer to the actual data availability.

During data collection, one metric was removed due to lack of expertise in the specific topic. It became clear that the planned metric on synthetic textiles could be further refined in the coming year when developing a specific CML module on textiles, enabling the use of cross-disciplinary expertise (plastics-textiles) to finalise this specific metric.

To present the metrics in line with the general CML, and to focus on streamlining the metrics, a template for the data (a 'fiche') with detailed instructive questions was generated. This was important for generating uniform content in the CML plastics module. The fiche includes all data needed for the presentation of the metrics in the online version of the CML, whereas this report includes only the informative content of the fiche.

Finally, once the fiches and supporting data had been reported, a cross-cutting analysis was done to generate a holistic picture of both the coverage of the metrics, and their ability of measuring Europe's plastics circularity. This is reported in the Section 'key observations'.

5 Metrics

The division of the metrics of the plastics module follow the same structure as the general CML into the categories of (1) the enabling framework (2) business (3) consumption, and (4) materials and waste:

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Metrics for 'Business'

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The next section in the report includes the informative sections of the fiche for each metric. The online plastics module of the CML can be referred to for further reading, as well as details on methodology and metadata for each metric.

The presentation starts with an informative sentence about each metric, followed by a 'tile' including the introductory information, such as

- Title – a short description of the metric
- Indication if this metric is an indicator, or a signal
- A number for the metric
- A short sentence describing the number
- Indication if the trend of this metric is: 'Improving', 'Deteriorating', 'Stable', or 'No Trend'.

The tile is followed by a background section describing the metric in terms of its relevance for CE monitoring, including also some context for the metric itself. This is followed by a figure displaying the trend and assessment thereof, and what impact this would have on plastics circularity.

The plastic module of CML is available here [Plastics (europa.eu)](#)

5.1 EU's plastics waste mechanical recycling capacity

The total recycling capacity has increased in the EU from 2 million tonnes in 1996 to over 11 million tonnes in 2021.

EU's mechanical recycling capacity **[SIGNAL]** **11 Mtonnes** of plastic waste could be processed for recycling in the EU in 2021 Trend: **Improving**

Coverage: EU 1996-2021

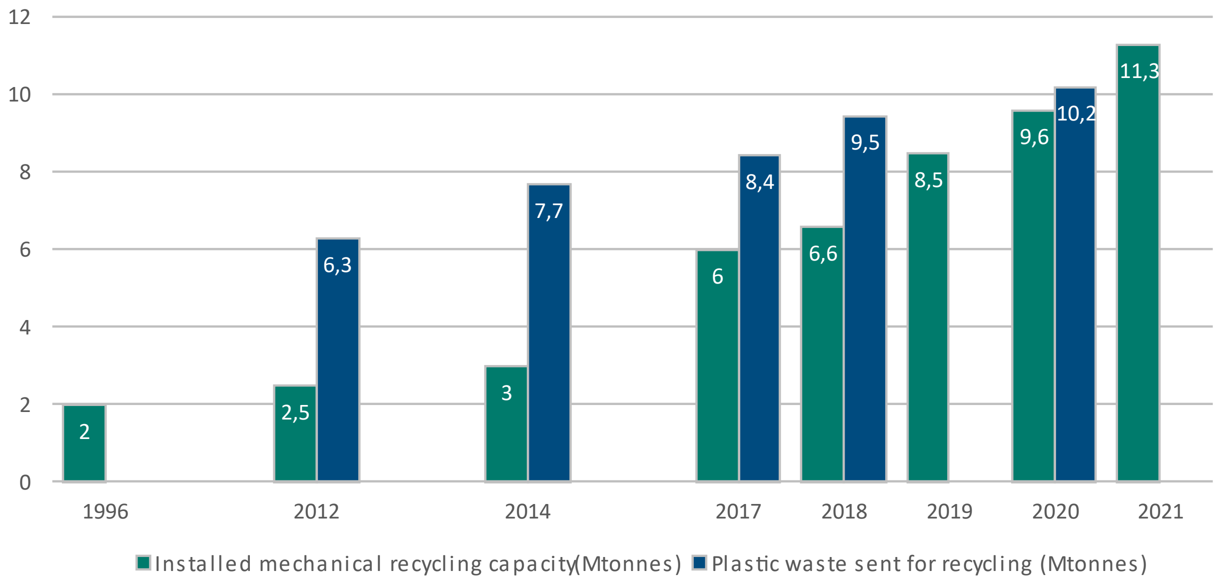
Background

Recycling capacity is necessary for increasing recycling of plastics in the EU. Domestic recycling reduces costs, adheres to EU environmental standards and offers a close-by secondary raw material source for EU manufacturers. Therefore, monitoring the EU's recycling capacity as an enabler of plastic waste recycling is an important component of plastics' circularity monitoring.

In the EU, 99 % of plastic recycling capacity is mechanical recycling. Mechanical recycling is based on mechanical processing where plastic waste is processed into plastic recyclates without significantly changing the chemical structure of the material (Plastics Recyclers Europe, 2023a, 2023b).

The European Commission launched a Circular Plastics Alliance (European Commission, 2022a) initiative under the European Strategy for Plastics (European Commission, 2018a) in 2018. The aim is to have 10 Mtonnes of plastic recyclates in final products by 2025. Currently, 290 organisations across the plastics value chain and academia have committed to the pledged goal. (Circular Plastics Alliance, 2021)

Figure 5.1 Installed mechanical recycling capacity and plastic waste sent to recycling in the EU plus Norway, Switzerland and the UK.



Note: Data gaps: 1996-2011, 2013, 2015-2016.

Source: installed capacity (Plastics Recyclers Europe, 2022, 2023b); plastic waste sent for recycling (Plastics Europe, 2013, 2015, 2018, 2019a, 2021)

Mechanical recycling capacity for plastics has significantly increased since 1996 from 2 million tonnes to 11,3 million tonnes in 2021 (Plastics Recyclers Europe, 2022, 2023b). This represents an almost six-fold increase reflecting the investments made by the recycling industry towards more plastic recycling, possibly triggered by EU legislation entering into force in the last decade calling for more separate collection of plastics for recycling. Looking at the amount of plastic waste collected for recycling in the EU, until recently there wasn't enough capacity for processing. This means that the EU was not self-sufficient and EU waste operators were forced to export waste for recycling. But since mechanical recycling capacity has been increasing faster than the plastic waste collected, the EU is now able to process all of the waste it collects for mechanical recycling, which is a significant milestone.

