EUROPEAN
COMMISSION

Brussels, 15.5.2023
SWD(2023) 306 final

COMMISSION STAFF WORKING DOCUMENT

Measuring progress towards circular economy in the European Union – Key indicators for a revised monitoring framework

Accompanying the document

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

on a revised monitoring framework for the circular economy

{COM(2023) 306 final}

Table of Contents

1. Introduction

In the EU's 2020 circular-economy action plan[1], the Commission announced that it would update the existing monitoring framework for the circular economy[2]. This monitoring framework was developed after the 2015 EU action plan[3].

The framework has attracted significant interest from stakeholders and has become a reference for other initiatives on circular-economy monitoring (e.g. building guidelines for circular-economy indicators for European cities[4] and setting circularity criteria for regional projects[5]). Other initiatives exist on: (i) monitoring circularity in business[6]; (ii) monitoring progress in the circular economy at national level[7] and globally[8]; and (iii) setting principles to monitor the circular economy[9].

The other EU institutions have welcomed the monitoring framework (see Box 1), while calling for greater focus on the production side rather than focusing on waste. They consider using 'material footprint' (which considers the materials embedded in imports) and 'consumption footprint[10]' based on lifecycle assessment (LCA) is essential to address the overall impacts of consumption in the EU.

Box 1. EU debate on monitoring the circular economy[11]

The EU institutions all expressed opinions on the **EU monitoring framework in 2018**.

- **The Council** adopted conclusions[12] on the circular-economy package in June 2018.
- **The European Parliament Environment Committee**[13] adopted a **draft motion for a resolution** in September 2018.
- **The European Economic and Social Committee** adopted an opinion[14] in July 2018.

[1] COM/2020/98 'A new Circular economy action plan for a cleaner and more competitive Europe'.
[2] COM(2018) 29 final and SWD(2018) 17
[3] COM/2015/0614 final 'Closing the loop – an EU action plan for the circular economy'.
[4] Specific action in the EU Urban Agenda Partnership on Circular Economy: https://ec.europa.eu/futurium/en/circular-economy/terms/all/City%20Indicators%20for%20a%20circular%20economy.
[5] Horizon 2020 SCREEN (Synergic CirculaR Economy across European regioNs) project: http://www.screen-lab.eu/documents/assessment-criteria-table-Rev3.pdf.
[6] https://www.ellenmacarthurfoundation.org/resources/apply/circulytics-measuring-circularity.
[7] For instance in the Netherlands, France, Italy, Sweden, Belgium. National sets of indicators use national data, which are not always available for the EU countries.
[8] Circularity gap report 2023.
[9] Bellagio principles declaration from the EEA and Italy's ISPRA.
[10] https://eplca.jrc.ec.europa.eu/ConsumptionFootprintPlatform.html
[11] The box includes an overview of the opinions from other EU institutions and links to official documents.
[12] https://data.consilium.europa.eu/doc/document/ST-10447-2018-INIT/en/pdf.
[13] https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/ENVI/RE/2018/09-13/1155453EN.pdf , reference B8-0000/2018.

Following the Commission's adoption of the **circular-economy action plan in 2020**, EU institutions expressed opinions on how to better monitor the transition to a circular economy, in anticipation of the upcoming revision of the monitoring framework. The four bullet points below list these opinions.

- In December, 2020, **the Council** adopted conclusions in its document 'Making the Recovery Circular and Green'[15], which included a section on monitoring progress towards circularity.
- **The European Parliament** adopted an own-initiative report on the new circular-economy action plan[16] in February 2021.
- **The European Economic and Social Committee** adopted an opinion on the new circular-economy action plan[17] in July 2020.
- **The Committee of the Regions** adopted an opinion on the new circular-economy action plan[18], including a specific section on targets and monitoring, in October 2020.

The update of the monitoring framework takes account of both the focus areas in the 2020 action plan and the interlinkages between circularity, climate neutrality and the zero-pollution ambition.[19], for a healthier, socialy fairer Europe and planet. The 2020 EU action plan calls for: (i) the further development of indicators on resource use, including consumption and material footprints; and (ii) linking these indicators together to monitor and assess both progress towards decoupling economic growth from resource use and the impacts of this progress in the EU and beyond. Together with bioeconomy and nature-based solutions, circular economy is a key component of the transformative change necessary to drive European and global societies towards a nature positive economy, at a time half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing[20].

This document lays out the methodology used for the indicators, and includes an analytical description for each of them. To assist in creating the updated methodology, the Commission consulted the Member States and stakeholders, and a summary of these consultations is included in this document. Section 4 of this document provides the key metadata (data sources, the use of the data in Commission documents, and web links) for each indicator.

---

[14] Full text: https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/monitoring-framework-circular-economy-communication . Adopted on 11/07/2018 - Bureau decision date: 19/09/2017; Reference: NAT/722-EESC-2018-00464.
[15] Council conclusions 'Making the Recovery Circular and Green': https://www.consilium.europa.eu/media/47583/st_13852_2020_init_en-1.pdf.
[16] European Parliament resolution of 10 February 2021 on the new circular-economy action plan (2020/2077(INI)) https://www.europarl.europa.eu/doceo/document/TA-9-2021-0040_EN.html.
[17] https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/new-circular-economy-action-plan.
[18] https://webapi2016.cor.europa.eu/v1/documents/cor-2020-01265-00-01-pac-tra-en.docx/content.
[19] COM/2021/400 final 'Towards Zero Pollution for Air, Water and Soil'
[20] 'Global Resources Outlook', United Nations Environment Programme, International Resource Panel

The underlying data populating the various indicators provide a snapshot of what we know today[21]. To ensure regular reporting on the circular economy, Eurostat regularly updates the monitoring framework for the circular economy on its website[22].

The Commission continues to improve both the knowledge base and **data availability** for measuring progress in the circular economy. Some of these improvements are set out in the bullet points below.

- Following the 2018 amendment of the Waste Framework Directive by the Council and the European Parliament, there is now more **reliable and comparable information on waste**, including food waste and electrical and electronic equipment waste.
- There are now: (i) **improved European statistics** on material footprints; (ii) PRODCOM statistics on secondary raw materials; and (iii) statistics on the number of jobs in the circular-economy sector. The Joint Research Centre produces estimates of consumption footprints.
- Work is ongoing to **collect** data for the indicators on green public procurement with a view to publishing this data in the coming years. Through Horizon Europe, the Commission is funding several **research projects** that will deliver better data to complement the official statistics, in particular via the EU's Raw-Materials Information System[23].

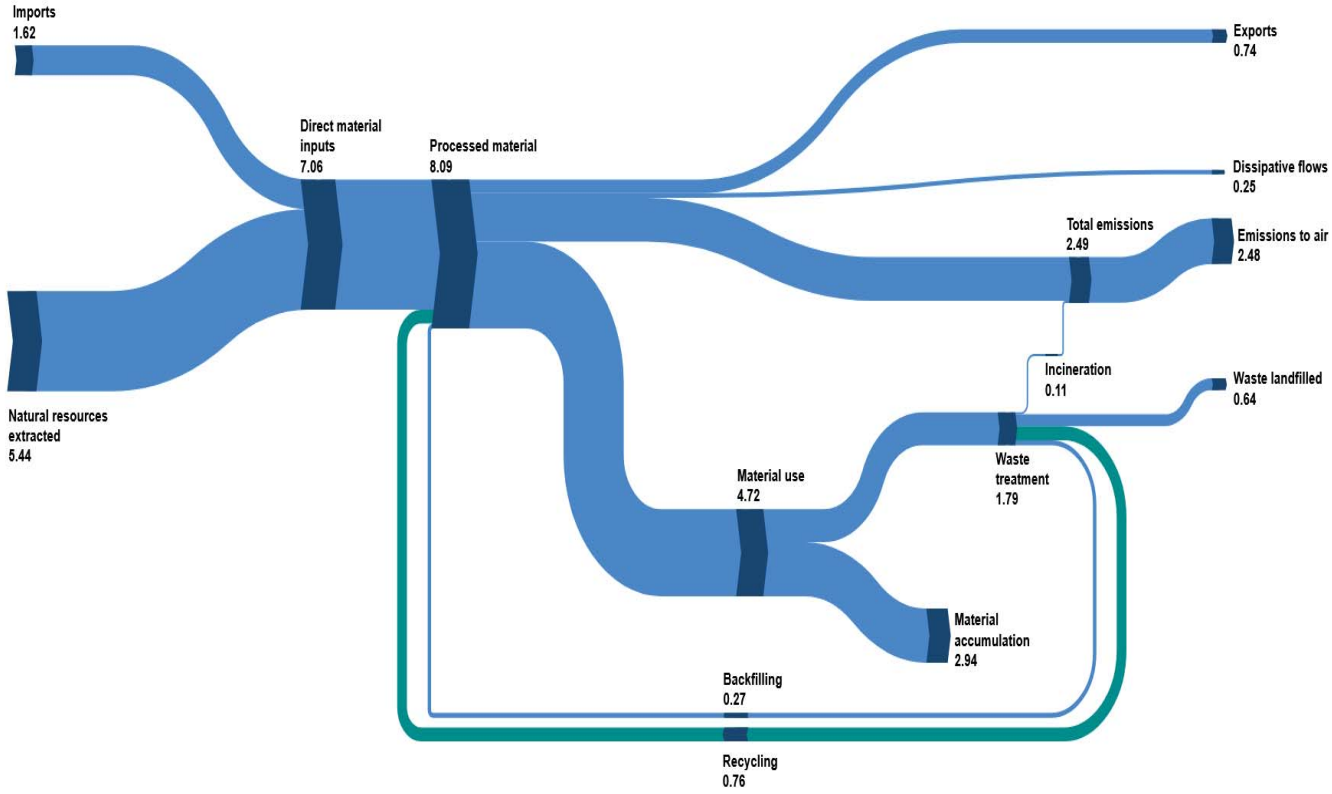
[21] The data used in this Staff Working Document are those available on 3 February 2023.
[22] http://ec.europa.eu/eurostat/web/circular-economy.
[23] http://rmis.jrc.ec.europa.eu/.

2. Material flows in the circular economy

The circular-economy paradigm takes a comprehensive and multi-faceted approach. One of the main aspects of this comprehensive approach is a focus on flows of materials. One effective illustration of material flows at macro level is a so-called Sankey diagram, which provides a representation of how many materials (coming from imports and 'extractions' such as mining or agriculture) flow into the economy, are used, and then become waste or are reused (recycling and backfilling[24]).

Eurostat publishes an interactive version of the following Sankey diagram alongside the monitoring framework for the circular economy.

Figure 2.1. Sankey diagram on material flows, EU, 2021 (billion tonnes per year)



Source: Eurostat

[24] *'backfilling' is whenever suitable non-hazardous waste is used for purposes of reclamation in excavated areas or for engineering purposes in landscaping.*

The overview of material flows in the EU (Figure 1) shows that on the input-side (the left-hand side of the diagram) 8.1 billion tonnes of raw materials were processed in 2021, of which: 1.6 billion tonnes (i.e. around 20% of the total) were imported, which shows the EU's dependency on imports of materials. Imports include not only raw materials and manufactured goods but also waste imported for treatment in Member States (e.g. conversion into secondary raw material).

The middle part of the Sankey diagram ('processed material') represents processed materials, which are defined as the sum total of direct material inputs and secondary material input, i.e. materials obtained from recycling and backfilling. Processed materials can either be exported or used domestically.

The size of the green loop in the 'processed materials' node is a possible metric of the economy's circularity. It represents the share of waste materials recovered from recycling out of all materials processed. Backfilling is another category of recovery different from recycling.

Materials and products may have a short or long lifecycle. For example, materials and products can be:

- single use (e.g. food);
- used for less than 1 year (e.g. paper);
- long-life products (e.g. furniture);
- assets (e.g. buildings, machinery).

In particular, large amounts of construction minerals (steel, cement, sand, gravel, etc.) are used to maintain stocks of assets, such as buildings and infrastructure. These stocks often stay in use for decades and only become available for recycling after they reach the end of their lifecycles. The materials in those assets accumulate as the economy grows. Each year, materials are added to the economy's stock (i.e. gross additions to stock) and some old materials are removed as buildings are demolished and durable goods disposed of (i.e. removals). In 2021, the EU's net material accumulation amounted to 3.0 billion tonnes. As long as the demand for raw materials for in-use stocks with long lifetimes (e.g. buildings and infrastructure) exceeds the amount of materials that can be supplied from recycled materials, primary extraction will remain necessary.

The output-side of the Sankey diagram (the right-hand side) presents outputs of materials from the economy, namely:

- exports of products;
- emissions to air, soil and water – flows of solid, liquid and gaseous materials that are discharged into water bodies (rivers, seas, etc.) or emitted into the atmosphere or buried in soil;
- dissipative flows – materials which are dispersed into the environment as a deliberate or unavoidable consequence of product use with current technology (for example, mineral fertilisers and pesticides, and abrasion from vehicles' tyres, plastic mulches from agriculture, sewage sludge.).

Several flows come out via the 'waste treatment' node. Three of these flows are set out in the bullet points below.

- Waste incineration: waste is incinerated to recover energy. However, this process also produces greenhouse gas and air pollutant emissions.
- Landfilled waste: the disposal of waste, including by landfill and other disposal operations such as releasing into releaseing into water bodies or oceans, deep injection or permanent storage[25].
- Waste recovery: operations involving waste materials being reprocessed into products, materials or substances to be reused – either for their original purpose or other purposes. This includes recycling and backfilling operations.

Most of the materials used are converted into emissions to air, including greenhouse gases and air pollutants (2.5 billion tonnes in the EU in 2021) or waste (1.8 billion tonnes). Only 0.8 billion tonnes of materials originate from recycling and are used as secondary raw materials. In addition, 0.3 billion tonnes are used for 'backfilling'. These 1.1 billion tonnes of raw materials (from recycling and backfilling) represent about half of the 1.8 billion tonnes of raw materials that are contained in products that have reached their end-of-life. The remaining 0.8 billion tonnes is waste that does not re-enter the economy.

The waste produced by the use of materials, including the materials removed from stocks of assets at end-of-life (demolition and discards) accounted for 1.8 billion tonnes in the EU in 2021. Part of this waste remains in the EU economy through recycling (0.8 billion tonnes) and through backfilling (0.3 billion tonnes). The recycling stream now captures 43% of all material waste flows, whereas backfilling accounts for 15%, and landfilled waste accounts for 36%. Some of the waste is incinerated and a fraction of it (0.1 billion tonnes) is released into the environment, together with other emissions, such as emissions to air (greenhouse gases and air pollutants, 2.5 billion tonnes) and emissions to water (0.01 billion tonnes). The outputs in Figure 2.1 also include exports (0.7 billion tonnes) and dissipative flows (0.2 billion tonnes).

There is **potential to improve the circularity of material flows**, in particular by increasing the share of recycled materials, by extending lifetime of products and by decreasing the amount of waste generated as well as the demand for raw materials.

It is also relevant to distinguish the material flows according to whether they are comprised of biomass, non-metallic minerals, fossil-energy carriers and metal ores (Figure 2.2). **Less than 20%** of the processed **biomass** is used for material purposes, whereas the rest is used for

[25] Annex II, Section 8(2) of Waste statistics based on Regulation (EC) No 2150/2002 of the European Parliament and of the Council

energetic purposes such as food, animal feed and agro-fuels. Over 40% of biotic materials that become waste are fed back into the economy through recycling.

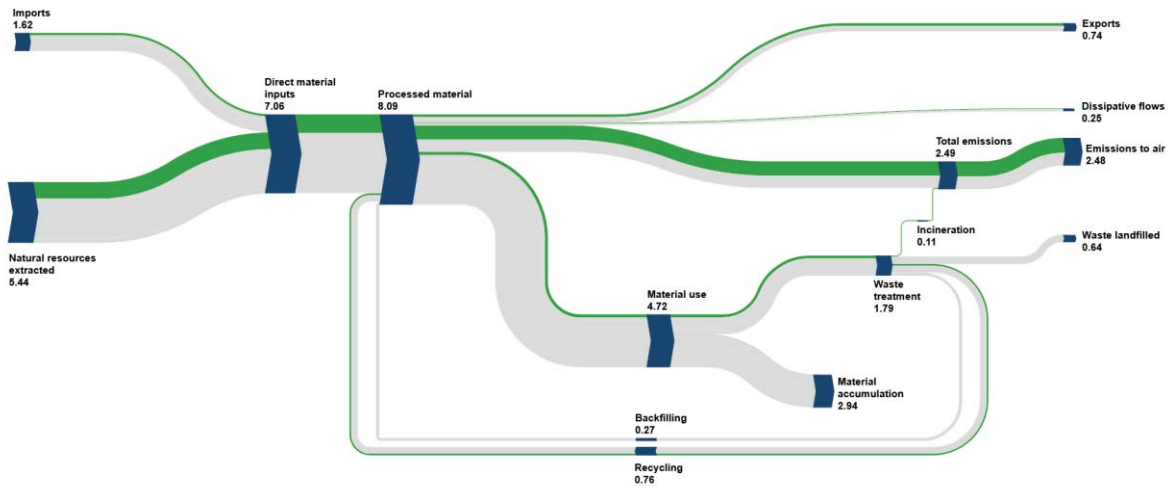
Most of the 3.3 billion tonnes of **non-metallic minerals**) that are used in the EU originate from domestic extraction. The rest comes from secondary materials recovered and fed back into the economy. 2.7 billion tonnes of non-metallic minerals are used to build up so-called societal stocks such as buildings and infrastructure.

Over 5% of the processed **fossil-energy carriers**) are used as plastics, oils, tyres or for chemical purposes. Almost half of these materials are recovered when they reach their end-of-life, either through recycling or backfilling.

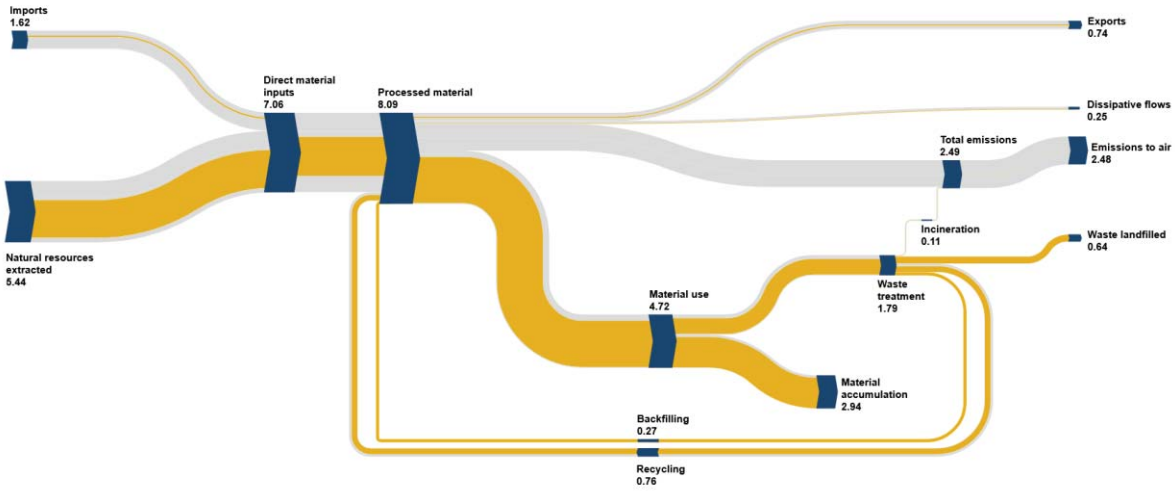
Metal ores) represent a minor fraction of the EU's material consumption in terms of mass, although they are of high value and strategic importance to the economy. Less than 20% of the metals that are processed in the EU originate from recycling.