However, the high amounts of plastics mechanically processed for recycling don't lead to equally high amounts of recycled plastics produced. Due to losses in plastic waste processing, the plastic recyclates produced by mechanical recycling plants were only about 65 % of the plastic waste entering such facilities (Amadei and Ardente, 2022).

5.2 Exports of plastics waste outside EU

The metrics shows the quantities of plastic waste exported outside EU 27.

Exports of plastics waste outside the EU
[INDICATOR]
-57 %
Was the reduction in the quantity of plastic waste exported outside EU-27 between 2016 and 2022.
Trend: **Improving**

Coverage: EU-27, 2000-2022.

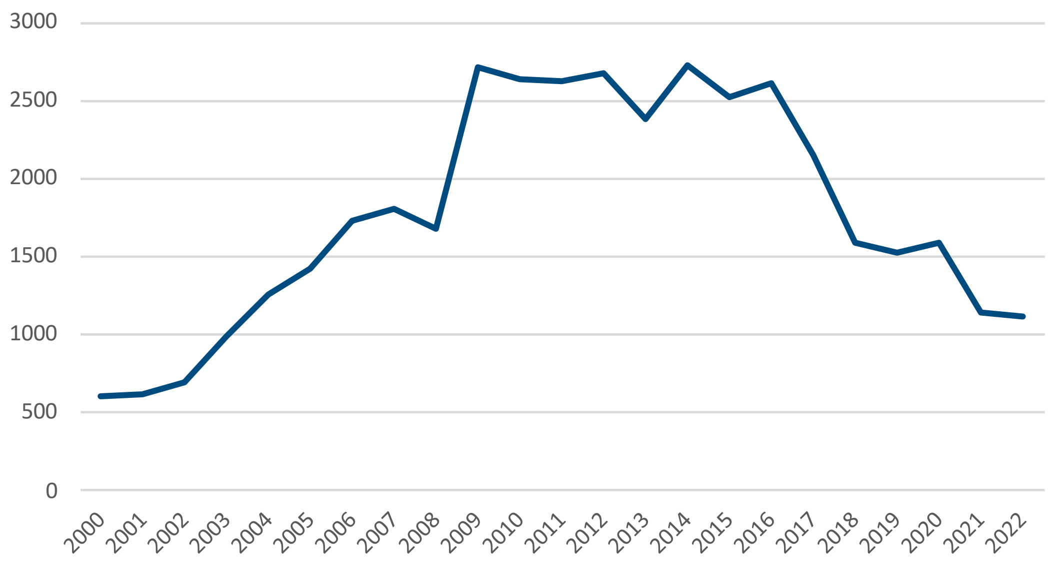
Background

The metric is based on quantities from international trade in goods statistics from Eurostat (code 3915: Waste Pairings and Scrap of Plastics), and it measures the amount of extra-EU waste exports for plastic waste flows.

Measuring the circular economy transition for plastics requires highlighting the relevance of plastic waste trade, with a specific eye on extra-EU exports as a measure of possible challenges related to waste management inside the EU. Exporting less plastic waste means that we handle more of the waste inside Europe and have opportunities in increasing recycling in Europe.

Assessment

Figure 5.2 Extra-EU plastics waste trade (1000 tonnes, EU-27, 2000-2022).



Source: EUROSTAT (international trade in goods. HS3915)

The trend in plastic waste exports shows a rather steady decrease since 2016. After a period featuring no clear trend between 2009 and 2016, extra-EU plastic waste exports have decreased significantly up to 2022. The recent reduction in extra-EU trade is partially compensated by an increase in intra-EU trade in most recent years – since 2017 intra EU trade has surpassed EU exports of plastic. Another trend is the change in destination countries. Following the 2018 Chinese import ban on low quality plastic waste, EU plastic waste exports were increasingly sent to other destinations most noticeably Türkiye. In addition, to the Chinese import ban, other drivers of change for EU plastic waste exports, include amendments in the Basel Convention and EU policies towards an increase in recyclable materials quality, as well as investments in domestic recycling capacity.

5.3 Average yearly price of plastic scrap

The average yearly price of (EUR/tonne) of plastic scrap.

Average price of plastic scrap

[INDICATOR]

467 EUR/tonne

Was the average price of traded plastic scrap in 2022.

Trend**: Increasing since 2020**

Coverage: EU-27, 2012-2022

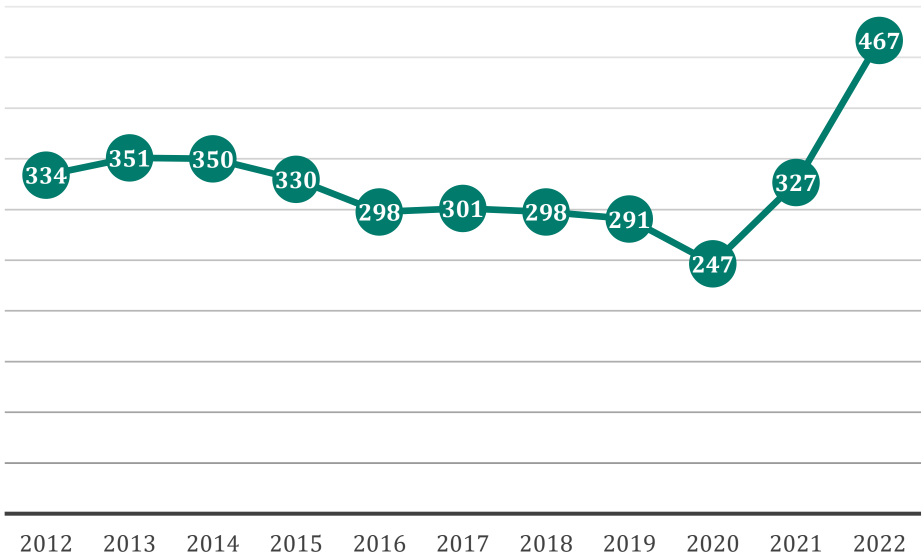
Background

Being a key feedstock for the production of secondary plastics, the value of plastic scrap is necessarily linked to the secondary plastics market. The price of plastic scrap provides an indicator that is useful to assess the degree of development of markets for secondary materials, as well as the role for intra and extra EU trade in the context of EU waste management practices (zu Castell-Rüdenhausen et al., 2022b).

A higher price of plastic scrap is expected to be triggered by larger trade flows and can be determined by larger demand for secondary materials or by larger quality (or both). Contrary, a lower price may be linked to a lower demand for secondary materials and/or a lower quality of the plastic scrap. An increase in trade of plastic scrap may be good news in terms of the circular economy transition, if these materials are used as substitutes for virgin materials and if it does not trigger additional plastic waste production. It also reduces the environmental impacts related to less desirable management practises. The price is also expected to be affected by recycling policies (e.g. current and future recycling targets according to the Packaging and packaging waste directive), as well as by policy interventions taking place outside the EU (such as the 2018 Chinese ban).