Figure 2.2. Material flows in the EU economy by material category (2021)

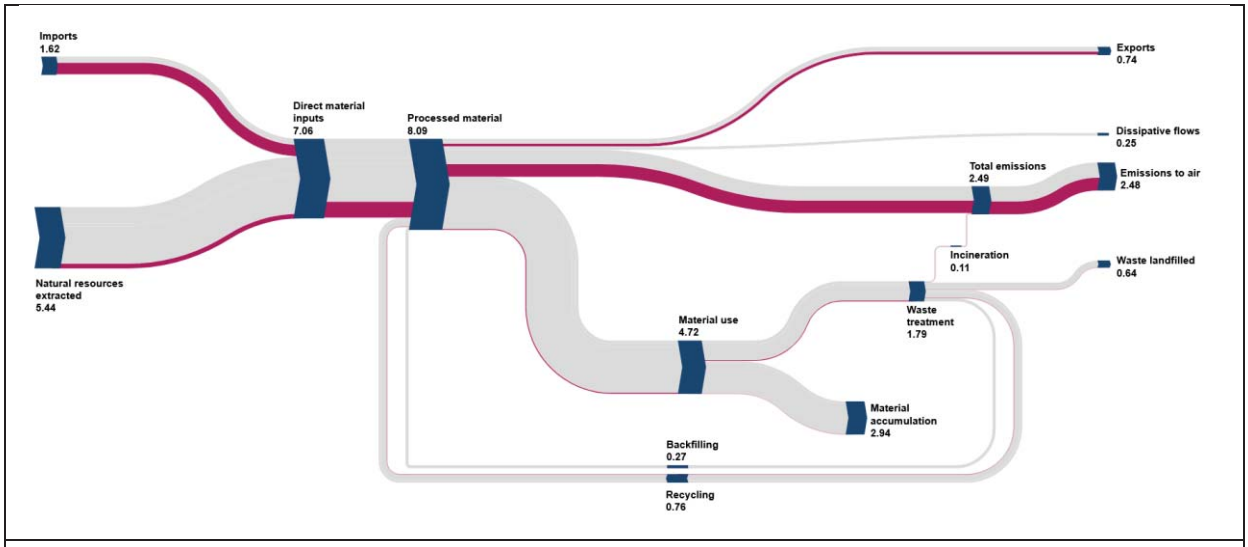
Biomass



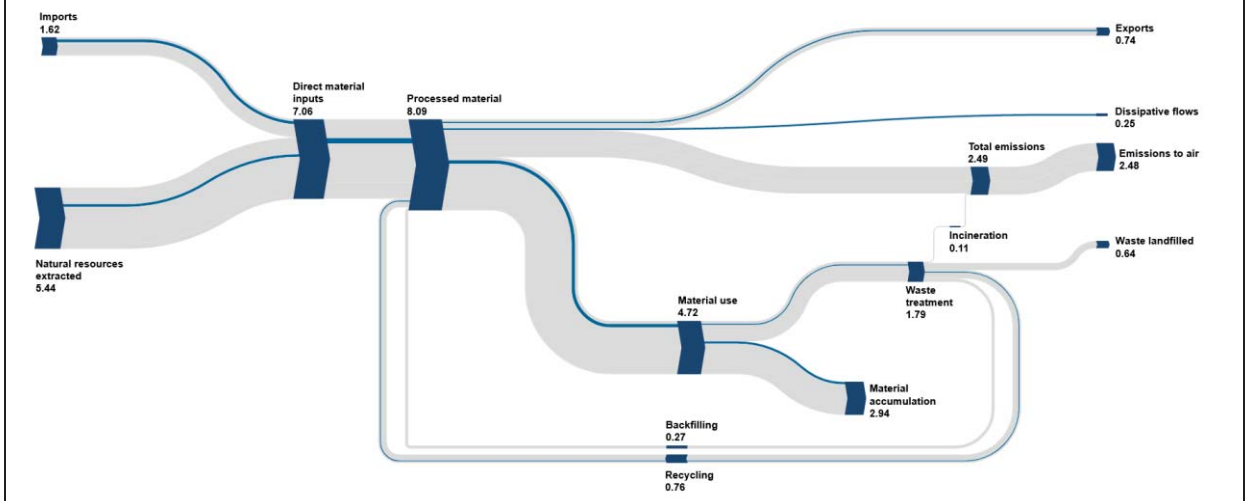
Non-metallic minerals



Fossil energy materials/carriers



Metal ores



Source: Eurostat

These Sankey diagrams of material flows provide an **overall picture** of how circular the economy is in a given year. A set of meaningful indicators is needed to monitor progress made over time in the different areas of the EU's circular-economy action plan.

3. Contribution of the circular economy to climate neutrality

The circular economy and climate change mitigation are strongly interlinked. The current economic model is close to linear, often described by extraction, production, use and disposal. A circular economy, in turn, maintains the value of products, materials and other resources for as long as possible[26]. It enhances their efficient use in production and consumption and applies the waste hierarchy, thereby reducing the impact of economic activity on the climate and environment. In other words, it is a regenerative growth model that keeps its resource consumption within planetary boundaries[27].

As described in the EU Long Term Strategy (LTS)[28], the circular economy presents a great potential for greenhouse gas (GHG) emissions reduction, especially in the primary and secondary sectors. Intervening at different stages of the supply chain, circularity can improve the material and energy efficiency of the industrial processes, thereby reducing their GHG emissions and other negative environmental impacts. Improved product designs (for instance by extending their lifetime and embedding circularity from the design phase) and enhanced waste management (for instance by increasing recycling rates) allow materials to remain longer in the economic cycle and reduce the need for primary raw materials. Starting from recycled and uncontaminated material feedstock instead of primary raw materials reduces the number of processing steps and energy needs, thereby decreasing GHG emissions.

Moreover, circular economy actions also help increasing the energy- and carbon-efficiency of industrial processes. Industry accounts for about 25% of EU final energy demand, which is mainly due to key energy-intensive industries. Processing recycled materials is less energy- and carbon-intensive than processing raw materials, leading to a reduction of the final energy demand in this sector, and, thus, GHG emissions.

The literature shows that ambitious demand side measures in the form of materials recirculation, increased material and energy efficiency as well as circular business models can reduce GHG emissions significantly in heavy industry by up to 60% in 2050 compared to 1990[29].

---

[26] Regulation (EU) 2020/852

[27] COM(2020) 98 final

[28] https://ec.europa.eu/clima/policies/strategies/2050_en

[29] Material Economics AB (2018), The Circular Economy.

The circular economy delivers on additional co-benefits linked to the transition towards climate neutrality[30]. Reduced energy and material demands lower the need for importing raw materials and fuels, thus decreasing the European economy's dependence on imports and improving the EU's strategic autonomy. It also creates jobs in proximity to the products that need to be maintained, refurbished or shared[31].

Considering all the above stated benefits and potentials, the European Commission adopted the new Circular Economy Action Plan in March 2020[32]. It highlights, among others, circularity as a prerequisite for climate neutrality and announces that the Commission will:

- analyse how the impact of circularity on climate change mitigation and adaptation can be measured in a systematic way;
- improve modelling tools to capture the benefits of the circular economy on greenhouse gas emission reduction at EU and national levels;
- promote strengthening the role of circularity in future revisions of the National Energy and Climate Plans and, where appropriate, in other climate policies

The EU took actions in all three areas. The in-depth analysis underpinning the EU long-term strategy explored in a stylised manner the role of a reduction of primary materials production in mitigating energy- and process-related GHG emissions in EU industry[33]. The scenario modelling the implementation of circular economy actions ("CIRC") assumes an average reduction of physical output for most energy industries. Together with other circular economy measures, and combined with moderate energy efficiency and fuel-switching, the CIRC scenario achieves the same ambition as other modelled scenarios at the least energy related cost[34].

Eurostat has undertaken a decomposition analysis of the reduction of greenhouse gas emissions by the EU economy over the period 2008-2020. According to Eurostat estimates, a more efficient use of natural resources (materials and energy) is a relevant factor in the decline of GHG emissions. Around 12% of the reduction are due to more circular material flows, i.e. secondary materials replacing primary materials in the economy.

---

[30] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A52022XC1229%2802%29&from=EN
[31] Circular Economy Action Plan, COM(2020) 98.
[32] Circular economy action plan : for a cleaner and more competitive Europe, COM(2020) 98

[33] https://ec.europa.eu/clima/policies/strategies/2050_en
[34] The energy related investment costs do not include certain additional costs that would be related to circular measures, like the improved of material collection methods, handling and transporting material for preparing their reuse etc.

The Commission has also launched external studies[35] on the links between circular economy and climate change whose results will be available in the coming years and will be taken into account for further analysis. Finally, the Commission underlines the relevance of the circular economy in its Notice on the Guidance to Member States for the update of the 2021-2030 national energy and climate plans[36]. More specifically, Member States are asked to integrate and model the contribution of the circular economy to the climate transition.

[35] The ongoing contract "Study on the Contribution of the Circular Economy (CE) to EU Climate Policies" aims at developing a methodology to quantify circular economy contributions to addressing climate change, while the contract on the "Role of the circular economy as a contributor to industry decarbonisation beyond 2030" seeks to improve the evaluation of the potential role of the circular economy in the context of mitigating GHG emissions in the EU. Other recently funded EU-projects look at demand side changes within the realm of resource efficiency and circular economy, including the climate benefits.

[36] C/2022/9264

4. Indicators

4.1.Structure of the framework

The monitoring framework consists of **11 indicators** (see Table 4.1) structured into the following **5 dimensions and aspects of the circular economy:** (1) production and consumption; (2) waste management; (3) secondary raw materials; (4) competitiveness and innovation; and (5) global sustainability and resilience. With this update, the monitoring framework better illustrates the role of the circular economy in: (i) achieving the circular-economy targets set out in the EU's 2030 agenda; (ii) promoting the UN's Sustainable Development Goals; and (iii) securing the supply of energy and materials.

The monitoring framework uses available data while also drawing attention to areas where new indicators are in the process of being developed, in particular for green public procurement and for food waste. All the indicators are published with the corresponding metadata explaining sources and methodologies[37].

Production and consumption

Monitoring the production and consumption phase is essential for understanding progress towards the circular economy. Progress in this sense is achieved by reducing the economy's **material consumption** by decreasing the consumption of materials and decoupling economic growth from resource use. **Green public procurement** accounts for a large share of public expenditure and can drive the circular economy. It also provides a useful indication of the extent to which public funds contribute to the circular economy. In a circular economy, **waste generation** is minimised. Discarding food has negative impacts on the environment, climate, health, social and economy. The indicator of **food-waste** generation measures an important waste stream with a significant environmental and climate impact.

Waste management

This dimension focuses on the share of waste which is recycled, as recycling is the method by which waste materials are returned to the economic cycle to continue creating value. One of the indicators in this dimension monitors **overall progress in the recycling of waste**, since increasing recycling is part of the transition to a circular economy. The most appropriate indicators to track overall targets are: **(i) the recycling of all waste excluding major mineral wastes; and (ii) the recycling of municipal waste**, which is subject to binding targets in EU legislation. **Recycling rates for specific waste streams** reflect the progress in recycling key waste streams. Policymakers are increasingly focused on specific waste streams that currently

[37] https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework.

present a significant challenge for the economy and the environment, such as **packaging waste (including plastic) and electrical and electronic waste**. Most of these specific waste streams are also linked to binding targets in EU legislation and to deliverables under the circular economy action plan.

Secondary raw materials

In a circular economy, secondary raw materials are widely used to make new products. To close 'loops' in the circular economy, materials and products must ultimately be reinjected into the economy. One of the most important indicators for the circular economy is the **contribution of recycled materials to raw-material demand**. This is the purpose of the indicators on both **circular material use rate (for the overall economy) and end-of-life recycling input rates** indicators (for specific important materials). Moreover, to ensure an increasing share of secondary raw materials in the economy, it is important to establish stable markets for these materials. Therefore, another indicator measures **trade in recyclable raw materials** between EU Member States and the rest of the world.

Competitiveness and innovation

A more circular economy increases the life-span of products by: (i) improved clean, safe and sustainable design for circularity; (ii) increasing reuse, reparability, durability, and upgradability; (iii) promoting innovative industrial processes (e.g. industrial symbiosis); and (iv) promoting innovative forms of consumption such as the collaborative economy. Two indicators are included under this dimension to monitor developments in this area. The first indicator reflects the contribution of the circular economy to the creation of **jobs, investment and gross value added**. The second indicator reflects **green innovation**, and therefore the development of innovative technologies related to the circular economy that help to boost the EU's global competitiveness. A third and final indicator under this dimension covers **patents** related to recycling and secondary raw materials as a proxy for innovation.

Global sustainability and resilience

This is a new dimension of the framework, introduced with this update. **Global sustainability** means that a more circular economy contributes to meeting both the EU's goals for climate neutrality and the UN's global Sustainable Development Goals. Global sustainability is measured by the EU's **consumption footprint** and the **contribution of the circular economy to climate neutrality.**

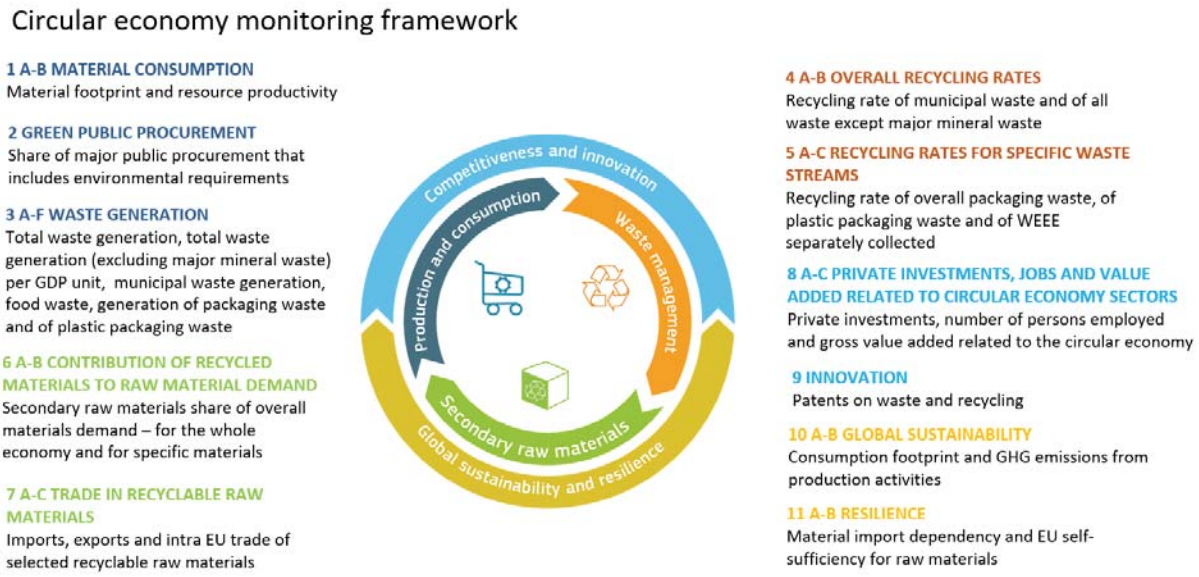
Resilience means that the EU will improve the security of its supply of both materials and energy by making its economy more circular. The indicator on **material dependency** illustrates the extent of the EU's dependence on imports of materials. In the longer term, the transition towards a circular economy may contribute to increasing the **EU's self-sufficiency in selected raw materials** for production in the EU.

4.2. Selection criteria

The framework consists of 11 indicators in total, and is based on existing official statistics from Eurostat and other official sources (the European Commission, including the Joint Research Centre and the European Patent Office). As the data already exist, the monitoring framework does not increase the administrative burden on Member States. The selected indicators have been evaluated against how they perform in terms of relevance, acceptability, credibility, easiness and robustness (also known as RACER).

The indicators on green public procurement are included even though statistical work is still ongoing and robust data will only be available in the coming years.

Figure 4.1. EU Monitoring framework for the circular economy - 11 indicators, 2023



4.3. Results of the stakeholder consultations

To help prepare this update, the Commission consulted Member States and stakeholders in 2021[38]. The Commission carefully assessed the comments it received in these consultations. Most stakeholders agreed with most of the proposed indicators. The consultations yielded many valuable technical comments on how to populate the indicators, measurement units, etc. These comments have helped to ensure a high degree of reliability and data comparison. A frequent concern expressed in the consultations was that there were many pieces of information and indicators on waste management, but fewer indicators covering the other phases of the circular-economy loop (such as production, consumption, reuse, and repair). Stakeholders were concerned that this could result in some important transformation trends and economic opportunities being overlooked. However, in the absence of available data or even methodologies to measure these aspects, it is necessary at present to work with other available information that may give some more indirect indications of performance.

The following table includes the final list of indicators and sub-indicators.

[38] The Commission consulted three Member State expert groups: the Working Group on Environmental Accounts, the Working Group on Resource Efficiency and SCP/IPP, and the Raw Materials Supply Group. The European Environmental Agency and the Eionet network were also consulted.

Table 4.1. Indicators in the monitoring framework for the circular economy

Indicator	Sub-indicators	2030 target or direction for improvement
Production and consumption		
1 Material consumption	1a Material footprint 1b Resource productivity	Reduce Increase – decoupling
2 Green public procurement		
3 Waste generation	3a Total waste generation per capita 3b Total waste generation (excluding major mineral waste) per GDP 3c Generation of municipal waste per capita 3d Food waste 3e Generation of packaging waste per capita 3f Generation of plastic packaging waste per capita	Significantly reduce total waste generation Halve the amount of residual (non-recycled) municipal waste Reduce (target proposal by 2023) Reduce by 5% compared to 2018 Reduce
Waste management		
4 Overall recycling rates	4a Recycling rate for municipal waste 4b Recycling rate for all waste excluding major mineral waste	60%
5 Recycling rates for specific waste streams	5a Recycling rate for overall packaging waste 5b Recycling rate for plastic packaging waste 5c Recycling rate for electrical and electronic equipment waste that is separately collected	70% 55%
Secondary raw materials		
6 Contribution of recycled materials to raw-material demand	6a Circular material-use rate 6b End-of-life recycling input rates	Double
7 Trade in recyclable raw materials	7a Imports from outside the EU 7b Exports to outside the EU 7c Intra-EU trade	
Competitiveness and innovation		
8 Private investments, jobs and gross value added*	8a Private investments 8b Employment 8c Gross value added	Increase

9 Innovation	9 Patents related to waste management and recycling	Increase
Global sustainability and resilience		
10 Global sustainability from circular economy	10a Consumption footprint 10b GHG emissions from production activities	Reduce to remain within the PB** Reduce
11 Resilience from circular economy	11a Material import dependency 11b EU self-sufficiency for raw materials	Decrease Increase

Notes: * in circular-economy sectors. ** PB: Planetary boundaries for all impact categories

4.4. Dissemination of the monitoring framework

The European Commission (Eurostat) disseminates the monitoring framework by a dedicated website for the circular economy[39]. This website also provides a brief introduction to the monitoring framework, background information, and relevant links.

The data for all the indicators and sub-indicators are reported together in a visualisation tool[40] to facilitate comparing the indicators for any Member State or the EU. This is the main data source for users, who can find all the information for the monitoring framework in a single place on the website. In addition, tables for each indicator and sub-indicator, as well as the corresponding explanatory metadata, are also available in the Eurostat online database. In some cases, tables with further breakdowns and alternative measurement units (e.g. percentages instead of absolute values, etc.) are also available.

[39] Overview - Circular economy - Eurostat (europa.eu).
[40] Monitoring framework - Circular economy - Eurostat (europa.eu).