Assessment

Figure 5.3 Average price indicator for plastic scrap



Source: EUROSTAT – EU trade since 1988 by HS2-4-6 and CN8 (former content). Code HS 3915.

As the figure shows, the average price of plastic scrap was 334 EUR/tonne back in 2012, while the lowest value was reached in 2020 (247 EUR/tonne) before increasing in 2021 and 2022, reaching the highest value in 2022, at 467 EUR/tonne. Possible reasons for the changes over the past few years may be explained, among others, by a combination of the consequences of the Chinese ban that started in 2018, the pandemic starting in 2020, the amendments in the Basel Convention in 2020 and a conjectured increase in quality of traded plastic scrap. The recent focus of EU policy making on recycled content requirements might also have stimulated demand for recycled plastics, which would influence their price (European Commission., 2019; European Commission, 2021c, 2022c). Looking at ethylene, which features the largest traded quantities among plastic scrap, the average value of 'virgin' and waste plastics exported intra- and extra-EU27 show similar trends in 2020-2022 (according to monthly data on quantities and values from Eurostat trade data). As a result, the trends do not seem to be specific for waste but for plastic materials in general.

5.4 Plastics consumption in the EU

Plastics consumption includes all packaging, plastic products, parts embedded in larger products and synthetic textiles put on the market for both private and industrial end-users.

Total plastics consumption by end-users in the EU
[SIGNAL]
56.5 Mtonnes
of plastics was consumed in the EU in 2020.
Trend: **N/A**

Coverage: EU27+3 (Norway, Switzerland, and the UK), in years 2018 and 2020

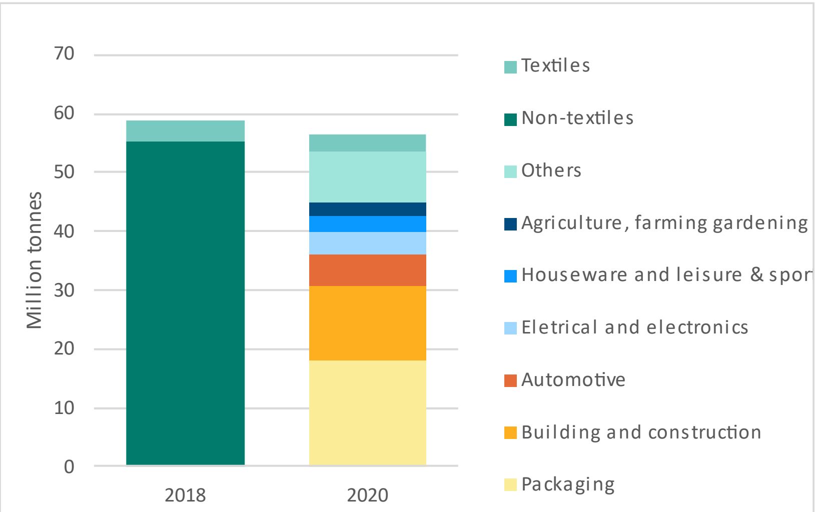
Background

Total consumption of plastics by end-users includes all plastic packaging, plastic products, parts embedded in larger products as well as synthetic textiles put on the market in the EU27+3 for both private and industrial end-users.

When assessing plastics circularity, it is important to measure total plastics consumption because consumption of fossil-based virgin plastic should be decreased to achieve circularity. In a circular economy all materials, including plastics, should be used in the most efficient way possible. Several EU strategies and directives aim, among others, to limit plastic consumption. A few examples include EU Plastics Strategy, Packaging and Packaging Waste Directive, Single-Use Plastics Directive.

Assessment

Figure 5.4 Total consumption of plastics in EU27+3



Sources: (Plastics Europe, 2019b, 2022b; EUROSTAT, 2023)

Data on plastics consumption by end-users in the EU27+3 shows a slight decrease from 58.8 million tonnes in 2018 to 56.5 million tonnes in 2020, which is equivalent of 107 kg/capita and year. However, this should not be regarded as a trend yet due to the lack of data for a longer period and is biased by the specificity of the year 2020. (Plastics Europe, 2019b, 2022b) This decrease is due to a slow-down in economic activity in Europe during the COVID19 pandemic and would not correlate with plastic circularity.

For 2020, data shows for what purposes plastics is used. Most is used for packaging, followed by building and construction; automotives; electoral and electronic appliances; houseware, leisure and sports; agriculture, farming and gardening; and textiles.

A major part of the plastic placed on the market for end-users becomes waste after a short life span. In 2020 for example, around 30 million tonnes of post-consumer plastic waste were collected in EU27+3 (Plastics Europe, 2022a).

5.5 Litter found on European beaches

Overall median value for plastic items found per 100 m on European beaches was 481 in 2022.

Litter on EU beaches

[SIGNAL]

481 items

found per 100 m on European beaches in 2022

Trend: **fluctuating**

Coverage: Four European seas: North-east Atlantic Ocean, Mediterranean Sea, Black Sea, and Baltic Sea.
Temporal coverage: 2013–2022

Background

In a circular plastics economy, the release of plastics to the environment should be kept to a minimum. This indicator provides insights into whether we are approaching this by focusing on litter on European beaches. In addition, many of the items identified are single-use plastic items contributing to marine pollution, which is key concern of the Single-Use Plastics Directive.