5. Description of the indicators and trends observed

PRODUCTION AND CONSUMPTION

5.1. Material consumption

Material footprint

Relevance for the circular economy

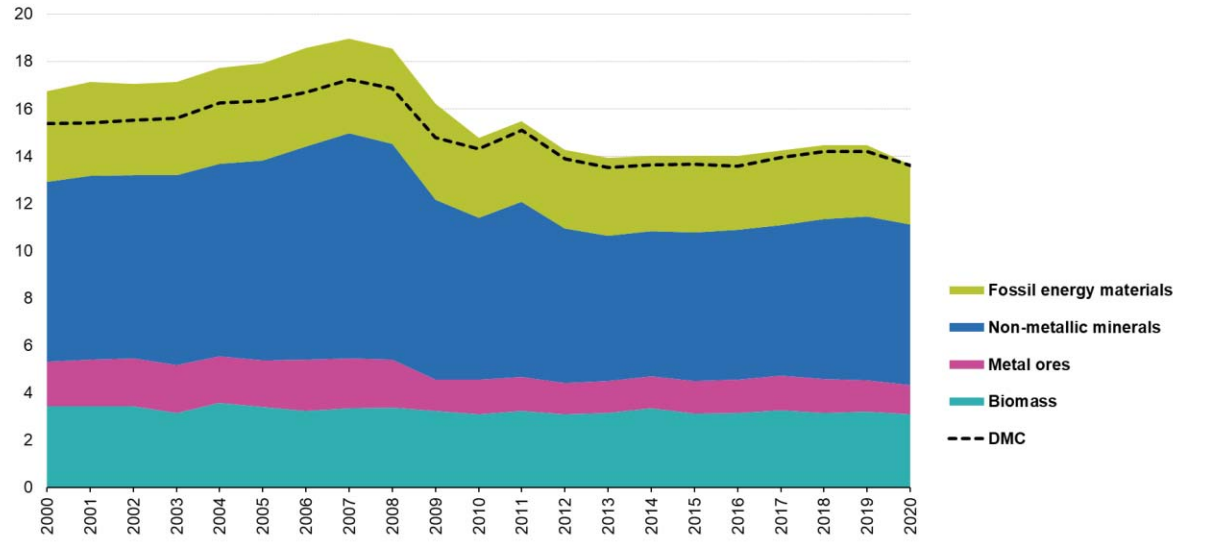
Global consumption of materials is expected to double in the next 40 years. Material footprints are therefore very relevant in the current policy context. The circular-economy action plan explicitly calls for metrics to measure material footprints. The rationale for this is that the EU has a greater share of the world's material consumption and investment than it does of the world's material production, as many goods consumed in the EU are produced outside Europe. Material-footprint metrics give visibility to the EU's responsibility for environmental pressures elsewhere in the world as a consequence of products exported to the EU.

This indicator on material footprint (raw-material consumption) is also included in the monitoring framework for the 8th environment action programme (8th EAP).

Facts and figures

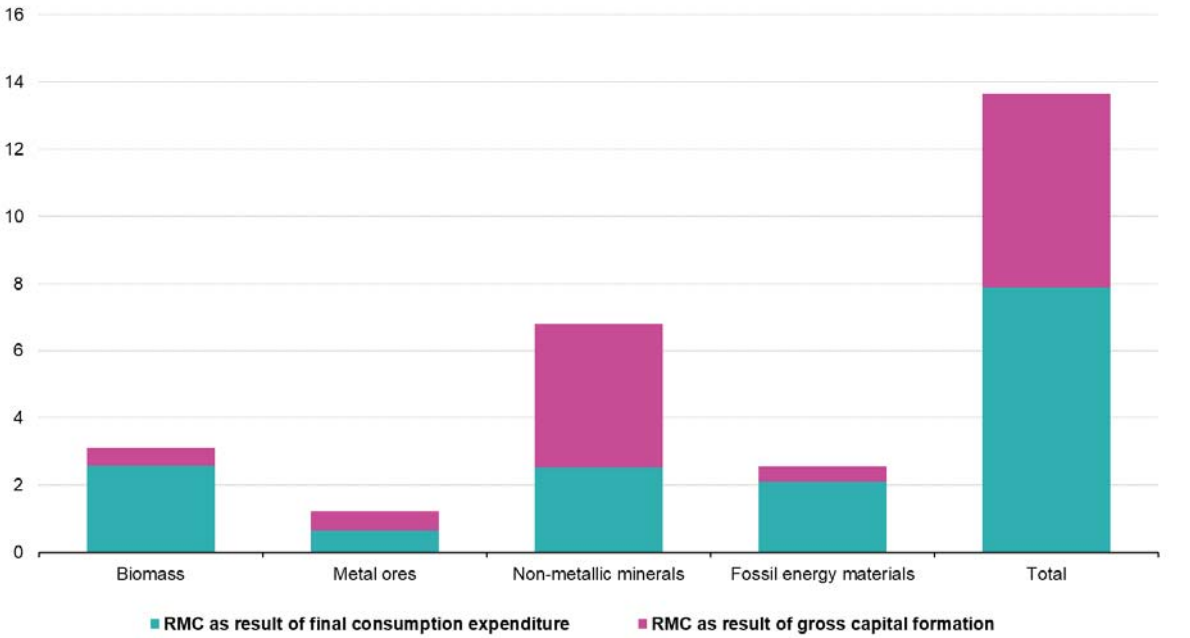
The EU's material footprint (measured as raw-material consumption) amounted to 13.7 tonnes per capita in 2020. This was a 2% decrease since 2014. Starting on year 2000, there is a long-term declining trend. The material footprint of non-metallic minerals is the main driver of the observed declining trend since 2010. This is driven by gross capital formation in the form of investments in construction. The domestic extraction of non-metallic minerals is mostly composed of construction minerals such as sand and gravel.

Figure 5.1.1 Material footprint by main material categories (tonnes per capita), EU, 2000-2020



Source: Eurostat (online data codes: env_ac_mfa, env_ac_rme)

Figure 5.1.2 EU material footprint as a result of final consumption expenditure and gross capital formation by type of materials (tonnes per capita), 2020



Source: Eurostat (online data codes: env_ac_rmefd)

Indicator description

- **Definition:** Raw-material consumption (RMC) is a measure of material footprints. It measures the amount of material in terms of raw-materials equivalent (RME) needed (or to put it another way, the amount of extractions, domestic and foreign, required

directly and indirectly) to produce the products consumed in the geographical reference area. It is calculated as raw-material input minus raw-material exports (RME). The indicator on RMC gives an insight into the quantity and type of materials required to meet the EU's demand for products, regardless of where they are produced.

- **Interpretation:** Material footprints quantify the worldwide demand for materials (biomass, metal ores, non-metallic minerals and fossil-energy materials/carriers) to produce goods and services for consumption or investment by households, governments and businesses in the EU.
- **Data source:** Environmental-economic accounts, material-flow accounts produced under Regulation (EU) No 691/2011. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.
  Material flow accounts in raw material equivalents - modelling estimates - Eurostat (europa.eu) (env_ac_rme).
  Material flow accounts in raw material equivalents by final uses of products - modelling estimates - Eurostat (europa.eu) (env_ac_rmefd).

Data are annual and available for the year 2000 onwards, but data for 2000-2007 is only available for the EU aggregate. Estimates for all Member States are available from 2008 onwards. The RME-based material-flow indicators are derived from data on domestic extraction of materials and trade flows in RME. Domestic extraction is recorded in the economy-wide material-flow accounts (EW-MFA) and represents the physical amount of materials extracted from the environment by a national economy.

References

- Material flow accounts statistics – material footprints – Statistics Explained (europa.eu)
- Material flow accounts and resource productivity – Statistics Explained (europa.eu)
- Material footprint - Eurostat (europa.eu) (cei_pc020)

Resource productivity

Relevance for the circular economy

Resource productivity measures the decoupling of economic growth from resource use. Improvements in material productivity – the efficiency of material use – help to reduce environmental pressures and impacts.

The term 'decoupling' refers to breaking the link between an environmental and an economic variable. As defined by the Organisation for Economic Cooperation and Development (OECD), decoupling occurs when the growth rate of an environmental pressure (for example, domestic material consumption or DMC) is less than that of its economic driving force (for example, GDP) over a given period. DMC measures the total amount of materials directly used by an economy. DMC is defined as the annual quantity of raw materials extracted from the domestic territory of the local economy, plus all physical imports minus all physical exports. It is important to note that the term 'consumption', as used in DMC, denotes apparent consumption and not final consumption, i.e. DMC does not include upstream flows related to imports and exports of raw materials and products originating outside of the local economy. Those are measured with the material footprint.

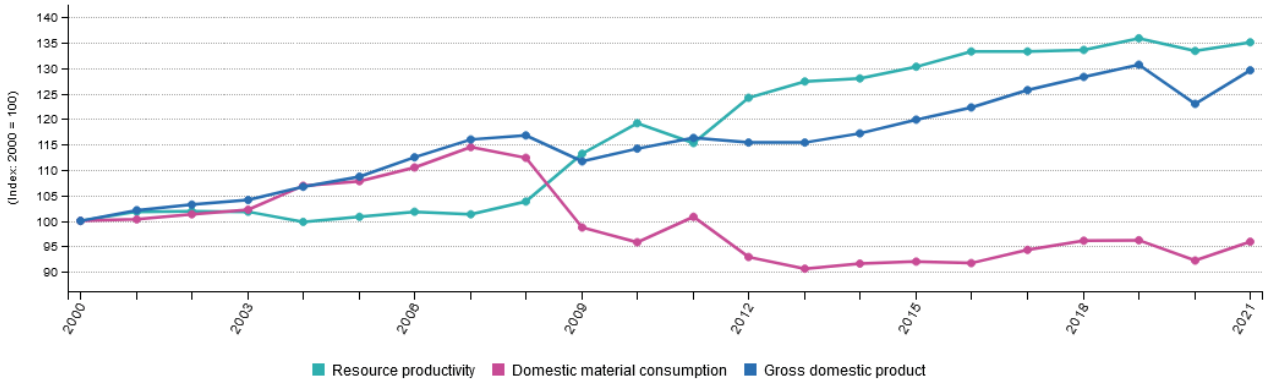
Decoupling can be either absolute or relative. Absolute decoupling is said to occur when the environmental variable is stable or decreases while the economic driving force grows. Decoupling is said to be relative when the rate of change of the environmental variable is less than the rate of change of the economic variable.

Facts and figures

Since 2000, the resource productivity of the EU economy increased by around 35%. This increase happened mainly since the global crisis in 2007-2008, as resource productivity was rather stable in the years before the crisis. The COVID-19 recession caused a moderate decrease in resource productivity in 2020, but it increased again in 2021.

An analysis of the resource-productivity components, namely GDP and DMC, helps to explain these developments. Before 2007-2008, GDP and DMC had been growing almost in parallel. Between 2008 and 2016, the two components decoupled, i.e. developed in opposite directions. Since 2016, both components seemed to re-couple again, i.e. they have shown similar patterns of annual change since then.

Figure 5.1.3 EU Resource productivity in comparison with GDP and DMC, EU, 2000-2021 (2000 = 100)



Note: GDP in chain-linked volumes, reference year 2015

Source datasets: env_ac_rp (resource productivity), env_ac_mfa (DMC) and nama_10_gdp (GDP)

Indicator description

- **Definition:** Resource productivity is defined as GDP divided by DMC.
- **Interpretation:** Resource productivity is a measure of the total gross value added in an economy (measured by the GDP) in relation to the amount of materials directly used by an economy (measured as DMC). It measures whether decoupling between the use of natural resources and economic growth is taking place and provides insights into the reasons for this decoupling.
- **Data source:** Environmental-economic accounts, material-flow accounts; national accounts. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.

  Resource productivity – Eurostat (europa.eu) (env_ac_rp). Based in the data sets:
  Material flow accounts – Eurostat (europa.eu) (env_ac_mfa)
  GDP and main components (output, expenditure and income) – Eurostat (europa.eu) (nama_10_gdp)

References

Material-flow accounts and resource productivity – Statistics Explained (europa.eu).
Eurostat monitoring report on progress towards the SDGs in a European context – 2021 edition
Resource productivity – Eurostat (europa.eu) (cei_pc030)

5.2. Green public procurement

Relevance for the circular economy

Public procurement accounts for a large proportion of European consumption. If circularity requirements (reparability, durability, recyclability, etc.) are systematically included in public contracts, public procurement can boost the circular economy and green innovation[41].

The indicator is also relevant for Sustainable Development Goal 12.7: 'Promote sustainable public-procurement practices, according to national policies and priorities'.

Facts and figures

The indicator is under development.

Data will be collected for the first time with a new version of the public-procurement standard forms[42], which is currently under preparation. This new version will mean that it would be mandatory to answer a question on green public procurement in all public-procurement procedures in the EU above the procurement thresholds[43], of which there are around 150 000 procurement procedures a year. The data are expected to become available in 2024.

Indicator description

- **Definition:** The share of public-procurement procedures above the EU thresholds (in number and value) that include environmental criteria. In the forms to be completed for all tenders above the EU value thresholds, public authorities could tick 'yes' or 'no' to say if in the tender documents, a 'technical specification, award criterion, or contract performance condition aims at reducing the environmental impact of the procurement'[44].
- **Interpretation:** Identifying product groups and Member States with less uptake of green public procurement gives new information and makes it possible to initiate more targeted actions. It is likely that the criterion of 'aiming to reduce environmental impact' will be interpreted differently by different authorities. This stems also from the fact that 'reducing environmental impact', and the underlying concept of 'green public procurement' is a complex, multi-faceted issue where finding a perfectly accurate legal

[41] http://ec.europa.eu/environment/gpp/index_en.htm. Improving public procurement can yield big savings: even a 1% energy-efficiency gain could save EUR 20 billion per year.
[42] The current standard forms are available on: http://simap.ted.europa.eu/en/web/simap/standard-forms-for-public-procurement.
[43] It is mandatory to open the procurement to all EU companies if the amount for public procurement is above the thresholds available on: https://ec.europa.eu/growth/single-market/public-procurement/rules-implementation/thresholds_en.
[44] The new standard form should be approved as an implementing regulation by the Advisory Committee on Public Procurement.

or environmental definition may not be possible. The results might generate an overly positive picture of the use of green public procurement and in particular for the value of green tenders. The most valuable contracts are often in construction, where almost every public authority is likely to take some environmental element into account. The indicator is therefore a proxy showing trends in a significant proportion of the demand side. In addition, not all the criteria will necessarily relate to the circular economy.

- **Data source:** European Commission.

References

- Green Public Procurement – Environment – European Commission (europa.eu)

5.3. Waste generation

Total waste generation per capita

Relevance for the circular economy

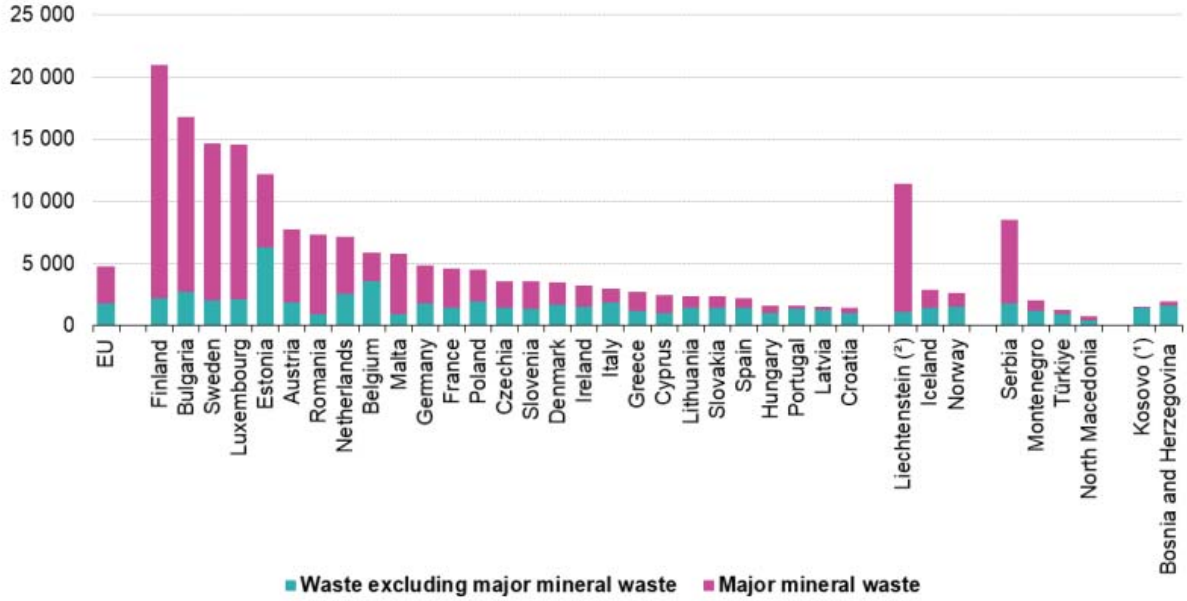
Minimising the generation of waste is a key part of the circular-economy action plan. In the circular-economy action plan, waste is considered as a resource. Waste management plays a central role in the circular economy. This indicator is also part of the monitoring framework for the 8th environment action programme.

EU waste-management policies aim to both reduce the environmental and health impacts of waste and improve the EU's resource efficiency. The long-term aim of these policies is to reduce the amount of waste generated and, when waste generation is unavoidable, to promote it as a resource and achieve higher levels of recycling and the safe disposal of waste.

Facts and figures

In 2020, the total waste generated in the EU by all economic activities and households amounted to 2 151 million tonnes, i.e. **4.8 tonnes of waste were generated per EU inhabitant in 2020. Overall, waste generation decreased by almost 3%** between 2010 and 2020. Almost two thirds of the total waste generated in the EU in 2020 was major mineral waste. Major mineral waste is closely linked to mining, quarrying activities, construction and demolition, which are important sectors in some Member States. In the EU, construction generated 37.5% of total waste in 2020. This was followed by mining and quarrying (23.4%), manufacturing (10.7%), waste and water services (10.8%), and households (9.4%).

Figure 5.3.1 EU waste generation (kg per capita), 2020



Note: sorted on total waste generated.

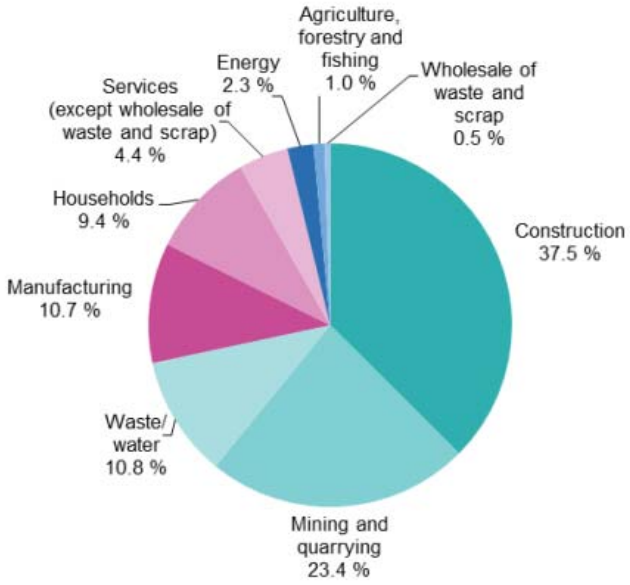
(¹) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo Declaration of Independence.

(²) 2018 data

Source: Eurostat (online data code: env_wasgen)

eurostat

Figure 5.3.2 EU waste generation by economic activity of producers and households, 2020 (% share of total waste per capita)



Source: Eurostat (online data code: env_wasgen)

eurostat

Indicator description

- **Definition:** The indicator is defined as total waste generated in a country including major mineral wastes (all NACE activities plus households), divided by the average population of the country. Waste, defined by Directive 2008/98/EC Article 3(1) of the Waste Framework Directive (Directive 2008/98/EC) as 'any substance or object which the holder discards or intends or is required to discard', potentially represents an enormous loss of resources in the form of both materials and energy. This indicator includes major mineral wastes for all NACE activities plus households.
- **Interpretation:** The indicator is commonly used in the context of monitoring waste generation at Member State level. It measures the effectiveness of waste-prevention measures. The indicator uses solid data and makes it possible to compare Member States' performance over time.
- **Data source:** Waste statistics based on Regulation (EC) No 2150/2002 of the European Parliament and of the Council. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.
  Generation of waste by waste category, hazardousness and NACE Rev. 2 activity - Eurostat (europa.eu) (env_wasgen).

References

Eurostat dedicated section on Waste – Eurostat (europa.eu)
Waste statistics – Statistics Explained (europa.eu)
Total waste generation per capita – Eurostat (europa.eu) (cei_pc034)

Total waste generation (excluding major mineral waste) per GDP

Relevance for the circular economy

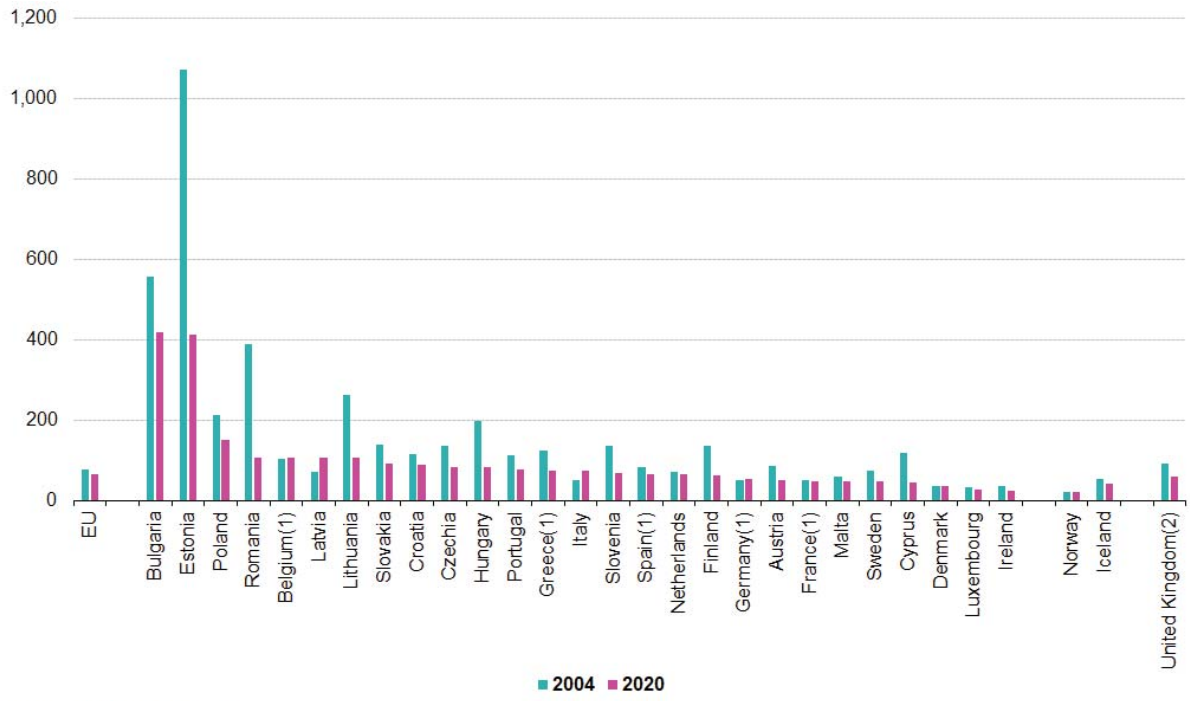
In the circular economy, waste generation is decoupled from GDP growth. This means that the generation of waste grows less rapidly than GDP (relative decoupling) or that the generation of waste actually decreases even when the economy is growing (absolute decoupling). Comparing waste generated to GDP allows us to measure the waste intensity of the economy and provides a measure of 'eco-efficiency'.

The indicator on overall waste generation excludes major mineral waste. This is because, on average, waste from construction/demolition and mining activities in the EU accounts for almost two thirds of total waste generated and is thus responsible for changes in total waste generation. Because those economic activities vary greatly in their significance across different Member State economies, excluding major mineral wastes gives a more accurate reflection of general trends than the total waste figure, thus improving comparability across countries.

Facts and figures

In the EU, 775 million tonnes of waste excluding major mineral waste were generated in 2020, equivalent to 36% of the total waste generated. When expressed per GDP, the EU generated, on average, 65 kilograms of waste per thousand euro of GDP in 2020. There are large differences between countries however, ranging from 26 kg of waste produced per thousand euro of GDP in Luxembourg to 418 kg of waste produced per thousand euro of GDP in Bulgaria.

Figure 5.3.3. Total waste generation (excluding major mineral waste) per GDP (kg per thousand EUR), EU, 2004 and 2020



Note: Sorted on 2020 data
(1) 2020: Provisional
(2) 2018 data
Source: Eurostat (online data code: env_wasgen, nama_10_gdp)

eurostat

Indicator description

- **Definition:** This indicator is defined as all waste generated in a country, excluding major mineral waste[45], per GDP. Excluding major mineral waste improves comparability across countries because some countries produce very large amounts of mineral waste due to both the nature of the country's economy and the relative prevalence of mining and construction in that economy.
- **Interpretation:** The large variation in the indicator may also be due to a number of factors. The three bullet points below discuss some of these factors.
    - Differences in waste classification by Member States may result in partial non-comparability, e.g. the high value for Estonia is the result of including waste from energy production.
    - Differences in purchasing power are not fully reflected in exchange rates, thus undermining comparability across Member States.

[45] Major mineral waste is excluded from this indicator. Major mineral waste refers to the following waste categories: Mineral waste from construction and demolition (European waste clasification for statistics, code 12.1),); other mineral wastes (12.2,12.3, 12.5),); soils (12.6)); and dredging spoils (12.7).

- Different structures in national economies affect the relative prevalence of materials-intensive sectors in those economies. Some Member States specialise in these materials-intensive sectors, while other Member States specialise in high-value services (e.g. finance or IT).

- **Data source:** Waste statistics based on Regulation (EC) No 2150/2002 of the European Parliament and of the Council. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.
  Generation of waste by waste category, hazardousness and NACE Rev. 2 activity - Eurostat (europa.eu) (en_wasgen)
  GDP and main components (output, expenditure and income) - Eurostat (europa.eu) (nama_10_gdp)

References

Eurostat dedicated section on waste – Eurostat (europa.eu)
Waste statistics – Statistics Explained (europa.eu)
Generation of waste excluding major mineral wastes per GDP unit – Eurostat (europa.eu) (cei_pc032)

Generation of municipal waste per capita

Relevance for the circular economy

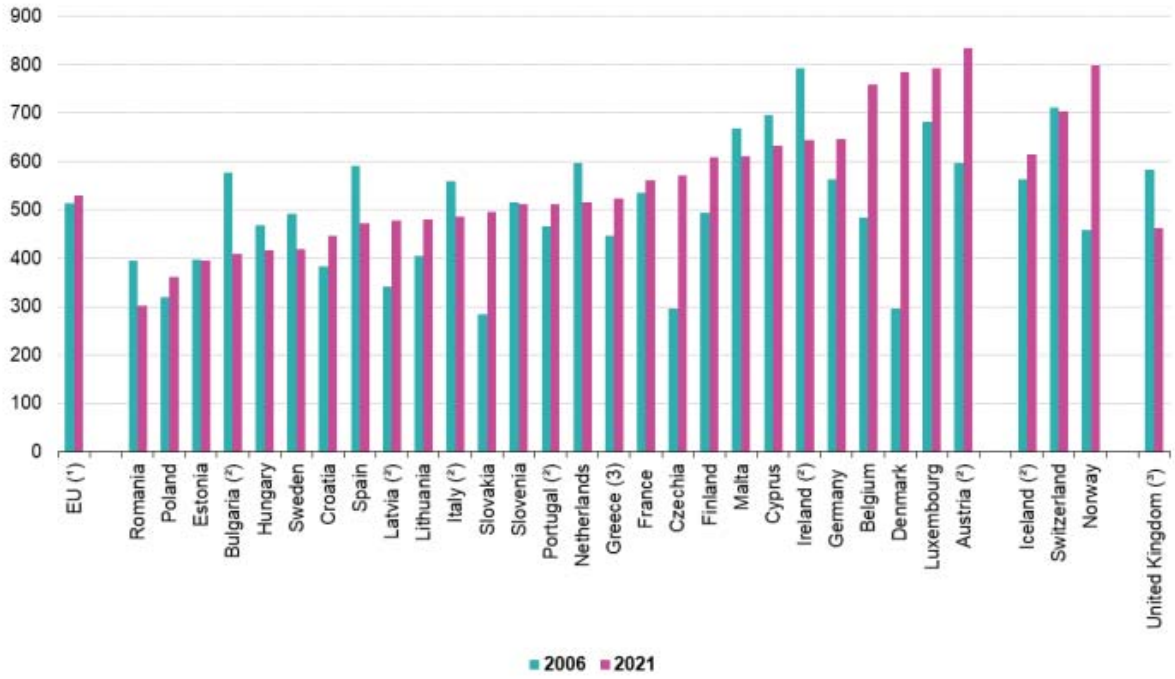
This is an indicator of municipal waste. Municipal waste is only approximately 10% of the total waste generated in the EU (measured by weight) or about 30% of the total amount of waste generated excluding major mineral waste. Nevertheless, changes in the amount of municipal waste generated per capita give a good indication of: (i) changing consumption patterns; (ii) Member States' performance in preventing waste; and (iii) the areas in which action and involvement by the general public is most relevant.

Facts and figures

EU municipal-waste[46] generation increased to **530 kg of municipal waste per capita in 2021** from 503 kg per capita in 2010. The Waste Framework Directive lays down measures to protect the environment and human health based on the waste hierarchy[47]. These measures include provisions and recommended measures to prevent or reduce the generation of waste. There is wide variation between Member States' generation of municipal waste per capita, with some Member States producing only 302 kg of waste per capita per year, while others produce 834 kg per capita per year[48]. There have also been mixed trends in Member States, and not all Member States saw declines in their generation of municipal waste in this period. In fact, some Member States saw an increase in municipal-waste generation per capita of more than 30%.

Figure 5.3.4 Generation of municipal waste per capita (kg per capita), 2006 and 2021

[46] Waste from households and in public spaces and similar waste from other sources.
[47] The Waste Framework Directive establishes in its Article 4 a priority order in waste prevention and management legislation and policy: (a) prevention; (b) preparing for re-use; (c) recycling; (d) other recovery, e.g. energy recovery; and (e) disposal.
[48] Differences in the way Member States measure waste generation can explain some of these differences.



Note: Countries are ranked in increasing order by municipal waste generation in 2020.
(1) Estimated.
(2) Bulgaria, Latvia, Italy, Portugal, Ireland, Austria, Iceland 2020 data.
(3) Greece 2019 data.
(4) United Kingdom 2018 data
Source: Eurostat (online data code: env_wasmun)

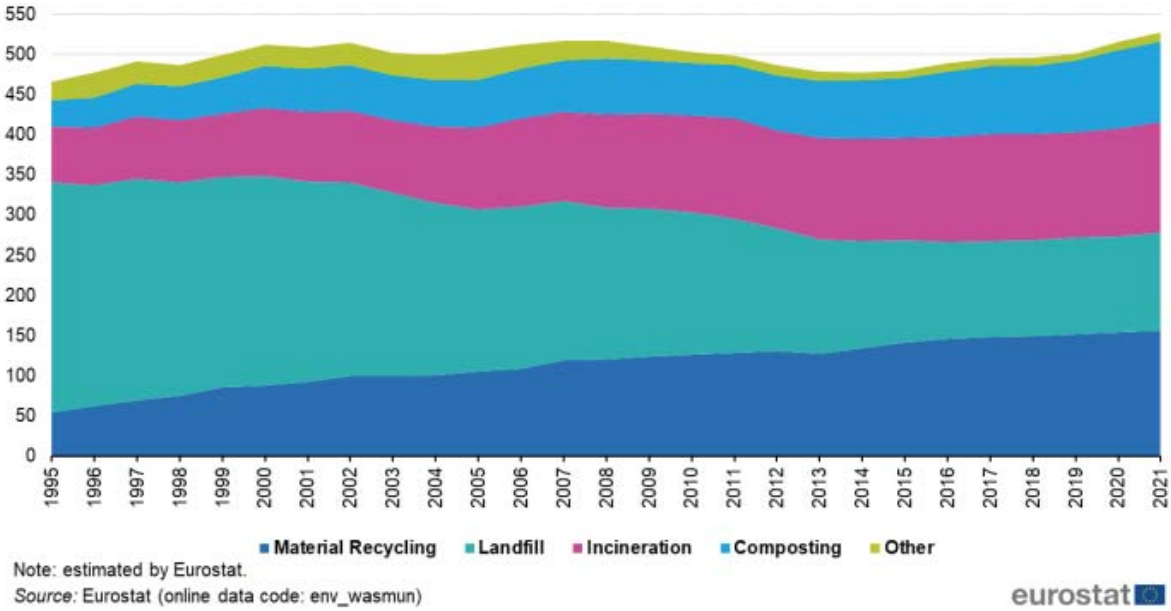
eurostat

In 2021, total municipal-waste generation varied considerably across Member States, ranging from 302 kg per capita in Romania to 793 kg per capita in Luxembourg. The values reflect differences in consumption patterns and economic wealth, but they also depend on how municipal waste is collected and managed. This is because Member States may report differently on waste from commerce, trade and administration, which in some Member States is managed – and therefore reported – together with waste from households.

Starting in 2004, methodologies were improved in most Member States which made the time series more accurate and stable than the previous time series for the period 1995-2003.

Figure 5.3.5 shows the amount of waste generated at EU level and the composition of this waste by treatment category (landfill, incineration, recycling, composting). During the period 1995-2021 the EU recycling rate for municipal waste increased continuously, reaching 49% of the total treated (equivalent to 263 kg per capita recycled) by 2021. Since 2014, the EU recycling rate of municipal waste has been higher than both the landfill rate and the incineration rates.

Figure 5.3.5 Municipal waste in the EU, by treatment category (kg per capita), 1995-2021



Indicator description

- **Definition:** The amount of municipal waste generated consists of waste collected by – or on behalf of – municipal authorities and disposed of through the waste-management system. It consists to a large extent of waste generated by households, although it can also include similar wastes from sources such as businesses, offices and public institutions. The scope of data collection on similar waste streams may vary from municipality to municipality and among Member States, depending on the local waste-management system. The overall amount of municipal waste generated is then divided by the population.
- **Interpretation:** Reducing municipal-waste generation is an indication of the effectiveness of waste-prevention measures and changing patterns of consumption. Concentrating on municipal waste rather than on industrial waste has the advantage that it reflects the consumption side and is not affected by the presence or lack of large manufacturing sectors in a country.
  The indicator is based on solid data and is available in time series. The population is factored in to enable comparability among Member States. However, different interpretations of the definition of municipal waste currently limit to some extent comparability among countries. The most important information is therefore given through the time series.
- **Data source:** Waste statistics based on Regulation (EC) No 2150/2002 of the European Parliament and of the Council. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.
  Municipal waste by waste management operations – Eurostat (europa.eu) (env_wasmun)

References

- Municipal waste statistics – Statistics Explained (europa.eu)

- Generation of municipal waste per capita – Eurostat (europa.eu) (cei_pc031)

Food waste

Relevance for the circular economy

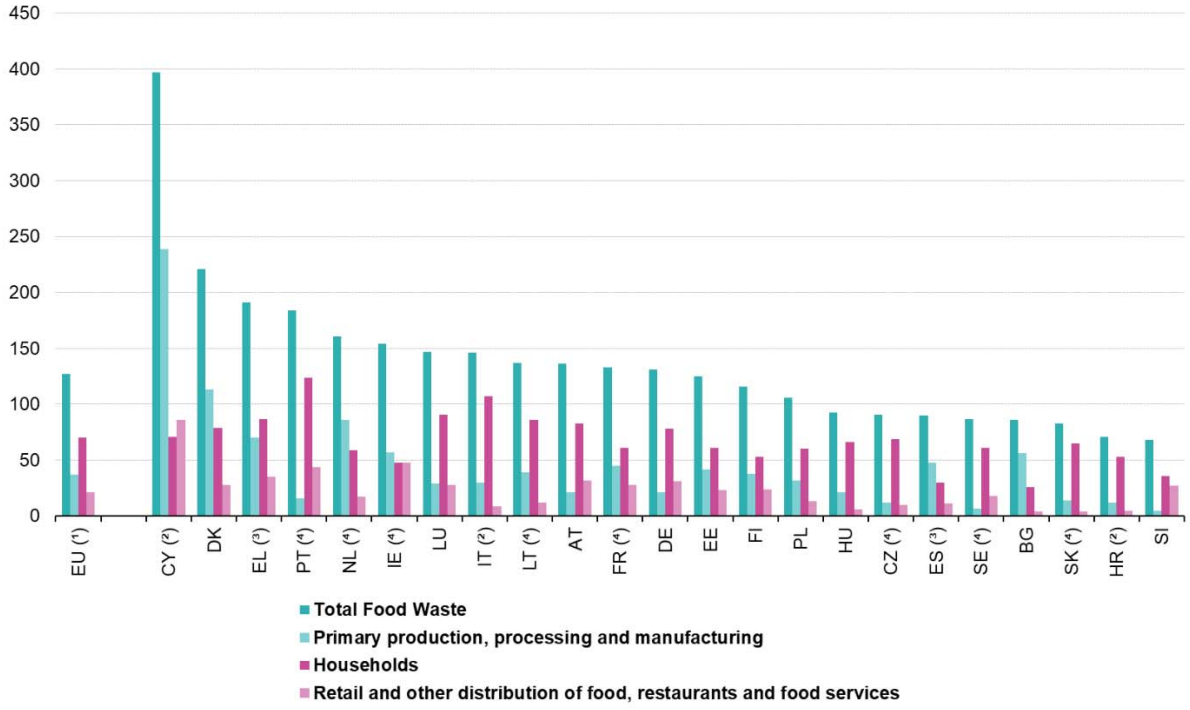
Producing food for everyone is obviously essential, but unnecessary food production depletes our natural resources and generates greenhouse-gas emissions. Reducing **food waste**[49] has enormous potential to save the resources we use to produce the food we eat. Under the EU's 'farm to fork' strategy, the Commission will propose legally binding targets to reduce food waste[50]. These targets will create a more sustainable food system by: (i) helping to limit the impact of the food supply chain on the environment and climate; and (ii) ensuring more food is available for human consumption. It is very difficult to measure food waste as it occurs all along the value chain: during production and distribution, and in shops, restaurants, catering facilities, and homes.

Facts and figures

This indicator is under development. According to Eurostat's estimates based on provisional 2020 data from food-waste reporting obligations, the **EU generated 59 million tonnes of food waste** in 2020, equivalent to 131 kg per capita.

[49] https://ec.europa.eu/food/safety/food_waste/eu_actions_en.
[50] The food -waste reduction target will be part of the revision of the Waste Framework Directive. The of adoption of the legislative proposal is planned for Q2 2023.