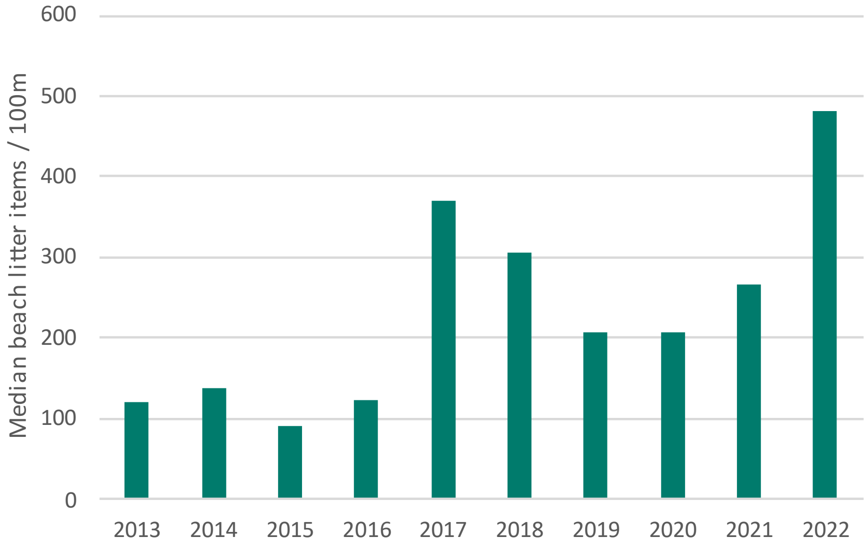
Marine litter is mismanaged waste that was discarded into the sea, rivers, land or beaches, that ends up in the sea via rivers, sewage, storm water or winds. Sources of beach litter can be either land-based or sea-based. Plastic items make up the bulk of total litter found on European beaches. Its environmental impacts are also largest in coastal and marine ecosystems because they have long life cycles and are ingested easily by many organisms. Marine litter causes large economic costs, ecological damage and social impact, adversely affecting tourism, fisheries, shipping and many other economic sectors. Costs of litter to EU fishery and tourism/recreation were once calculated as a minimum of EUR 61.7 and EUR 630 million respectively for the EU (ARCADIS, 2013).

European policies tackling marine litter are most notably the Marine Strategy Framework Directive (MSFD), the Single Use Plastics Directive (SUPD), the Zero Pollution Action Plan (ZPAP). The MSFD aims to reach Good Environmental Status in European Seas and has a threshold value of 20 macro litter items per

100 m of beach strip. The SUP directive forbids specific plastic single-use items that are shown to make up for a significant share of marine litter in Europe (47 % in 2022). One of the six main interim targets of the ZPAP for 2030 is reducing litter at sea by 50 % (European Commission, 2021b)

Assessment

Figure 5.5 Median values of litter items collected from European beaches



Source: (European Environment Agency, 2024)

The threshold value for beach litter ‘Good Environmental Status’ was defined as 20 macro litter items/100 m of beach strip by the EU Technical Group on Marine Litter and stated in the Marine Strategy Framework Directive (MSFD). Applying this threshold value to the Marine Litter Watch (MLW) monitoring and clean-up data for the period 2013-2022 reveals that the overall median values of beach litter exceed the threshold in three out of four European seas in 2022.

The overall trends of sea and beach litter show fluctuations, but it is evident that we are far from reaching the Good Environmental Status on European beaches in terms of marine litter. The Mediterranean Sea and the Black Sea’s beaches are more littered, compared to the North-east Atlantic Ocean and Baltic Sea.

Top five items that are found on European beaches in 2022 are given below in decreasing order:

- Cigarette butts and filters (23.4 %)
- Plastic pieces 2.5 > < 50 cm (9.5 %)
- Polystyrene pieces 2.5 cm > < 50 cm (5.3 %)
- Other plastic/polystyrene items (identifiable) (4.6 %)
- Plastic caps/lids drinks (3.9 %)

5.6 Unintentional release of microplastics into the environment in the EU

Tonnes of microplastics unintentionally released into the environment every year in the EU.

Unintentional release of microplastics into the environment in the EU
[SIGNAL]
0.7-1.8 million tonnes of microplastics leaking into the environment in the EU every year are caused by unintentional release
Trend: **N/A**

Coverage: EU, 2019

Background

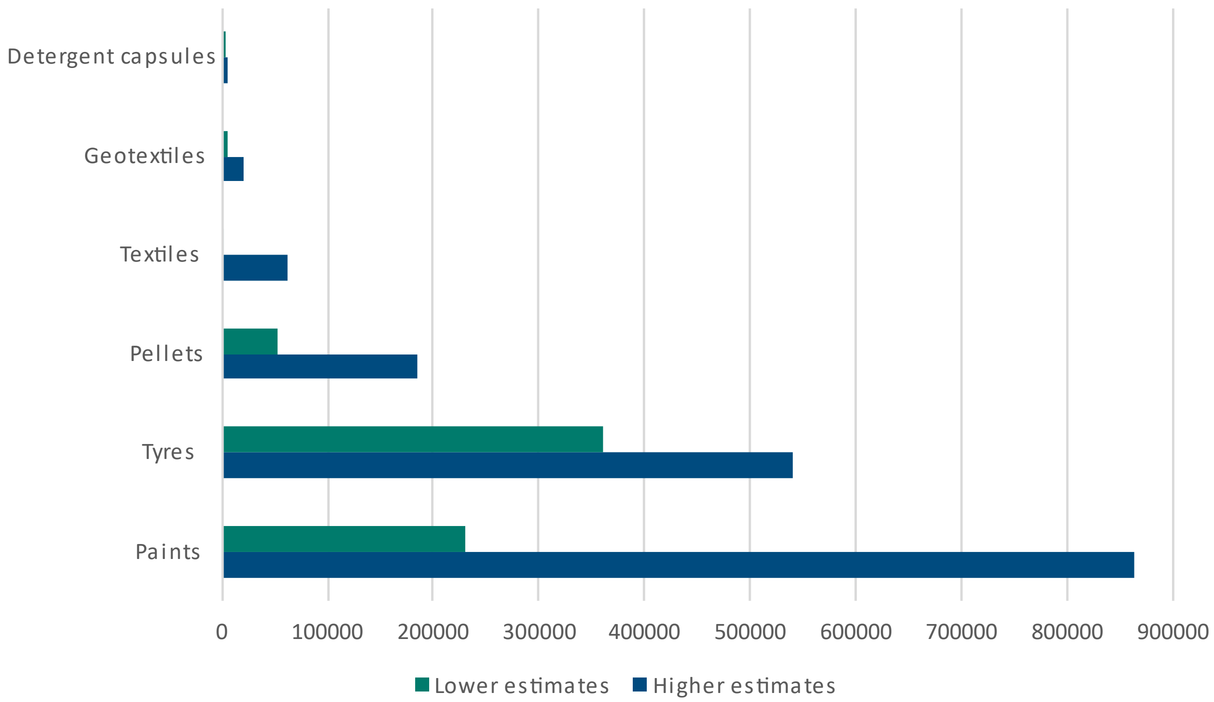
Microplastics are bits of plastic which are less than five millimetres in size. They are found everywhere from mountain tops to the bottom of oceans, in the air, and even in our bodies. Once microplastics reach the environment they are extremely difficult to remove, they are also persistent and very mobile, therefore the accumulation of microplastics in the environment (and in our bodies) is a serious and growing concern.