Figure 5.3.6 Food-waste amounts, by groups of economic activities (kilograms per capita), 2020



Note: Countries are ranked based on the total amount of food waste per capita in year 2020.
(1) Eurostat estimate.
(2) Definition differs in some figures.
(3) Definition differs or estimates in some figures

eurostat

Indicator description

- **Definition:** The amount of food waste generated per year. Starting in the reference year 2020, the indicator has been computed according to the methodology and minimum quality requirements for the uniform measurement of food waste set out in Commission Delegated Decision (EU) 2019/1597. This means that food waste will be measured as fresh mass all along the food value chain, including: (i) production; (ii) processing and manufacturemanufactureing,; (iii) retail and distribution; (iv) restaurants and food services; and (v) households.
  The Waste Framework Directive obliges Member States to report annually on food-waste generation as of the reference year 2020. Commission Delegated Decision (EU) 2019/1597 provides a set of rules to define food waste so that it can be better measured. These definitions exclude food losses and food by-products from the definition of food waste. These definitions are derived from – and are consistent with – the definition of food according to the General Food Law and the definition of waste according to the

Waste Framework Directive. Commission Implementing Decision (EU) 2019/2000 lays down a format for reporting data on food waste.

- **Interpretation:** Food-waste monitoring is currently hampered by a lack of time-series data, since the reporting obligations and methodology have just entered into force for the reference year 2020. The indicator differentiates between food waste generated at different steps in the food value chain: (i) primary production sectors (agriculture, fisheries); (ii) food processing; (iii) retail; (iv) restaurants and hospitality; (v) and households. The greatest proportion of food waste is generated by households, where most food is consumed, followed by restaurants and hospitality services.. The definition of food waste in the Waste Framework Directive and Commission Delegated Decision (EU) 2019/1597 excludes food losses in primary production from the definition of food waste, which reduces comparability with previous studies and UN initiatives.

  With data available only one reference year (2020), the implementation of the methodology has only just begun. Even though the data seem robust at present, there are aspects of the methodology to be improved in the years to come to ensure better comparability between countries. Time series are not present and cannot therefore be analysed. The data are measured and presented in kg per capita, and would benefit from further refining the level of detail to make it possible to consider food-waste generation by resident and non-resident population.

- **Data source:** Reporting obligations of the Member States set in Commission Delegated Decision (EU) 2019/1597, for data starting from reference year 2020 (collection started in June 2022). References
  - Food waste and food-waste prevention – estimates
  - Commission Delegated Decision (EU) 2019/1597
  - Commission Implementing Decision (EU) 2019/2000

Generation of packaging waste per capita

Relevance for the circular economy

The 2020 circular-economy action plan announced an objective to reduce packaging, over-packaging and packaging waste, including by setting targets and other waste-prevention measures.

Waste management plays a central role in the circular economy. Packaging waste is a waste stream which is affected by both consumer behaviour and producers' own patterns of production and distribution.

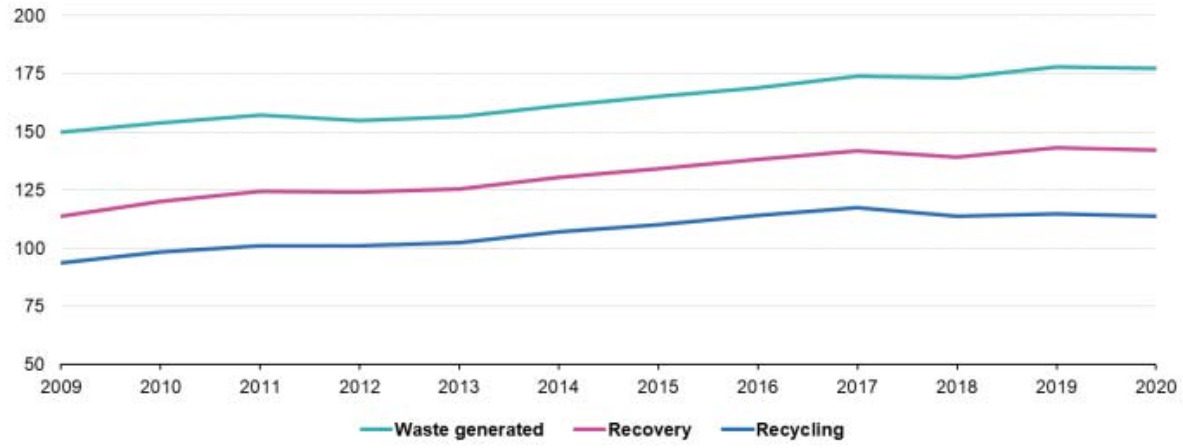
In 2022 the Commission adopted a proposal[51] to prevent waste packaging generation, which includes a target of reducing packaging waste by 5% by 2030 compared to 2018.

Facts and figures

Between 2009 and 2020, the generation of EU packaging waste **increased by 21%** to 178 kg per capita. It increased in all Member States except Greece, Croatia and Sweden. Packaging waste per capita varies considerably among countries, with Croatia generating only 66 kg per capita per year, while Germany and Ireland generate respectively 226 and 225 kg per capita per year. 19% of all EU packaging waste is made up of plastics.

Figure 5.3.7 Packaging waste generated, recovered and recycled (kg per capita), EU, 2009-2020

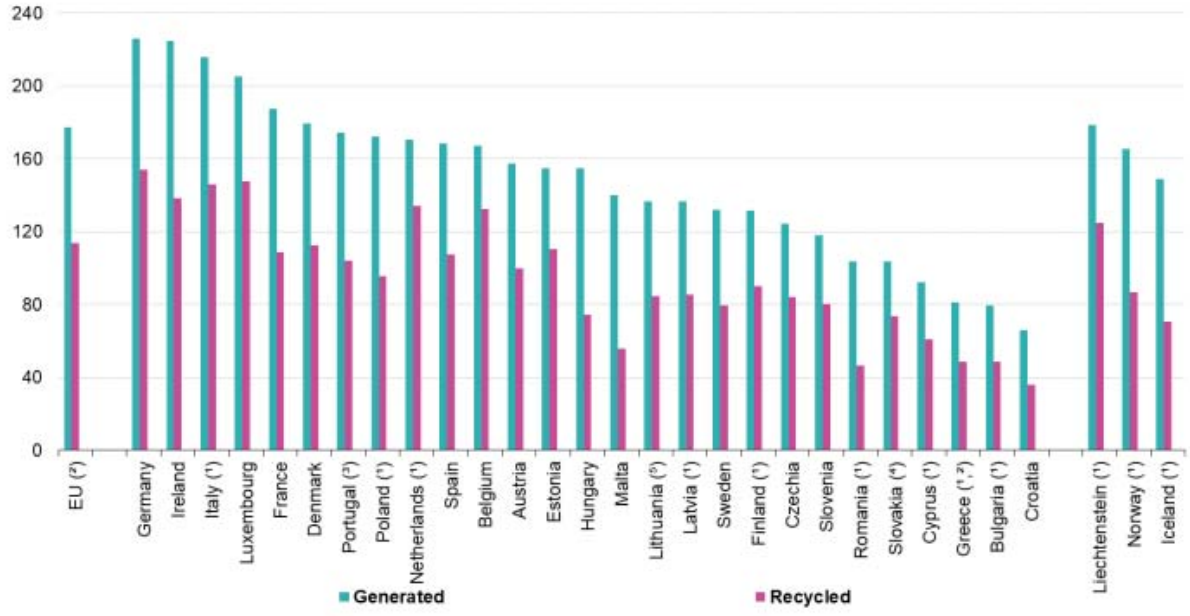
[51] COM (2022) 677: Proposal for a Regulation of the European Parliament and of the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC



Note: Eurostat estimates between 2009 and 2011, 2020. The y-axis is cut.
Source: Eurostat (online data code: env_waspac)

eurostat

Figure 5.3.8 Packaging waste generated and recycled (kg per capita), 2020



Note: Countries are ranked based on 'Waste generated'.
(1) 2019 instead of 2020 data.
(2) Estimated data.
(3) Provisional data.
(4) Definition differs.
(5) Break in series.
Source: Eurostat (online data code: env_waspac)

eurostat

Indicator description

- **Definition:** 'Packaging' in this context means all products made up of any materials of any nature to be used for the containment, protection, handling, delivery and

presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable' items used for the same purposes also constitute packaging. 'Packaging waste' means any packaging or packaging material covered by the definition of waste in the Waste Framework Directive[52], excluding production residues.

- **Interpretation**: One of the central pillars of a circular economy is avoiding waste. Packaging waste is a significant waste stream. Much packaging is made of plastic and thus creates waste that is harder to recycle and potentially more hazardous for the environment and human health.
- **Data source:** Reporting obligations of the Member States laid down in the Waste Framework Directive. Data provider: European Commission.
  Packaging waste by waste management operations – Eurostat (europa.eu) (env_waspac)

References

- Eurostat dedicated section on Waste – Eurostat (europa.eu)
- Packaging waste statistics – Statistics Explained (europa.eu)
- Generation of packaging waste per capita – Products Datasets – Eurostat (europa.eu) (cei_pc040)

[52] Article 3(1): 'waste' means any substance or object which the holder discards or intends – or is required to – discard.

Generation of plastic packaging waste per capita

Relevance for the circular economy

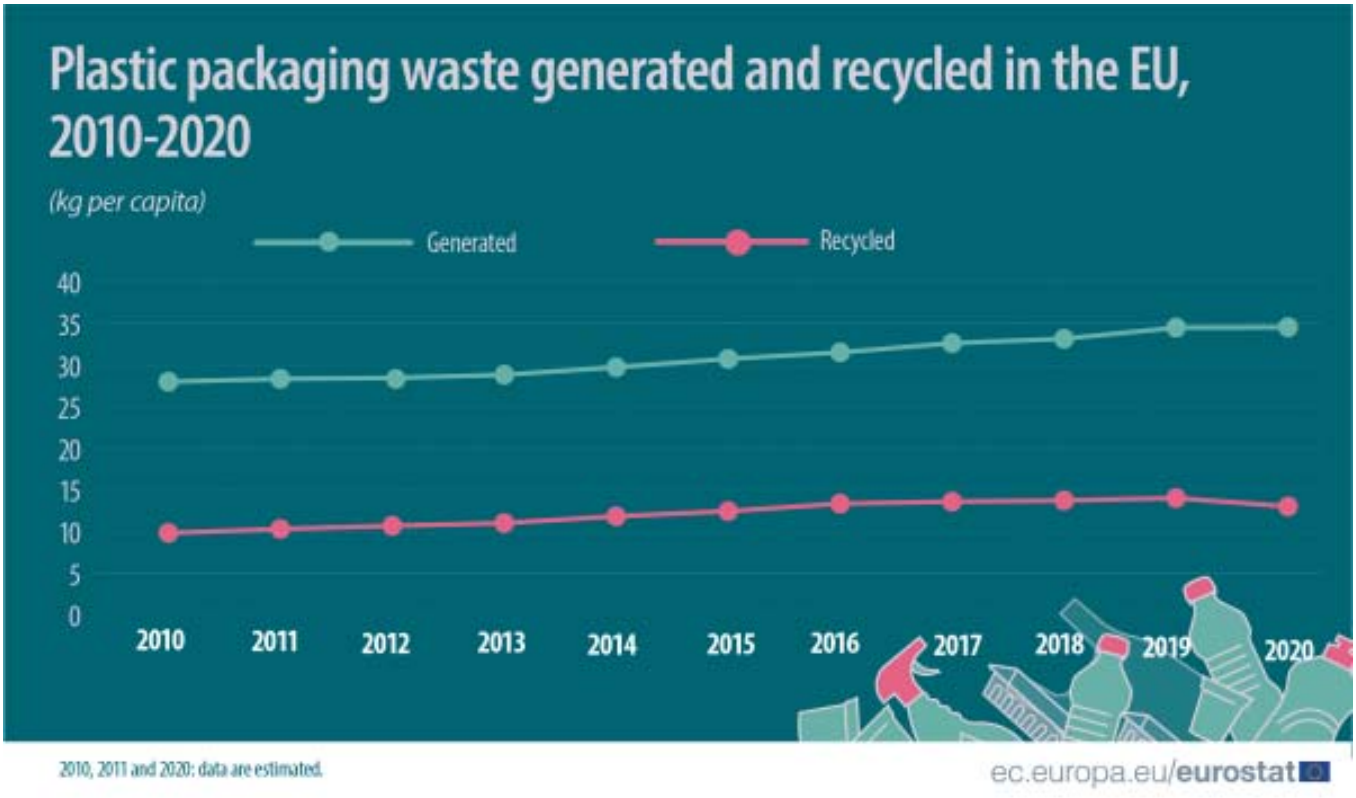
The 2020 circular-economy action plan announced an objective to reduce packaging, over-packaging, and packaging waste, including by setting targets and other waste-prevention measures.

One of the central pillars of a circular economy is feeding material back into the economy and avoiding waste being sent to landfill or incinerated. This captures as much of the value of materials as possible and reduces the loss of any residual value in waste materials.

Facts and figures

On average, **each European produced 35 kg of plastic packaging waste in 2020.** The generation of plastic packaging waste increased by **25% between 2010 and 2020,** the greatest increase in all packaging-waste streams.

Figure 5.3.9 EU plastic packaging waste generated and recycled, 2010-2020 (kg per capita)



Source: Eurostat (env_waspac)

Indicator description

- **Definition:** Packaging is defined as any material that is used to contain, protect, handle, deliver or present goods. Packaging waste can arise from a wide range of sources including supermarkets, other retail outlets, manufacturing industries, households, hotels, hospitals/healthcare industries, restaurants, and transport companies. Items like glass bottles, plastic containers, aluminium cans, food wrappers, timber pallets, and drums are all classified as packaging. The main packaging materials are glass, paper, cardboard, plastics, metals (aluminium and steel) and wood. This indicator only includes plastic packaging.
- **Interpretation**: One of the central pillars of a circular economy is avoiding waste. Packaging waste is a significant waste stream. Much packaging is made of plastic and thus creates waste that is harder to recycle and potentially more hazardous for the environment and human health.
- **Data source:** Reporting obligations of the Member States laid down in the Waste Framework Directive. Data provider: European Commission.
  Packaging waste by waste management operations – Eurostat (europa.eu) (env_waspac).

References

- Eurostat dedicated section on waste – Eurostat (europa.eu)
- Packaging waste statistics – Statistics Explained (europa.eu)
- Generation of plastic packaging waste per capita – Products Datasets – Eurostat (europa.eu) (cei_pc050)

5.4. Overall recycling rates

Recycling rate of municipal waste

Relevance for the circular economy

The recycling of municipal waste indicates how waste from final consumers is used as a resource in the circular economy. Municipal waste reflects mainly waste generated by final consumers, as it includes waste from households and waste from other sources that is similar in nature and composition to household waste. Municipal waste accounts for around 10% of total waste generated in the EU by weight (or 30% of total waste when excluding major mineral waste). Because of its diverse composition, good management of municipal waste is challenging. The recycling rate of municipal waste provides a good indication of the quality of the overall waste-management system.

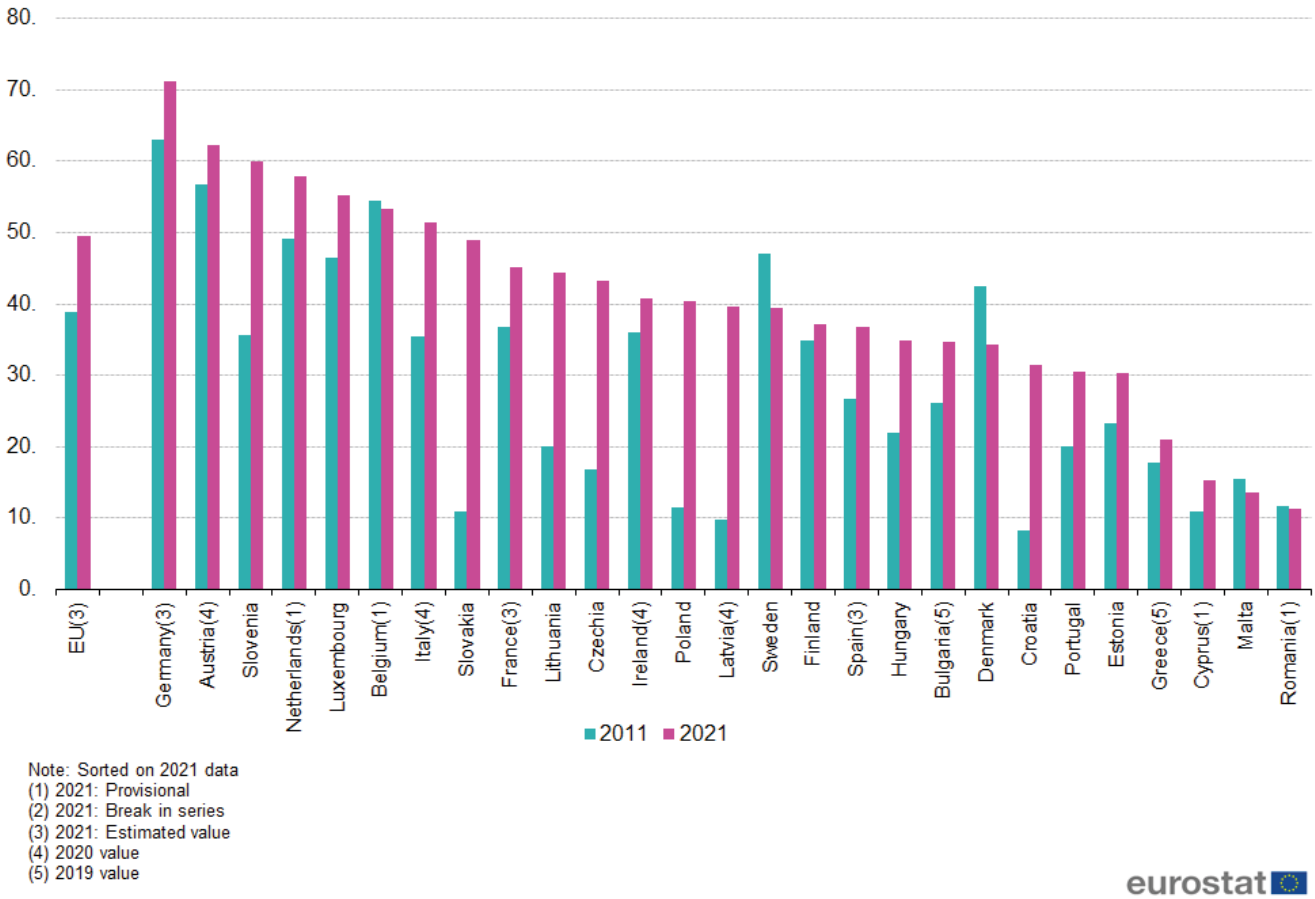
This indicator supports the monitoring of progress towards the 50% recycling target for 2020, and the 65% recycling target for 2035 set in the Waste Framework Directive.

Facts and figures

EU **recycling rates for municipal waste increased from 39% to 49% between 2011 and 2021**. Seven Member States recycle more than half of their municipal waste, and some are approaching the 2030 recycling target of 60%[53]. In fact, Germany has already met the 2035 target of recycling 65% of its municipal waste. However four Member States lag behind with a share below 25%.

[53] COM(2015) 595 final.

Figure 5.4.1 Recycling rate of municipal waste, 2011 and 2021



Indicator description

- **Definition:** The recycling rate is the share of recycled municipal waste out of the total amount of municipal waste generated. For areas not covered by a municipal-waste collection scheme, the amount of waste generated is estimated.
- **Interpretation:** The recycling rates have a straightforward interpretation. However, comparability across countries is hindered because countries measure the recycled quantities in different ways (for instance before or after sorting of collected waste), which has implications for accuracy and comparability. This issue is addressed in Article 11(a)(1)(c) of the Waste Framework Directive. For the calculation of recycled waste, the data cover the amount of waste entering the recycling operation in which waste materials are actually reprocessed into products, materials or substances.
- **Data source:** Municipal waste statistics. Data provider: Statistical Office of the European Union (Eurostat) based on data reported by the countries.

Municipal waste by waste management operations – Eurostat (europa.eu) (env_wasmun)

References

- Directive 94/62/EC of 20 December 1994 (consolidated version)
- Commission Implementing Decision (EU) 2019/1004 of 7 June 2019
- Recycling rate of municipal waste – Eurostat (europa.eu) (cei_wm011)

Recycling rate of all waste excluding major mineral waste

Relevance for the circular economy

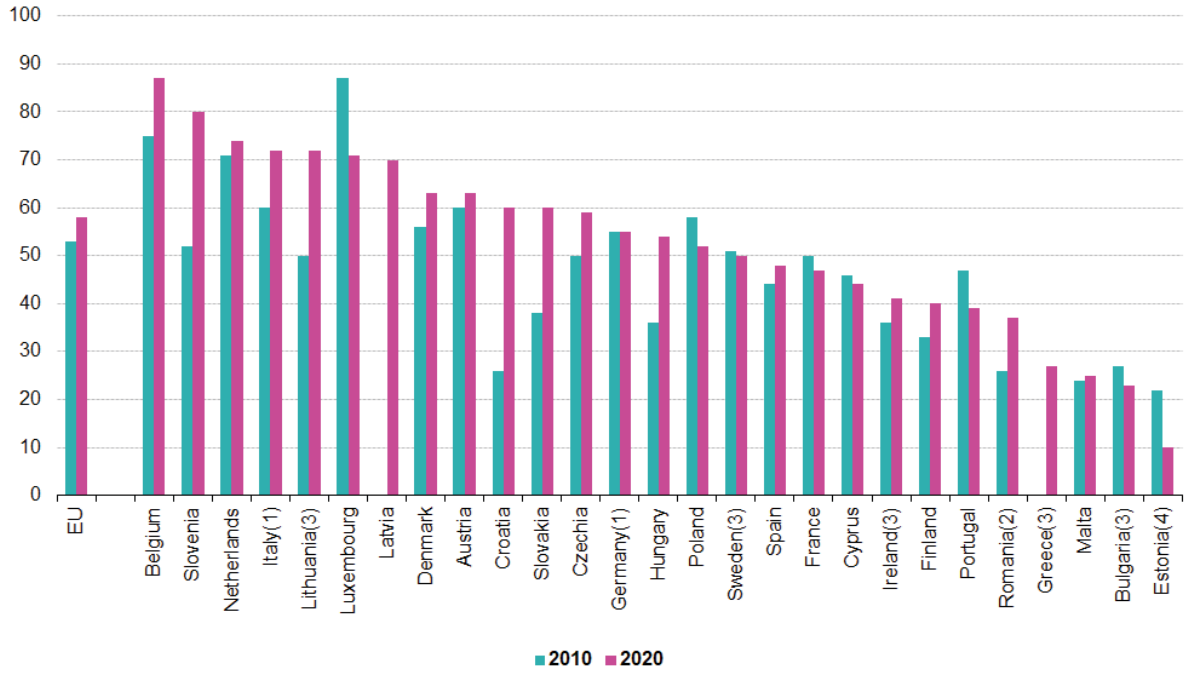
The recycling rate of all waste excluding major mineral waste indicates the extent to which key waste materials are reincorporated into the economy. This rate adds the production phase to the final consumption phase reflected by municipal waste recycling, and in this way encompasses waste-recycling arising from both consumption and production.

Facts and figures

In the EU, the recycling rate of waste (excluding major mineral waste) was 58% in 2020, up from 53% in 2010.

The recycling rate varies a lot among Member States. For example, some Member States have high rates for the recycling of waste (excluding major mineral waste). These include Belgium at 87%, Slovenia at 80%, and The Netherlands at 74%. However, other Member States have rates below 30%

Figure 5.4.2 Recycling rate of all waste excluding major mineral waste, 2010 and 2020



Note: Sorted on 2020 data
(1) 2020: Estimated value
(2) 2020: Definition differs
(3) 2018 value
(4) 2016 value

eurostat

Indicator description

- **Definition:** This indicator is defined as the share of waste that is recycled divided by all waste treated in a country (excluding major mineral wastes which mainly arise from mining and construction).
- **Interpretation:** The indicator corrects treatment data collected under the Waste Statistics Regulation with data on imports and exports. It therefore takes into account the amount of waste collected in one country and recycled in another country. Changes in this indicator indicate the overall progress in recycling performance.
- **Data source:** Waste statistics based on Regulation (EC) No 2150/2002 of the European Parliament and of the Council. Data provider: Statistical Office of the European Union (Eurostat).
  Management of waste excluding major mineral waste, by waste management operations – Eurostat (europa.eu).
  Comext database for imports and exports of waste materials from Foreign Trade Statistics.

References

Regulation on Waste Statistics (EC) No 2150/2002
Commission Regulation (EU) No 849/2010
Recycling rate of all waste excluding major mineral waste – Eurostat (europa.eu) (cei_wm010)

5.5. Recycling rates for specific waste streams

Recycling rate of overall packaging waste

Relevance for the circular economy

Packaging waste accounts for 10.3% of all waste generated in the EU excluding major mineral waste. Packaging waste generally consists of similar materials which are particularly suitable for recycling. The waste legislation sets specific recycling targets for packaging, and the amended Packaging and Packaging Waste Directive, PPWD, includes increased recycling targets for packaging materials by 2025 and 2030.

The indicator is used to monitor progress towards the target to recycle 55% of packaging set for 2008 and the targets of 65% and 70% by 2025 and 2030[54] respectively.

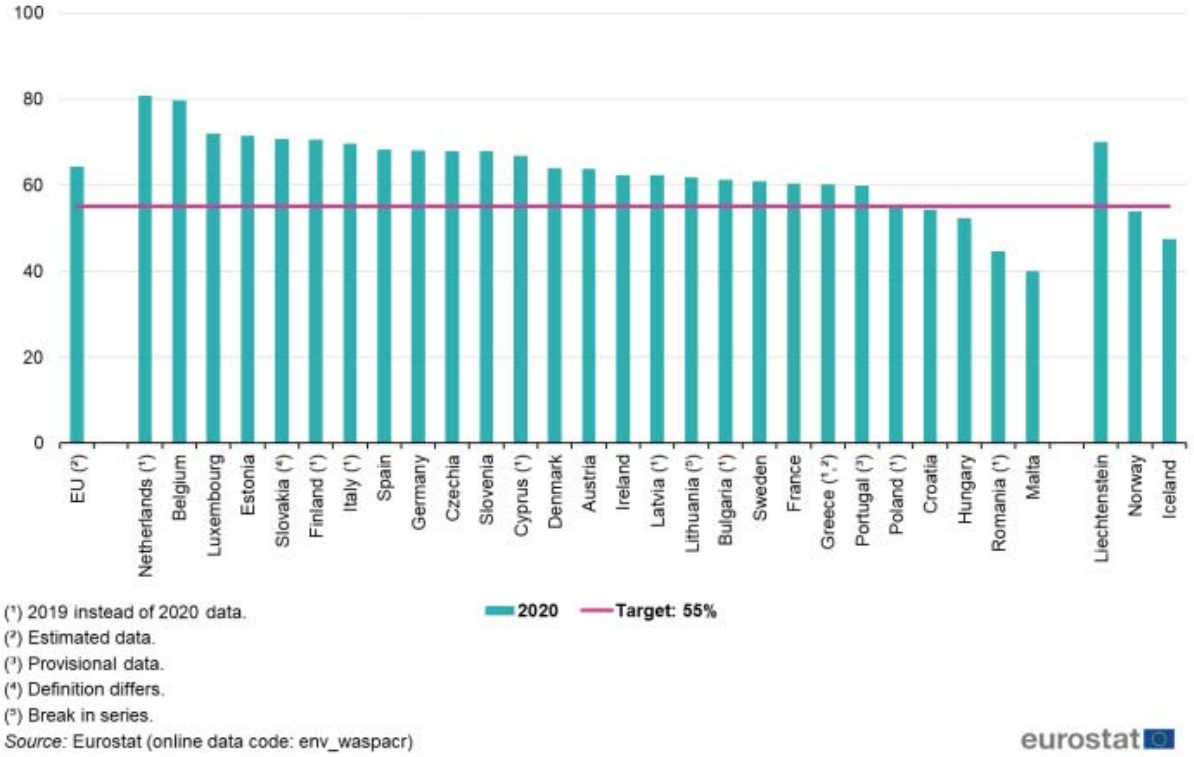
Facts and figures

The EU recycled 67% of all packaging waste in 2015 and 64% in 2020, showing an increase of more than 10 percentage points compared to 2008 (when only 54.6% of packaging waste was recycled).

Figure 5.5.1 shows the recycling rate for all packaging waste for the EU Member States and EEA/EFTA countries in 2020. Recycling covers material recycling and other forms of recycling (e.g. organic recycling). The current target to recycle 55% of packaging waste was met by all Member States, except Croatia (54.2%), Hungary (52.4%), Romania (39.9%) and Malta (40%).

Figure 5.5.1 Recycling rate of packaging waste, 2020

[54] Packaging and Packaging Waste Directive 94/62/EC, Article 6(1)



Indicator description

- **Definition:** Packaging waste covers all the waste packaging materials from products used to contain, protect, handle, deliver and present goods. These goods include everything from raw materials to processed goods, and cover all stages from the producer to the user or the consumer, excluding production residues.
- **Interpretation:** In some cases, differences between Member States are due to methodological differences, i.e. the possibility to report output from sorting instead of input to recycling if there are no significant losses in the recycling process. Most Member States assume that waste generated is equal to the amounts of packaging placed on the market in a given year in that country. This might result in underreporting or inflate recycling rates.
- **Data source:** Reporting obligations of the Member States laid down in the Packaging and Packaging Waste Directive 94/62/EC. Data provider: European Commission.
  Packaging waste by waste management operations – Eurostat (europa.eu) (env_waspac).
  Recycling rates of packaging waste for monitoring compliance with policy targets, by type of packaging – Eurostat (europa.eu) (env_waspacr).

References

- Directive (EU) 2018/852
- Eurostat dedicated section on waste – Eurostat (europa.eu)
- Packaging waste statistics – Statistics Explained (europa.eu)

- Recycling rate of packaging waste by type of packaging – Eurostat (europa.eu) (cei_wm020)

Recycling rate of plastic packaging waste

Relevance for the circular economy

Recycling more plastic is essential for the transition to a circular economy. The use of plastics in the EU has grown steadily in recent years, but less than 30% of plastics are collected for recycling and another third goes to landfill. Large quantities of plastics, including packaging, also end up in the oceans and are the principal cause of marine litter.

Plastic packaging accounts for around 60% of plastic waste in the EU. Between 2005 and 2015, EU generation of plastic packing waste increased by almost 12% to reach 15.8 million tonnes, or 31 kg per capita.

The revised Packaging and Packaging Waste Directive stipulates: (i) a minimum target that 50% of plastic packaging waste should be either prepared for reuse[55] or recycled by 2025; and (ii) a minimum recycling target of 55% by 2030. This indicator will make it possible to monitor progress towards this target.

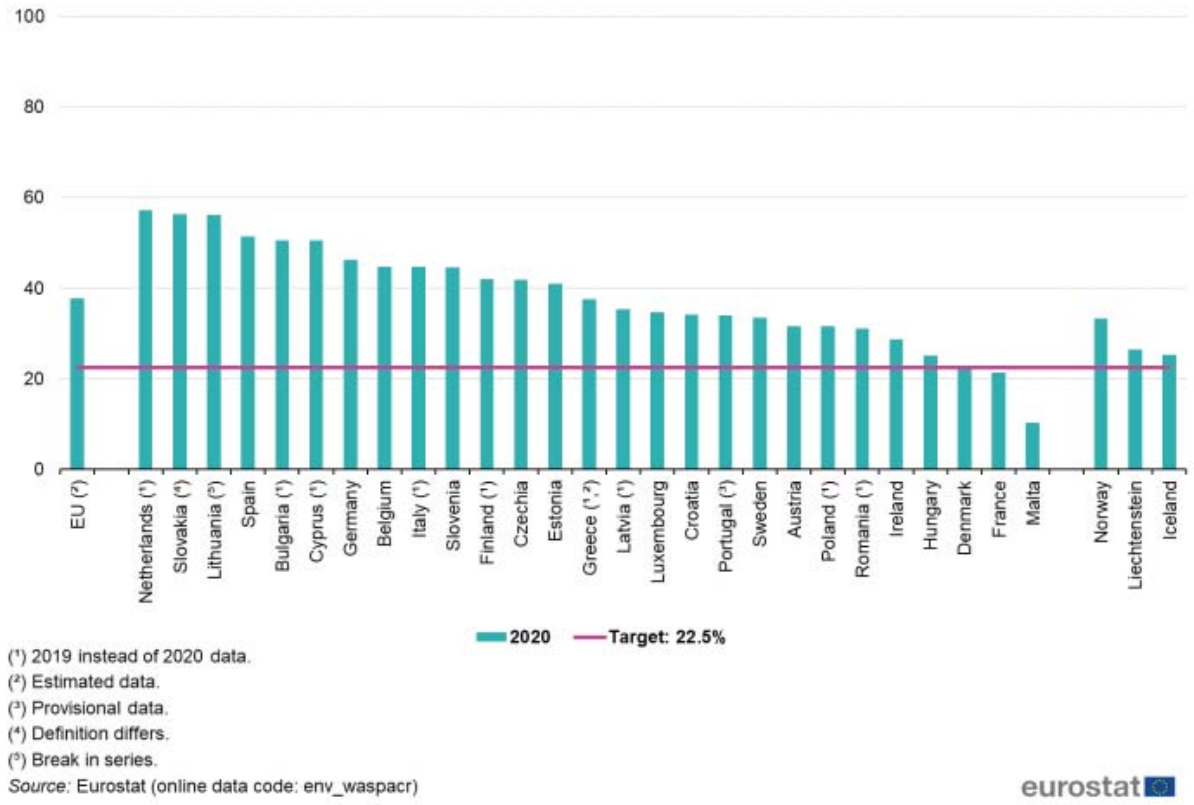
Facts and figures

The EU recycling rate for plastic packaging stood at 38% in 2020, up from 34% in 2010. Three Member States recycle more than 50% of plastic packaging waste. The target of recycling 22.5% of all plastic packaging waste was met by all Member States in 2020, except Malta (which recycled 10.2% of plastic packaging waste).

Figure 5.5.2 shows the recycling rate for plastic packaging waste for the EU Member States and the EEA/EFTA countries in 2020. The recycling rate includes only material recycling and no other forms of recycling, i.e. it exclusively covers material that is recycled back into plastics.

Figure 5.5.2 Recycling rate for plastic packaging, 2020

[55] Waste Framework Directive Article 3.16 *'preparing for re-use' means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing.*



Indicator description

- **Definition:** The recycling rate for plastic packaging is calculated as the total quantity of recycled plastic packaging waste divided by total plastic packaging waste generated (both expressed in kg or tonnes).
- **Interpretation:** In some cases, differences between Member States are due to methodological differences;most Member States assume that waste generated is equal to the amounts of packaging placed on the market in a given year in that country. This might result in underreporting or inflate recycling rates as compared to other Member States which use waste composition analysis to determine the generated plastic packaging waste.
- **Data source:** Reporting obligations of the Member States laid down in the Waste Framework Directive. Data provider: European Commission.
  Packaging waste by waste management operations – Eurostat (europa.eu) (env_waspac).
  Recycling rates of packaging waste for monitoring compliance with policy targets, by type of packaging – Eurostat (europa.eu) (env_waspacr).

References

- Directive (EU) 2018/852
- Eurostat dedicated section on waste – Eurostat (europa.eu)
- Packaging waste statistics – Statistics Explained (europa.eu)

- Recycling rate of packaging waste by type of packaging – Eurostat (europa.eu) (cei_wm020)

Recycling rate of waste electrical and electronic equipment separately collected

Relevance for the circular economy

Waste electrical and electronic equipment (WEEE), also known as e-waste, comprises items such as out-of-use computers, televisions, fridges and mobile phones. It is one the fastest growing waste streams in the EU. WEEE poses a risk to the environment (hazardous components), but it also has high potential for recycling by replacing raw materials with secondary raw materials (such as precious metals and other highly valuable special materials including critical raw materials.).

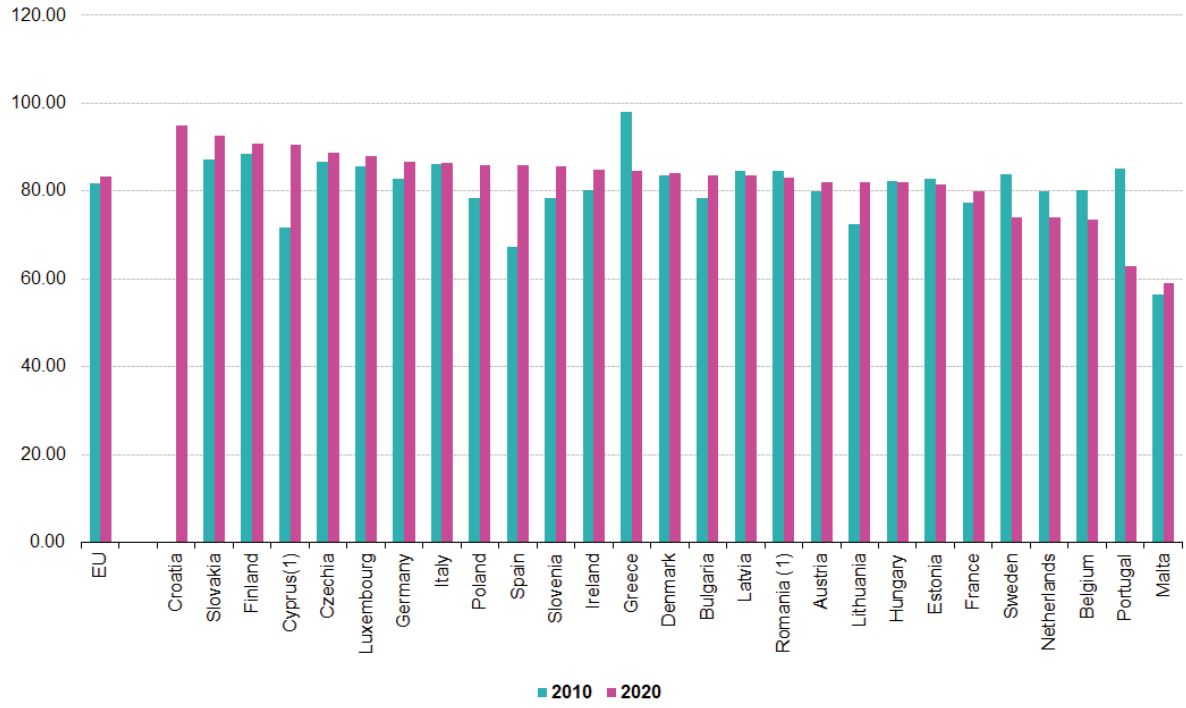
Compared with other waste streams, e-waste may not appear to be significant in terms of weight: some 9 million tonnes were generated in the EU in 2012 and it is expected that this will have grown to more than 12 million tonnes by 2020. However, e-waste provides a good example of the untapped potential to recover valuable raw materials. Furthermover, the carbon footprint of WEEE material extraction and use is relatively high considering it comprises of metals and involves complex processes. It is estimated that up to 60 out of 118 chemical elements in the periodic table can be found in complex electronics, many of which could be recovered, although very little of it is currently recycled. Critical raw materials such as gallium, germanium, indium, silicon and dysprosium are widely used in electrical and electronic equipment and are a priority area for recycling under the EU's circular-economy action plan.