Microplastics can enter the environment either directly as microplastics (this is referred to as primary microplastics) or indirectly through the breakdown of larger plastic pollution items (secondary microplastics). Secondary microplastics represent the bulk of microplastics release and all plastic pollution eventually breaks into smaller and smaller pieces (Manshoven et al., 2022; European Commission, 2018c). Primary microplastics, on the other hand, come from either intentionally added microplastics, which are microplastics deliberately added in products, such as cosmetics or personal care products, or from unintentional release. Unintentionally released microplastics are emitted during the use-phase of products, such as textiles, tyres, or paints.

The Circular Economy Action Plan, the Soil Strategy, the REACH restriction (on microplastics intentionally added to products), the proposal for a Regulation on preventing plastic pellet losses to the environment as well as the negotiations on the Drinking Water Directive and Urban Wastewater Treatment Directive represent a growing number of actions contributing to the Zero Pollution Action Plan target of reducing microplastic releases into the ocean by 30 % by 2030 (European Commission, 2020, 2021a; ECHA, 2019; European Commission, 2023b; European Parliament, 2023; European Commission, 2022d, 2021b).

Assessment

Figure 5.6 Main sources of unintentional microplastics released into the EU in 2019 (tonnes/year).



Source: (Directorate-General for Environment, 2023)

DG Environment estimates that between 0.7-1.8 million tonnes of microplastics were unintentionally released into the environment in the EU in 2019 (Directorate-General for Environment, 2023).

The main sources of microplastics and the estimated released amounts are (Directorate-General for Environment, 2023):

- Paints: between 231,000 – 863,000 tonnes. Paint releases occur during application, wear and tear, or removal of paint. Approximately 21 % of the 2.4 million tonnes of plastic polymers used in paints in the EU in 2019, leaked into the environment in the form of microplastics;
- Tyres: between 360,000 – 540,000 tonnes. Microplastic releases from tyres are generated as a consequence of the friction of tyres on road surfaces. Passenger cars make up the largest source of tyre wear particle emissions;
- Pellets: between 52,140- 184,290 tonnes. Pellets are small pieces of raw material used to produce plastic products, these are lost during the handling and transportation. Pellets are known to be eaten by a range of marine and coastal species and can cause physical harm or death.
- Textiles: between 1,649 – 61,078 tonnes. Approximately 60 % of textiles are made from plastics. Small textile fibres are lost during production, use, washing, drying, and waste handling of textiles.
- Geotextiles: between 6,000- 19,750 tonnes. Geotextiles are mainly made of synthetic fibres, used primarily in road construction, erosion prevention and drainage. Their use in harsh conditions leads to microplastic release into the surroundings.
- Detergent capsules: between 4,140 – 5,980 tonnes. They are designed to dissolve during the washing cycle, but more research is needed to determine to what extent this occurs in all environmental media and their possible emissions of microplastics into the environment.

5.7 Global bio-based plastics production

Total global production capacities of biobased plastics reached 2.2 Mt in 2022 which is less than 1 % of global plastics production.

Global bio-based plastics production

[SIGNAL]

< 1 %

is the share of plastics globally produced from a bio-based feedstock

Trend: **Improving**

Coverage: Global 2010–2022

Background

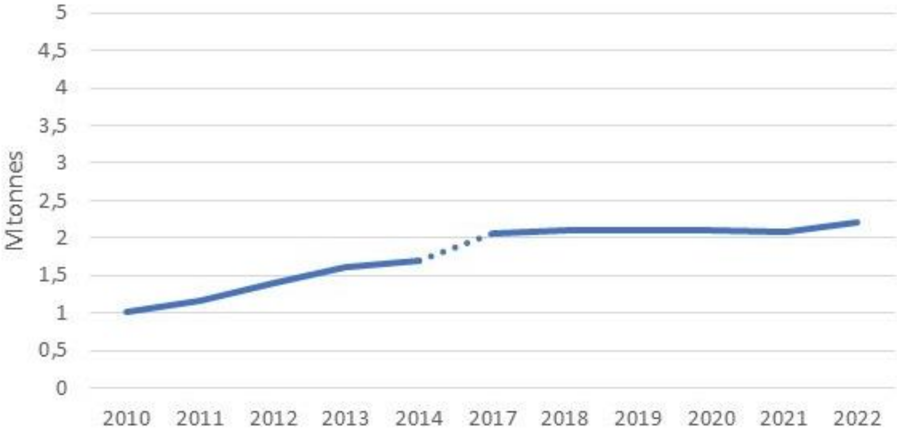
Bio-based plastics is a way to switch to alternative feedstocks, thereby reducing dependence of fossil fuels and GHG emissions. Bio-based plastics are produced from renewable biomass sources. The biomass mainly originates from plants such as sugarcane, cereal crops, oil crops or non-food sources like wood, organic waste and by-products, such as used cooking oil, bagasse and tall oil. The benefit of bio-based plastics is that they potentially have a lower climate impact (GHG emissions along the life span) than plastics made from fossil sources. This depends on the raw material and production process. They help to reduce dependency on (foreign) fossil fuels. However, they may have higher environmental impacts (land use, water use, biodiversity etc.)

Some bio-based plastics are chemically identical to fossil-based polymers, simply made from a different (bio-based) feedstock. These are referred to as drop-in bio-based plastics and include bio-PET and bio-PE. They can be collected and recycled together with their fossil-based counterparts. Other bio-based polymers such as PLA, PHA or starch blends are bio-based and biodegradable. (EEA, 2023)

Biodegradable plastics are designed to decompose at the end of their life under suitable conditions. These are typically not compatible with waste management systems for conventional plastics, but instead need their own systems such as industrial composting facilities.

Assessment

Figure 5.7 Global production capacities of bioplastics (Mt/a).



Notes: Note the break in series for 2015–2016.

Source: (Aeschelmann and Carus, 2015; Siracusa and Rosa, 2018; European Bioplastics, 2017, 2018, 2019, 2020, 2021, 2022)

Global bio-based plastics production capacity has more than doubled since 2010, although it only experienced a slight increase of 10 % during the past five years. Today, about 2.2 Mt or 0.5 % of plastics on the global market are bio-based, i.e., produced from a bio-based feedstock. The share of bio-based in total plastics production is only slightly increasing year by year (from 0.54 % in 2013 to 0.56 % in 2022). This is due to the fact that the production of fossil-based plastics is increasing as well. So, although the capacity for bioplastics production is rising, the share of biobased plastics of the total plastics production volume remains quite stable.

5.8 GHG emissions from EU's plastics value chains

In 2020, the estimated total GHG emissions of the European plastics value chain were 190,88 million tonnes of CO2 equivalent.