Facts and figures

The percentage of **WEEE recycled and prepared for reuse** has increased in the EU from 81.8% in 2010 **to 83.4% in 2020**. Three Member States (Croatia, Slovakia and Finland) achieved more than 90% recycling and reuse of WEEE in 2020. In most Member States, recycling of e-waste increased in the period 2010-2020. Some Member States have seen a significant increase as they have increased not only the amount of e-waste collected, but also the amount of e-waste that is recycled.

Figure 5.5.3 Recycling rate of WEEE separately collected, 2010 and 2020

Recycling rate of (WEEE) separately collected
(percentage)



Note: Sorted on 2020 data
(1) 2018 value
Source: Eurostat (online data code: cei_wm060)

eurostat

Indicator description

- **Definition:** This indicator has been implemented in the revision of the circular economy monitoring framework to replace the indicator 'Recycling rate of e-waste', the definition of which differs.
  The indicator is calculated by dividing the weight of WEEE that enters the recycling/preparing-for-reuse facility by the weight of all separately collected WEEE (both measured in kg or tonnes) in accordance with Article 11(2) of the WEEE Directive (Directive 2012/19/EU).
  WEEE means electrical or electronic equipment which is waste under Article 3(1) of Directive 2008/98/EC, including all components, sub-assemblies and consumables which are part of the product at the time of discarding. Electrical and electronic equipment means: (i) equipment which is dependent on electric currents or electromagnetic fields in order to work properly and designed for use with a voltage rating not exceeding 1 000 volts for alternating current and 1 500 volts for direct current; and (ii) equipment for the generation, transfer and measurement of such currents and fields.
  The indicator is expressed as a percentage.

Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE) applies to electrical and electronic equipment as follows:
(a) until the reference year 2018 for electrical and electronic equipment falling within 10 product categories set out in Annex I (Annex II of Directive 2012/19/EU contains an indicative list of electrical and electronic equipment falling under the categories in Annex I).
(b) from the reference year 2019 onwards, all electrical and electronic equipment must be classified within 6 product categories set out in Annex III.

- **Interpretation:** The indicator provides a measure of the WEEE recycled and prepared for reuse, taking into consideration the electrical and electronic equipment that had been put on the market having a high potential for recycling to replace raw materials by secondary raw materials.
  The indicator is commonly used to monitor recycling at Member State level. Overall weight-based figures do not adequately capture recycling rates for critical raw materials which are typically present in e-waste in low quantities compared to the total weight of the e-waste. The indicator also does not capture options higher in the waste hierarchy – repair/reuse/remanufacturing.
- **Data source**: Reporting obligations of the Member States laid down in the Waste Framework Directive. Data provider: European Commission.
  Waste electrical and electronic equipment (WEEE) by waste management operations – Eurostat (europa.eu) (env_waselee)
  Waste electrical and electronic equipment (WEEE) by waste management operations – open scope, 6 product categories (from 2018 onwards) (env_waseleeos)

References

Waste statistics – electrical and electronic equipment – Statistics Explained (europa.eu)
Waste from electrical and electronic equipment (WEEE) (europa.eu)
Recycling rate of WEEE separately collected – Eurostat (europa.eu) (cei_wm060)

5.6. Contribution of recycled materials to raw-material demand

The use of secondary raw materials is a key part of the circular economy, and it is important to be able to measure it. For this purpose, two separate sub-indicators have been developed based on different datasets. The first sub-indicator (indicator 7a) gives an overall view of the use of secondary raw materials in the economy, whereas the second sub-indicator (indicator 7b) focuses on a subset of specific materials.

Circular-material-use rate

Relevance for the circular economy

The circular economy aims at increasing the amount of material recycled and fed back into the economy, thus reducing the generation of waste and limiting the extraction of primary raw materials. The circular-material-use rate (CMU) – also called the circularity rate – measures the share of recycled materials over total material demand.

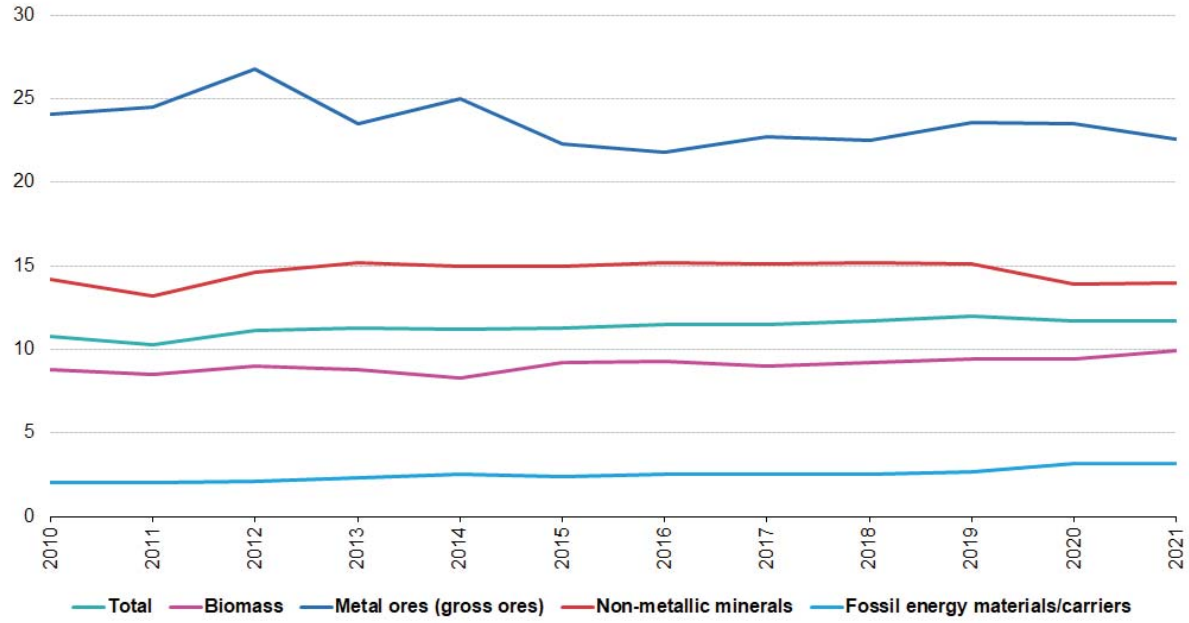
The CMU indicator is the ratio of recycled waste material to overall material demand (expressed as DMC plus recovered waste). The CMU indicator also has a clear connection with the Sankey diagram of material flows, in particular the ratio between the closing loop and the materials used in the economy.

The CMU indicator complements indicator 7a on the end-of-life recycling input rate. While the latter focuses on specific raw materials, the former measures material flows for the whole economy and for four big groupings of materials. The CMU indicator makes it possible to compare the EU and individual Member States, as well as to analyse progress over time.

Facts and figures

Recycled materials accounted for 11.7% of EU material demand in 2021. There has been a steady improvement since 2011 when this rate stood at 10.3%, with a constant increase every year since. This was due to material consumption peaking and then falling, while recovered waste amounts were more or less stable.

Figure 5.6.1 CMU rate by material category, EU, 2010-2021



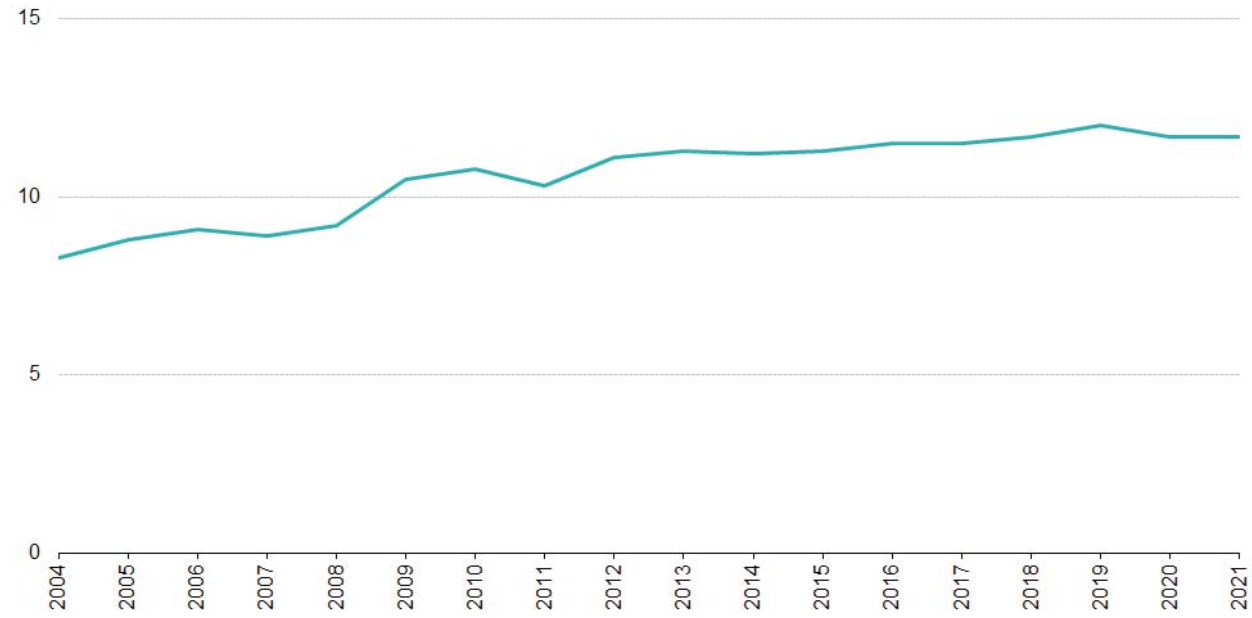
Source: Eurostat (online data code: env_ac_curm)

eurostat

It is possible to analyse the changes in the EU's CMU rate by breaking it down into four broad categories of materials: biomass, metal ores, non-metallic minerals and fossil fuels. Between 2011 and 2021, the CMU rate increased most notably for biomass, rising from 8.5% to 9.9%, followed by fossil-energy materials – albeit from a much lower baseline – which rose from 2.0% to 3.2%. The very significant category of metal ores exhibited some volatility over this period, rising from 24.5% in 2011 to 26.8% in 2012, but then falling to 21.8% in 2016, only to reach 22.6% in 2021. Finally, the non-metallic minerals category saw its CMU rate increase from 13.2% to peak at 15.2% in 2013 and remain stable at 15% until 2019, to fall to 14% in 2021.

Member States present a range of CMU rate values between 33.8% and 1.4%. The highest values are recorded in the Netherlands (33.8%), Belgium (20.5%) and France (19.8%). Values are lowest in Romania (1.4%), Finland (2.0%) and Ireland (2.0%).

Figure 5.6.2 Circular material use rate



Source: Eurostat (online data code: env_ac_cur)

eurostat

Indicator description

- **Definition:** The indicator measures the share of material recycled and fed back into the economy – thus avoiding the extraction of primary raw materials – in overall material use. The CMU rate, also known as the circularity rate, is defined as the ratio of circular use of materials to overall material use.
  Overall material use is measured by summing up the aggregate DMC and the circular use of materials. DMC is defined in economy-wide material-flow accounts. An approximate figure for the circular use of materials can be reached by taking the amount of waste recycled in domestic recovery plants and adding exported waste destined for recovery abroad and then subtracting imported waste destined for recovery. Waste recycled in domestic recovery plants comprises the recovery operations R2 to R11. The imports and exports of waste destined for recycling (i.e. the amount of imported and exported waste bound for recovery) are approximated from the European statistics on international trade in goods.
- **Interpretation:** The CMU rate indicates the amount of domestically collected waste – destined for material recovery in domestic treatment plants as well as abroad – that is fed back into the economy thus avoiding the extraction of primary raw materials. A higher rate means more circular (secondary) materials in the economy in relation to overall material use. A higher amount of secondary materials substituting for primary raw materials avoids extraction of primary material.
  Member States with very high CMU rates have either high levels of waste recycling or low levels of domestic material consumption (DMC) or both. Member States with very

low CMU rates have extremely low levels of waste recovery. This is the main reason for their low CMU-rate values. But differences in the circularity rate across Member States are due not only to the amount of recycling in each country, but also to structural factors in national economies. The circularity rate is high if the amount of waste recycled is high. However, the circularity rate could also be high if DMC is low, i.e. the country consumes relatively fewer materials (biomass, metals, minerals, fossil fuels, etc.). This can occur if domestic extractions of materials for use in the country are low, imports of materials for use in the country are low, or exports of domestically extracted materials are high.

- **Data source:** Eurostat calculations based on waste statistics, material-flow accounts and international trade statistics. Data provider: Statistical Office of the European Union (Eurostat).

  Treatment of waste by waste category, hazardousness and waste management operations – Eurostat (europa.eu) (env_wastrt)
  Material flow accounts – Eurostat (europa.eu) (env_ac_mfa)
  Overview – International trade in goods – Eurostat (europa.eu) (Comext)

  Waste statistics are available every second year, but Eurostat interpolates the data to produce annual CMU estimates.

References

- Circular material use rate – calculation method – 2018 edition
- Circular economy – material flows – Statistics Explained (europa.eu)
- Circular material use rate – Eurostat (europa.eu) (cei_srm030)

End-of-life recycling input rates

Relevance for the circular economy

Secondary raw materials contribute to developing a robust circular economy. For most materials, the share of secondary raw materials is far below the economy's demand for these materials, even though overall recycling rates for certain materials are relatively high.

This indicator is unlike the indicators of the monitoring framework on waste management, which focus on collection or recycling rates for certain waste streams. Instead, this indicator measures the contribution made by recycling to demand for materials by type of material for a selected subset of materials. In this sense, this indicator provides complementary information to that given in the recycling flow in the Sankey diagram on material flows in the circular economy (i.e. it disaggregates by material type the contribution to material demand made by recycling).

Facts and figures

The values of the end-of-life recycling input rates (EOL-RIR) have been used as a reference for various publications, including the review of the list of critical raw materials (CRMs) in 2020 (EC, 2020); the raw-material scoreboard (EC, 2021)); and the monitoring framework for the circular economy (EC, 2018).

Table 5.6.1 illustrates a review of the values for the EOL-RIR for these materials, including detail on the data sources used for the assessment.

Values for 2017 refer to the CRM assessment in 2017 and the EU raw-materials scoreboard (2018 edition). The methodology and data-source ranking used to calculate the EOL-RIR refer to the revision of the criticality-assessment methodology in 2017 (Blengini et al., 2017).
Values for 2020 have been estimated based on the same methodology and data sources used in 2017 (Blengini et al., 2017) and complemented by: (i) results from new Material System Analysis, MSA studies (conducted in 2019-2020); and (ii) discussions between the European Commission and sector experts, held in particular during workshops to validate the CRM assessment in September 2019 in Brussels.
Values for 2014 refer to the study of the CRM assessment conducted by Oakdene Hollins & Fraunhofer ISI (2013). This study asessed the CRM list using an indicator 'Recycling Input Rate (EoL %)'. This indicator was intended to measure the contribution made by recycling to meeting demand for a certain material, and it is conceptually equivalent to the EOL-RIR. However, the study by Oakdene Hollins & Fraunhofer ISI (2013) did not provide details on the methodology used for the calculation of this indicator, nor did it provide detail on the data sources used. Therefore, the data source for the 'recycling input rate (EoL %)', as presented in Table 5.6.1 below, has been considered to be a combination of: (i) references to the UNEP (2011) report; and (ii) data from literature and industry. The only exceptions relate to 'gypsum' and 'natural rubber', which were not present in the UNEP report from 2011 and were therefore based only on data from literature and industry.

Table 5.6.1 EOL-RIR values used in the assessment of the CRM lists (2014-2023)

	2014[i] [%]	2017[ii] [%]	2020[iii] [%]	2023[iv] [%]
Aggregates	-	8.0%	8.0%	9.0%
Aluminium/bauxite	35.0%	12.4%	12.3%	32.0%
Beryllium	19.0%	0%	0%	0%
Bismuth	-	1.0%	0%	0%
Cobalt	16.0%	0%	22.1%	22.0%
Copper	20.0%	55.0%	16.9%	55.0%
Dysprosium	0%	0%	0%	0%
Gallium	0%	0%	0%	0%
Germanium	0%	1.7%	1.7%	2.0%
Gypsum	1.0%	1.1%	1.1%	1.0%
Indium	0.0%	0.1%	0.1%	1.0%
Iron ore	22.0%	24.0%	31.5%	31.0%
Lead	-	75.0%	75.0%	83.0%
Limestone	0%	58.0%	19.0%	1.0%
Lithium	0%	0%	0.1%	0%
Magnesium	14.0%	9.5%	13.4%	13.0%
Molybdenum	17.0%	30.0%	30.0%	30.0%
Natural Rubber	0%	0.9%	1.0%	5.0%
Neodymium	0%	1.3%	1.3%	1.0%
Nickel	32.0%	33.9%	17.0%	16.0%
Palladium	35.0%	9.7%	27.8%	10.0%
Platinum	35.0%	11.5%	25.3%	11.0%
Praseodymium	0%	10.0%	10.0%	10.0%
Sapele wood	-	15.0%	0%	7.0%
Tantalum	4.0%	1.0%	5.0%	13.0%
Tellurium	0%	1.0%	1.0%	1.0%
Titanium	6.0%	19.1%	19.1%	1.0%
Vanadium	0%	44.0%	1.7%	1.0%
Yttrium	0%	31.4%	31.4%	31.0%
Zinc	8.0%	30.8%	31.0%	34.0%

Sources: UNEP; MSA; literature & industry data

i) Values for the 'EOL recycling rate' index as developed for the assessment of the CRM list (2014). Date indicated in the header of the table is the year when the estimates were produced.

ii) Values for the EOL-RIR, as developed for the assessment of the CRM list (2017) and referenced in the European Commission Monitoring Framework and the Raw Materials Scoreboard (2018).

iii) Values for the EOL-RIR, as developed for the assessment of the CRM list (2020) (update February 2020).

iv) Values for the EOL-RIR, as developed for the assessment of the CRM list (2023) (update March 2023).

Indicator description

- **Definition:** The EOL-RIR measures, for a given raw material, how much of the material's input into the production system comes from the recycling of 'old scrap' (or 'end-of-life scrap') i.e. scrap derived from the treatment of end-of-life products at their end-of-life. The EOL-RIR does not take into account scrap that originates from manufacturing processes ('new scrap' or 'process scrap'). Indeed, process scrap has a known composition and is generally more homogeneous and not contaminated by other substances, therefore making it easier and more economically convenient to recycle.
- **Interpretation:** Several factors determine the EOL-RIR. The first factor is demand for raw materials, which tends to increase over time for almost all materials. The second factor is the amount of materials in waste that are available to be recycled. The presence of these two factors make it difficult to interpret the indicator. In fact, the EU can recycle higher amounts of old scrap, but still be characterised by decreasing values for EOL-RIR because of a sudden increase in the demand for certain materials (e.g. occurring for several CRMs in some low-carbon or digital technologies).
  Several materials (as bulk metals) are already largely and efficiently recycled. However, their EOL-RIR is still relatively low, mainly because they are embedded in long-life capital goods, and they will be available for recycling only in the future. Other materials instead very high EOL-RIR values because demand for – and use of – these materials have been drastically reduced by legislative bans. For many materials (including many CRMs), the EOL-RIR is null or very low because they have been introduced only recently in innovative and complex products (e.g. e-vehicles, renewable energy plants, electronics) and technologies to recycle them are still not available or not profitable.
  - **Data source:** The EOL-RIR is part of the methodology to make a list of CRMs for the EU, an exercise that is carried out by the Commission every 3 years[56]. Data come from the European Commission's Material System Analysis Study[57] and the Commission's CRM assessment. All estimates are based on Commission studies for the revision of the CRM list, performed from 2014 to 2020. The Joint Research Centre (JRC) has proposed rules on the quality of data (2018), and also published both the Study on the EU's list of CRMs (2020), Study on the Critical Raw Materials for the EU (2023), analysis of CRM list 2023 and the raw-materials scoreboard. All the values from these data sources have been peer-reviewed within so-called criticality-validation workshops (i.e.