GHG emissions from EU's plastics value chains

[INDICATOR]

191 Mtonnes CO_2-eq.

was the estimated total GHG emissions of the European plastics value chain in 2020.

Trend: **Fluctuating**, with highest emissions in 2014 and 2018

Coverage: EU 2013-2021

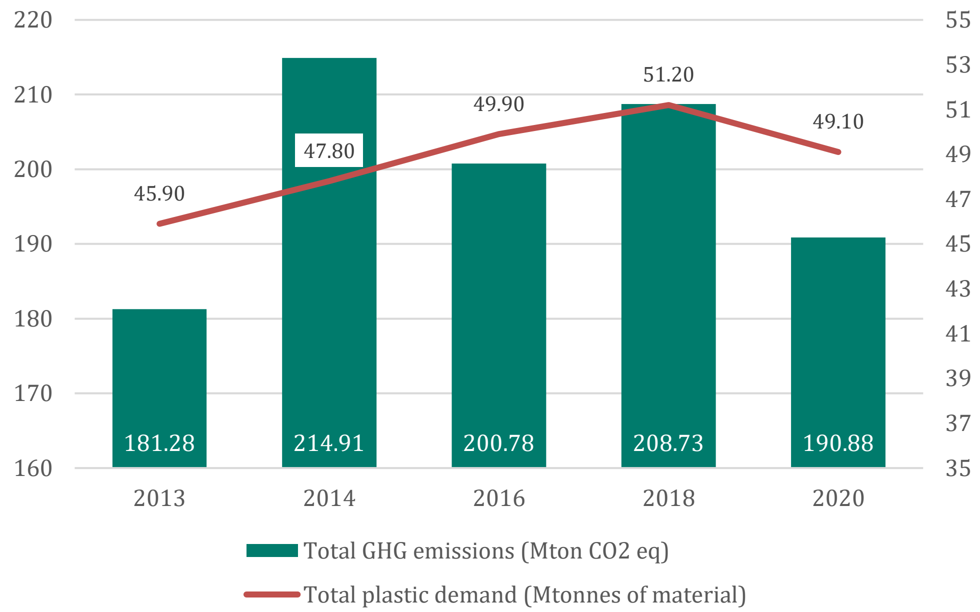
Background

The European Commission aims to achieve carbon neutrality by 2050, and the EU 2020 Circular Economy Action Plan highlights the need for measures to enhance circularity and mitigate the environmental effects of plastic. The plastics value chain is both very diverse and complex, as well as globally spread, hence attempts to map material flows and related GHG emissions for the total plastics value chain globally and EU-wise are scarce.

Despite the limitations and uncertainties of the model and data sources (see Vanderreydt et al. (2021)), it can be concluded that there is a significant untapped potential to reduce the CO_2 emissions in the plastics value chain. Higher recycling rates would contribute to CO_2 emission reductions because (1) if plastic waste is recycled instead of incinerated, CO_2 emissions related to incineration are avoided; and (2) recycled outputs can replace the production of primary raw materials and therefore avoid the corresponding greenhouse gas emissions of these processes.

Assessment

Figure 5.8 Total GHG emissions of the plastics value chain (EU, 2013-2021)



Notes: Data gaps: 2015, 2017, 2019 & 2021
Source: (Vanderreydt et al., 2021)

The total GHG emissions from EU's plastics value chain for 2020 were 191 million tonnes of CO_2 equivalent[2]. For comparison, the total annual GHG emissions from Belgium were 123 million tonnes (2019).

In 2018, the year for which there are data, the majority (63%) of the greenhouse gas emissions in the European Union plastics value chain were from plastics production. Converting polymers into products accounts for 22 %, and plastic waste treatment at end-of-life adds another 15 %, mainly due to incineration.

2 This estimation is based on a model that was built for the Eionet Report ETC/WMGE 2021/3 (Vanderreydt et al., 2021). The data is enriched on annual plastics demand and end-of-life data extracted from Plastics Europe's annual Plastics facts between 2014-2022.

The total GHG emissions mimic the similar pattern of the total plastics use. There has been a drop of emissions from highest (2018) 208.39 million tonnes of CO_2 equivalent to about 190.88 million tonnes of CO_2 equivalent (2020).

5.9 EU circularity of plastic materials

In 2020, the contribution of secondary plastics produced/recycled in the EU amounts to 8,1 % of the total plastic material consumption in the EU.

Use of recycled plastics

[SIGNAL]

8,1 %

is the share of consumed plastics that originates from secondary plastics in 2020 in the EU.

Trend: **Improving**

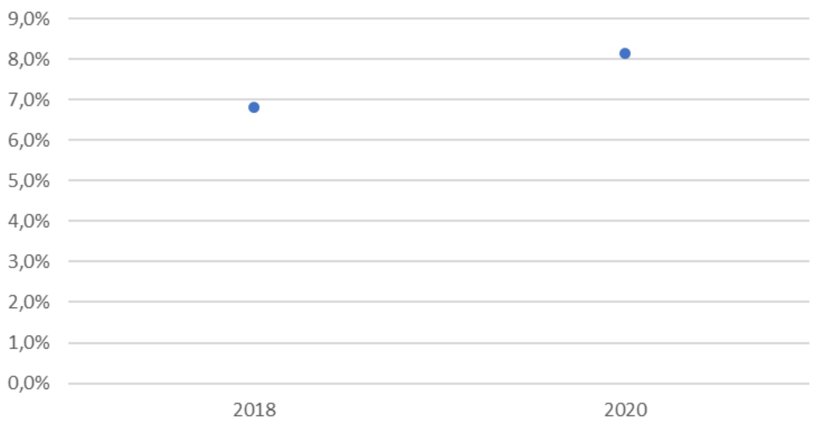
Coverage: EU27+3, 2018-2020

Background

The EU circularity of plastic materials is the share of secondary plastics consumed in the EU in the overall EU plastics consumption. This metric addresses the main objective of the circular economy policy agenda to close material cycles. Increases in the plastics circularity mean that more and more of the EU plastics consumption needs are covered by recycled materials, thus reducing the need for virgin plastics and the associated negative impacts on the environment and climate. Increasing the EU circularity of plastic materials can happen either by increasing the amount of secondary materials production or decreasing the amount of material consumed.

Assessment

Figure 5.9 EU circularity of plastic materials



Source: Plastics consumption (Plastics Europe, 2019b, 2022b; EUROSTAT, 2023), plastic recycling capacity (Plastics Recyclers Europe, 2022)

The EU use of recycled plastics shows an increasing trend reaching 8.1 % in 2020, up from 6.8% in 2018. This is due to both an increased uptake of recycled materials and a small decrease in plastic consumption in the EU. Both trends have a positive effect on the EU circularity of plastics as more recycled plastics is being used and less plastics is being consumed. However, the reduction in the consumption of plastics in 2020 might have been affected by the economic slowdown due to the measures addressing the COVID pandemic. Although the methodology for calculation is not directly comparable, the circularity of plastics is still lower than the EU overall circularity standing at 11.7 % in 2020.

6 Key observations

6.1 Key observation 1: Increasing the EU circularity of plastic materials would reduce the associated negative impacts on health, the environment and climate.

Throughout the lifecycle of fossil- and bio-based plastics, there are several impacts and risks associated with soil, water, and groundwater pollution, as well as water depletion. The unsustainable production, consumption and end-of-life management of plastics have led to significant impacts on the environment and climate. Plastics recycling mitigates the environmental impacts of plastics end-of-life treatment, while also reducing the need for extraction of fossil raw materials (Geyer et al., 2017; Hahladakis et al., 2018; Tenhunen-Lunkka et al., 2022).

GHG emissions are released throughout the lifecycle of plastics, although a majority originates from production. Reducing production and consumption would contribute to reduced GHG emissions, and could also lead to increasing recycling rates with less volumes on the market. It is estimated that every tonne of fossil virgin plastic produced and incinerated at the end of life produces 5 tonnes of carbon dioxide equivalent (CO2-eq) (Material Economics, 2019).

Poor waste management and plastic littering form a substantial negative impact on human health and the environment, such as through emissions and by losing materials to incineration, landfilling, dumping and littering. Plastic is leaking from the economy into the environment, where the durability and longevity characteristics of plastics leads to adverse impacts when accumulating in ecosystems. Specifically in coastal and marine ecosystems, plastic litter causes enormous costs, ecological damage and social impact. Plastics make up the bulk of total litter found on European beaches.

The breakdown of plastic litter further forms microplastic pollution. Microplastics are also generated from either intentionally added microplastics in for example cosmetics, or through unintentional release through use e.g. tire abrasion, washing of textiles, and scaling of paint. As microplastics are mobile and persistent, as well as very difficult to remove from the environment, they have lately become a source of concern. Microplastics have been found in many living organisms, including humans.

Increasing the EU circularity of plastic materials — either by increasing the amount of secondary materials production or decreasing the amount of material produced and consumed — would reduce the amount of primary material needed, and the associated negative impacts on the environment and climate. Shifting from virgin fossil-based towards more recyclate-based and bio-based plastics has the potential to decrease the GHG emissions of the plastic value chain. However, these alternatives come with other types of environmental implications. (Vanderreydt et al., 2021)

6.2 Key observation 2: Policies are a key driver for circularity

There has been a significant number of new plastic policies and legislation in Europe in recent years, aiming to reduce negative impacts on health, environment and climate related to the use of plastics. Furthermore, the ongoing negotiations at the United Nations on a global treat to end plastic pollution is expected to drive provide a new global policy framework for plastics. Key drivers of the increased plastics recycling trend since 2016 include the legislative environment, particularly plastic waste export restrictions (European Commission, 2022a). At present, EU and national policies widely support the transformation of as much of the plastic waste as possible into recyclates and new products. However, according to the European Court of Auditors (2020), there is a substantial risk of the EU falling short of its plastic recycling targets unless efforts are substantially intensified. Continued policy development for recycled content mandates, design for circularity, and export restrictions is important to increase the EU plastics circularity.

EU strategies and directives aiming to regulate and to some extent limit plastic production and consumption in order to reduce negative impacts on health, environment and climate include EU's Plastics Strategy, the Packaging and Packaging Waste Directive, the Single-Use Plastics Directive, the Zero Pollution Action Plan among others (European Commission, 2018a, 2018b; European Commission., 2019; European Commission, 2021b). In response to the policy framework, some brand owners and manufacturers have pledged to reduce their use of virgin material and use more recycled content and reducing plastic pollution. Voluntary pledges have arisen, such as the European Commission's Circular Plastics Alliance (CPA) (European Commission, 2022b), the New Plastics Economy Global Commitment of Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2022). And negotiations are ongoing on the development of a UN Global treaty to end plastic pollution (United Nations, 2021).

Due to efforts in increasing plastic circularity and related policies with voluntary pledges supporting increasing demand for secondary plastics raw materials, the European mechanical recycling capacity for plastic waste has significantly increased during the past years. In relation to trade of plastic waste, the recent policies may trigger a further reduction in plastic waste exports, providing at the same time incentives to EU Member States to increase circularity in the management of plastic waste. On the contrary, few policies and initiatives directly target plastic consumption and waste generation. As increasing recycling can be seen as a response to policy support, there is, however, few direct ambitions to reduce plastic consumption and prevent waste generation. The lack of progress in waste prevention may be linked to the lack of policies with currently no direct targets or reporting obligations for plastics consumption and waste generation.

6.3 Key observation 3: Although recycling is increasing, there is a gap in EU's recycling capacity that limits circularity and also drives plastic waste exports

The European mechanical recycling capacity for plastic waste has significantly increased during the past years. From 1996 to 2021, the capacity has increased almost 6-fold from 2 million tonnes to over 11 million tonnes. Between the years 2020–2021 data shows an increase of recycling capacity by 1.7 Mtonnes and the amount of recycling facilities increased from 650 to 730 facilities. In 2021, a total of 29.5 Mtonnes of plastic waste was separately collected, of which 10.2 Mtonnes was recycled, 12.4 Mtonnes incinerated, and 6.9 Mtonnes landfilled (Plastics Europe, 2022a). The recycling capacity of today needs to be further expanded to increase the overall recycling of plastic waste (Plastics Recyclers Europe, 2023b).

Overall, according to the Early Warning assessment related to the 2025 targets for municipal waste and packaging waste carried out by the European Environment Agency, 19 Member States have been identified as at risk of missing the target of 50 % recycling of plastic packaging waste by 2025 (European Environment Agency, 2023a). For meeting the recycling target, the need for additional plastics recycling capacity is substantial.

Increasing EU capacities for plastic recycling reduces the need for exports outside the EU. This is also supported by an increasing trend of uptake of recycled materials, with more recycled plastics is being used in production. Although there is yet not sufficient recycling capacity in Europe, prices of scrap plastics are currently increasing after a quite long trend of decreasing prices. However, the trends do not seem to be specific for waste but for plastic materials in general.

The trends in plastic waste exports reflects waste management trends inside and outside the EU. The gap in recycling capacity is a driver for plastic waste exports, while increasing EU capacities drives intra-EU trade. The recent reduction in extra-EU trade is now partially compensated by an increase in intra-EU trade. A reduction in the EU's reliance on primary resources, including imported materials, would increase its strategic autonomy, as the EU would increase its ability to meet its own needs, without relying on countries outside the EU.

6.4 Key observation 4: Plastics consumption is increasing, alternative feedstocks are winning ground, but remain a fraction of the fossil plastics.

Plastics consumption in Europe is increasing overall. However, data on plastics consumption show a slight decrease in the past years, with indications of this being due to covid and economic slowdown. Yet, this slight decrease is not reflected in the production and use of alternative feedstocks. This could perhaps indicate that the growth in alternative feedstocks is compensated by less virgin feedstock consumption.

In 2021, a total of 57.2 million tonnes of plastic was produced in the EU, of which 10.1% was post-consumer recycled plastics and 2.3 % bio-based plastics. The use of recycled plastics in EU has increased by 27% from 4 million tonnes to approximately 5.5 million tonnes in 2018–2021. This is despite the small drop in consumption of plastics, showing that indeed, the use of recycled feedstock is decoupled from virgin plastics use. Indeed, the EU circularity of plastics shows an increasing trend; in 2018 it was 6.8 %, while in 2020 it was 8.1%. Also, bio-based plastics production is continuously increasing globally, but still remains a fraction of the fossil based at less than 1 %. Thus, there is not sufficient data to tell whether the market share of bio-based plastics is changing.

6.5 Key observation 5: There are major data gaps regarding plastic flows in the EU and globally.

Reliable and publicly accessible information, knowledge, indicators and data is needed to support decision-making both for policymakers and the private sector. Currently, there is a significant knowledge gap related to the plastic flows in Europe and globally. The lack of availability and accessibility to data prevents the comprehensive indication of trends due to lack of historical data, prevents reliable analysis due to poor data quality, and prevents the formation of a holistic picture, providing a weak foundation for policy-making. Improved and better accessible data would facilitate forming an overview of current situation, follow-up on changes, and enables decision-making to promote plastics circularity.

A majority of the total plastic consumed is in non-packaging applications, such as electronics, textiles and automotive (Hsu et al., 2021). Yet relatively few policies and initiatives directly target plastic in non-packaging sectors. As EU legislation often is accompanied with reporting obligations, the lack of targets may result in a lack of data. Plastic packaging flows in the EU are fairly well documented by Eurostat (2023) due to reporting obligations for follow-up on achieving the recycling targets of the Packaging and Packaging Waste Directive. There are currently no reporting obligations for plastics of non-packaging applications, which is reflected in the different data availability of packaging and non-packaging plastics. Improving the data availability on non-packaging plastics would enable policy-making that target plastics of non-packaging applications.

There is also a significant data focus on waste management, that need to shift towards other circularity measures. As long as data focus is on waste management and recycling, policies to support other R-strategies (such as product reuse, lifetime extension) will be absent due to the poor knowledge base to support policy-making. Furthermore, there are major data gaps regarding the total volume of plastics embedded in products put on market in Europe. Even less is known about plastic in stocks, since data of the past plastics put on the market and removed from stocks in waste streams are not documented.

This publication highlights the need for reliable data to support measuring plastic circularity. For the nine metrics presented in this publication, data reliability has been a key obstacle for enabling measuring plastic circularity in Europe. In general, the metrics form an overview of current situation and trends, but issues with data availability, reliability and coverage prevents this data as such to be used as a basis for decision-making that could promote plastics circularity. Table 6.1 presents the data availability, reliability and coverage for the metrics that have been presented in this report. The metrics are characterised based on data availability, where *indicators* have good data avialability and reliability, and s*ignals* have less reliable and/or complete data available. Data availability can range between well-established data sets and specific studies, data quality is categorised by the reliability of the source, and data coverage includes both the spatial and temporal coverage of data, as well as the number of data spots.

Table 6.1 Data availability, reliability and coverage for the metrics for measuring plastic circularity in Europe

Metrics	Data availability	Data quality	Data coverage	Characterisation
1. EU's plastics waste mechanical recycling capacity	Annually or semi-annually updated data from two industry assiciations	Not fully transparent methodology	Good spatial and temporal coverage	Signal
2. Exports of plastics waste outside EU	Annually updated EUROSTAT data	Fully transparent methodology	Good spatial and temporal coverage	Indicator
3. Average yearly price of plastic scrap	Annually updated EUROSTAT data	Fully transparent methodology	Good spatial and temporal coverage	Indicator
4. Plastics consumption in the EU	Two specific studies by the industry association. Foreseen to be updated bi-annually.	Not fully transparent methodology	Good spatial coverage. Two data spots for temporal coverage	Signal
5. Litter found on European beaches	Annually updated data by authority.	Fully transparent methodology but methodology has changed the dataset has grown, there are uncertainties in implementation and related to overlaps of data, as well as potential impacts of COVID-19.	Good spatial and temporal coverage	Signal
6. Unintentional release of microplastics into the environment in the EU	Specific publication by DG Environment.	Data from several different studies using different methodologies is not fully transparent	Good spatial coverage. One data spot for temporal coverage	Signal
7. Global bio-based plastics production	Annually updated data from industry assiciation.	Not fully transparent methodology. The broad coverage reduces reliability.	Good temporal and very broad spatial (global) coverage	Signal
8. GHG emissions from EU's plastics value chains	Specific publication by ETC WMGE.	Data from several different studies using different methodologies is not fully transparent	Good spatial and temporal coverage	Indicator
9. EU circularity of plastic materials	Data from several statistics and studies	Data from several different studies using different methodologies is not fully transparent	Good spatial coverage. Two data spots for temporal coverage	Signal

7 List of abbreviations

Abbreviation	Name	Reference
CML	Circularity Metrics Lab	https://www.eea.europa.eu/en/circularity/
CO_2-eq	carbon dioxide equivalent	
EEA	European Environment Agency	www.eea.europa.eu
ETC	European Topic Centre	
ETC/CE	European Topic Centre on Circular Economy and Resource Use	https://www.eionet.europa.eu/etcs/etc-ce
ETC/WMGE	European Topic Centre on Waste and Materials in a Green Economy	
EU	European Union	
EU27+3	EU member states + Norway, Switzerland, and the UK	
GHG	Greenhouse Gas	
MLW	Marine Litter Watch	
MSFD	Marine Strategy Framework Directive	
NOx	nitrogen oxides	
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals.	
SOx	Sulfur oxides	
ZPAP	Zero Pollution Action Plan	

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