[56] Data are published in the European Commission's Raw Materials Information System.
[57] http://rmis.jrc.ec.europa.eu/?page=msa-methodology-548216

meetings to validate the results for revisions of the CRM list), involving experts from industry and academia. Data provider: European Commission.

References

EC (2010). Critical raw materials for the EU – Report of the Ad-hoc Working Group on defining critical raw materials.
EC (2017a). Methodology for establishing the EU list of critical raw materials. Guidelines – Study. (https://publications.europa.eu/s/m6D2)
EC (2018). Commission Staff Working Document Measuring Progress Towards A Circular Economy In The European Union – Key Indicators For A Monitoring Framework Accompanying The Document Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions On A Monitoring Framework For The Circular Economy. SWD(2018) 17 Final.
EC (2020) CRM list 2020
EC (2023) Study on the Critical Raw Materials for the EU 2023 – Final Report
EC (2023) CRM list 2023
EC (2021) Raw materials Scoreboard 2021
Critical Raw Materials
Raw Materials Information System
Study on the EU's list of Critical Raw Materials (2020)
Raw Materials Scoreboard (europa.eu) (2021)
Contribution of recycled materials to raw-material demand – end-of-life recycling input rates (EOL-RIR) – Eurostat (europa.eu) (cei_srm010)

5.7. Trade in recyclable raw materials

Relevance for the circular economy

A circular economy seeks to recycle residual materials and re-introduce them into the economy as new raw materials. These materials are then called 'secondary raw materials'. This has several benefits, both in reducing waste and in increasing the security of supply of raw materials. An accurate picture of the European raw-materials sector must include: (i) movements of raw materials originating from waste (i.e. secondary raw materials) crossing European boundaries both as imports and exports; and (ii) intra-EU trade.

The indicator measures the quantities of recyclable waste and scrap as well as other secondary raw materials (by-products) that are shipped between EU Member States (intra-EU) and across EU borders (extra-EU).

Many non-hazardous waste streams are regarded as valuable resources because they are potentially a significant source of raw materials. Overall, cross-border movements of recyclable waste have significantly increased in the last decade and may contribute to circular economy objectives by maintaining the value of products, materials and resources for as long as possible.

This indicator is clearly relevant for obtaining a picture of trends in the markets for selected secondary raw materials, at both national and EU levels.

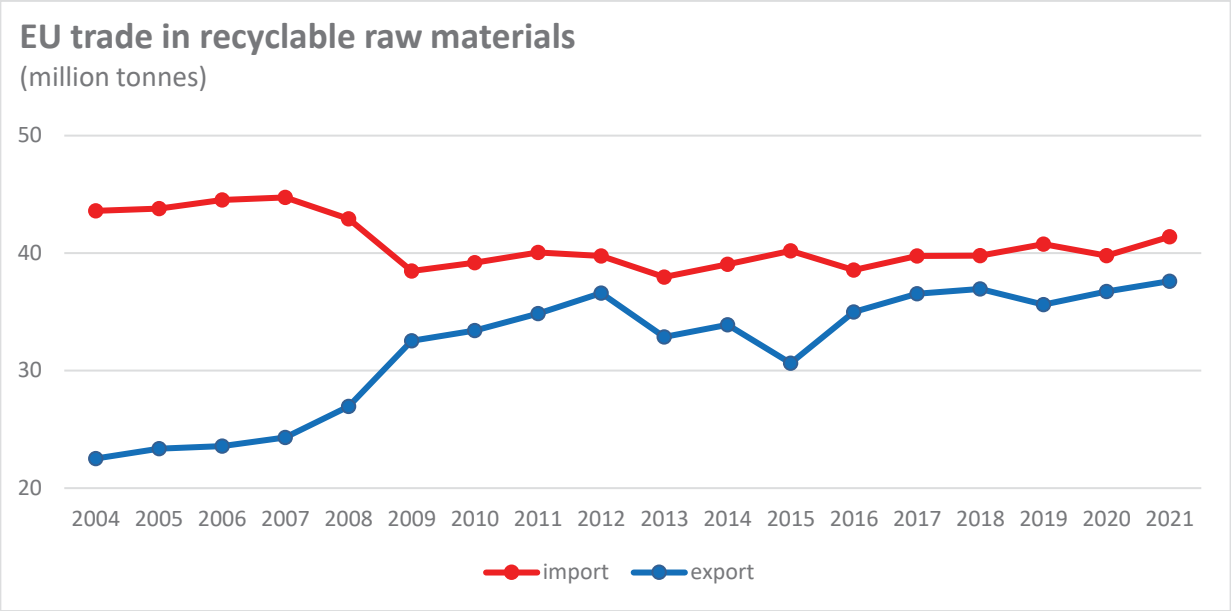
To provide an accurate picture of the European raw-materials sector and the provenance of secondary materials used by EU industries, this revised indicator includes more materials. In addition to the five categories of products included in the previous version of the monitoring framework ('iron and steel', 'copper, aluminium and nickel', 'precious metals', 'paper and cardboard' and 'plastics – including rubber'), it now includes 'glass', 'wood', 'textiles', 'minerals' and 'animal and vegetal' products. The new total includes all the products considered waste or by-products (see the list in the section definition). This means that the amounts of the categories previously included in the indicator do not change, but the total number of categories increases.

Facts and figures

In 2021, exports of recyclable raw materials – which include recyclable waste and scrap as well as other secondary raw materials (by-products) – from the EU to non-EU countries amounted to 37.6 million tonnes, 1.0 million tonnes more than in 2020. There has been an upward trend in the volume of these exports since 2004, reaching a new peak in 2021 with an 67% increase compared with 2004 (+15.0 million tonnes).

Imports of recyclable raw materials from non-EU countries into the EU amounted to 41.4 million tonnes in 2021, an increase of almost 1.6 million tonnes compared with 2020 and a decrease of 5% compared with 2004 (-2.2 million tonnes).

Figure 5.7.1 EU trade in recyclable raw materials, 2004-2021

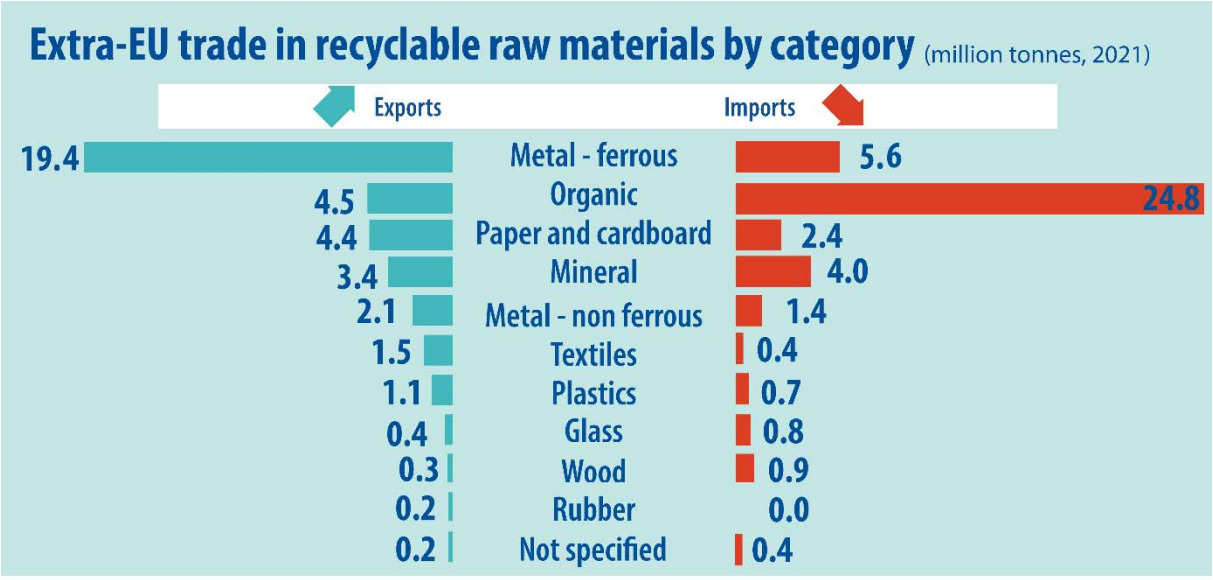


Source: Eurostat online database (cei_srm020)

In 2021, exports of ferrous metals (iron and steel) from the EU amounted to 19.5 million tonnes, accounting for almost half (52%) of all exports of recyclable raw-materials. The second-largest category was products of animal and vegetal origin (4.5 million tonnes of which were exported, or 12% of all exports of recyclable raw-materials), followed by paper and cardboard (4.4 million tonnes or 12%).

For imports to the EU, the largest category was products of animal and vegetal origin (24.8 million tonnes of which were imported in 2021), accounting for more than half (60%) of all imports of recyclable raw materials. The second-largest category was ferrous metals (iron and steel) at 5.5 million tonnes (or 13% of all imports of recyclable raw materials), followed by minerals at 4.0 million tonnes (10% of all imports of recyclable raw materials).

Figure 5.7.2 EU trade in recyclable raw materials selected by category, 2021



Indicator description

- **Definition:** The indicator measures the quantities of recyclable waste and scrap as well as other secondary raw materials (by-products) that are shipped between EU Member States (intra-EU) and across EU borders (extra-EU).

  The indicator includes the following variables:

  - intra-EU trade of selected recyclable raw materials (measured by imports from EU countries to each other);
  - imports from non-EU countries and exports to non-EU countries of selected recyclable raw materials (extra-EU trade).

  Data are disaggregated by EU Member State and by category of material, following the table of correspondence between products (CN-codes) and materials.

  This data set is based on the international trade-in-goods statistics published by Eurostat. The data measure the physical quantity of both goods traded between EU Member States (intra-EU trade) and goods traded by EU Member States with non-EU countries (extra-EU trade). 'European' means that the statistics are compiled on the basis of the concepts and definitions set out in EU legislation. 'National' statistics, i.e. statistics published at national level by the Member States, are compiled on the basis of national rules which may differ from EU rules.

  Product coverage: The scope of the 'recyclable raw material' is defined and approximately measured by using relevant product codes selected from the list of Combined Nomenclature codes used in international trade-in-goods statistics.

- **Interpretation:** The indicator provides an accurate picture of the trade flows of a number of waste streams that could be recycled into secondary raw materials. However, this indicator only covers legal exports of waste materials. Due to their nature, illegal

waste shipments are not tracked in official reporting systems. However, there is extensive evidence that the amount of illegally exported waste is significant, and that for some categories of waste such as end-of-life vehicles or WEEE these amounts may even be higher than the amount of legal exports.

- **Data source:** International trade-in-goods statistics. Data provider: Statistical Office of the European Union (Eurostat).
  Trade in recyclable raw materials by partner – Eurostat (europa.eu) (env_trdrrm)
  Easy Comext (europa.eu)

References

Overview – International trade in goods – Eurostat (europa.eu)
International trade statistics – background – Statistics Explained (europa.eu)
Trade in recyclable raw materials – Eurostat (europa.eu) (cei_srm020)

5.8. Private investment, jobs and gross value added related to circular-economy sectors

Relevance for the circular economy

Innovation and investments (in eco-design, secondary raw materials, recycling processes and industrial symbiosis) are a key element of the transition to a circular economy.

A circular economy can make a significant contribution to the creation of jobs and economic growth, while reducing inequalities and enhancing collective resilience. Sectors that are closely related to the circular economy (such as recycling, repair and reuse) are particularly job intensive, and contribute to local employment. The patterns of growth in both jobs and in the sale of goods/services will indicate whether the transition to a circular economy is delivering the expected results.

Facts and figures

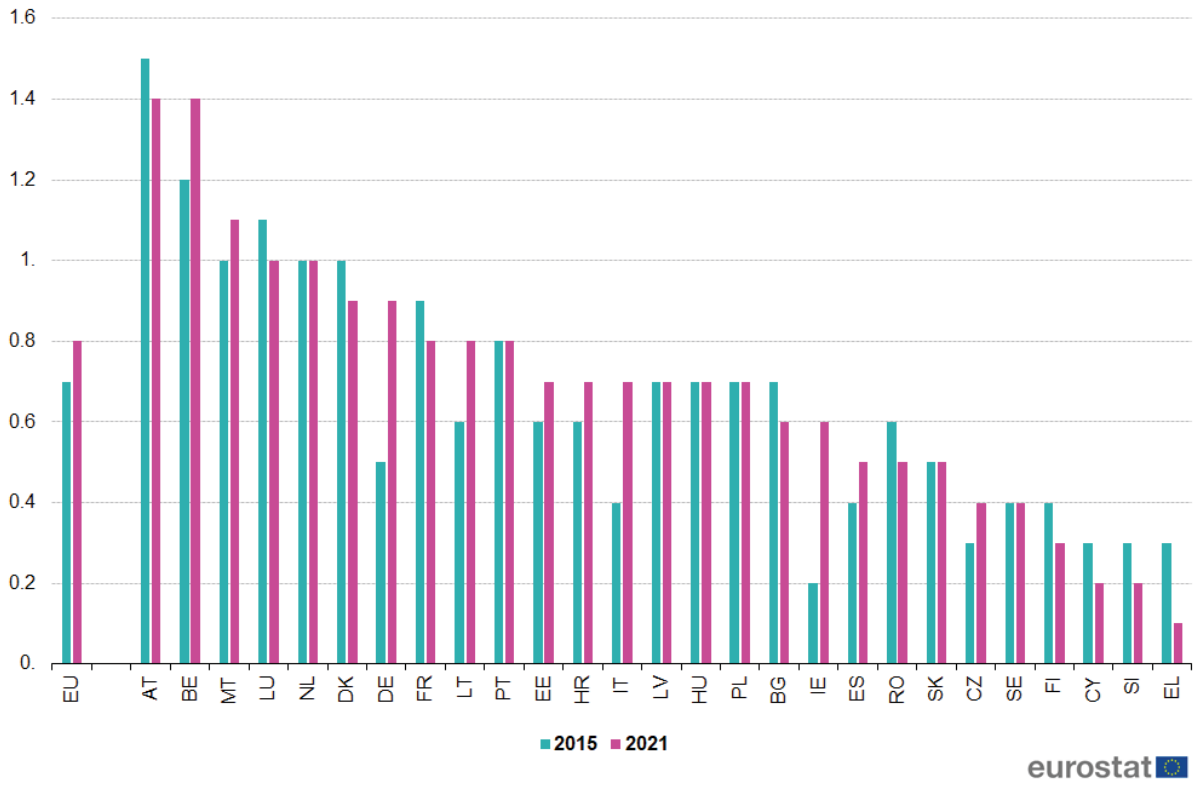
a) Private investment

In 2015, there was EUR 84 billion in private investment in circular-economy sectors in the EU (0.7% of EU GDP). In 2021, private investment rose to EUR 121.6 billion (0.8% of EU GDP), an increase of 45% compared with 2015 (around 37.6 billion).

The share of private investment in circular-economy sectors differs greatly across Member States, ranging from 0.1% of GDP in Greece to 1.4% in Belgium and Austria. In addition to Belgium and Austria, three other Member States (Malta, Luxembourg, and the Netherlands) have shares of private investment in the circular economy that are above 1% of GDP. 16 Member States have a share of between 0.5% and 0.9%. Cyprus and Slovenia had shares of 0.2% in 2021.

In 2015-2021, private investment in the circular economy increased considerably in most Member States. Over this period, private investment in the circular economy increased the most in Ireland (+515%), Lithuania (+101%) and Germany (+94%) in percentage terms. Compared to GDP, the share of private investment in the circular economy increased by 0.4 percentage points in both Ireland (from 0.2% to 0.6%) and Germany (from 0.5% to 0.9%).

Figure 5.8.1. Gross investment in tangible goods related to circular-economy sectors (% GDP at current prices), 2015 and 2021



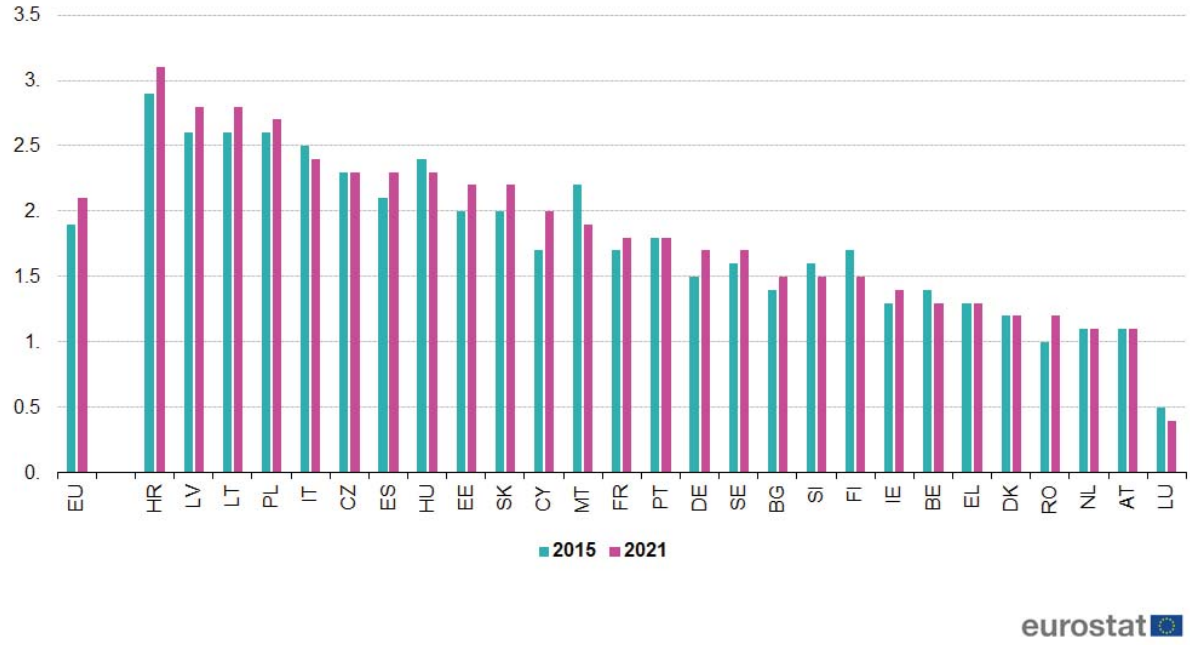
b) Employment

In 2021, there were almost 4.3 million people employed in circular-economy sectors in the EU i.e. 2.1% of all people in employment. This is an increase of around 11% compared with 2015. Employment in the circular economy increased in most Member States, both in absolute and relative terms, between 2012 and 2021.

Croatia, Latvia and Lithuania had the most people working in the circular economy as a share of total employment in 2021, with more than 3.1% (Croatia) and 2.8% (Latvia and Lithuania) of employed people working in the circular economy. However, in absolute terms, Germany has the most people employed in the circular economy (more than 785 000), followed by Italy and France (around 613 000 and 524 000 respectively).

According to the available data, total employment growth in circular-economy sectors between 2012 and 2021 was particularly strong in Cyprus (up 58.1%), Ireland (up 43%) and Estonia (up 32.4%).

Figure 5.8.2 People employed in circular-economy sectors (share of total people employed), 2015 and 2021



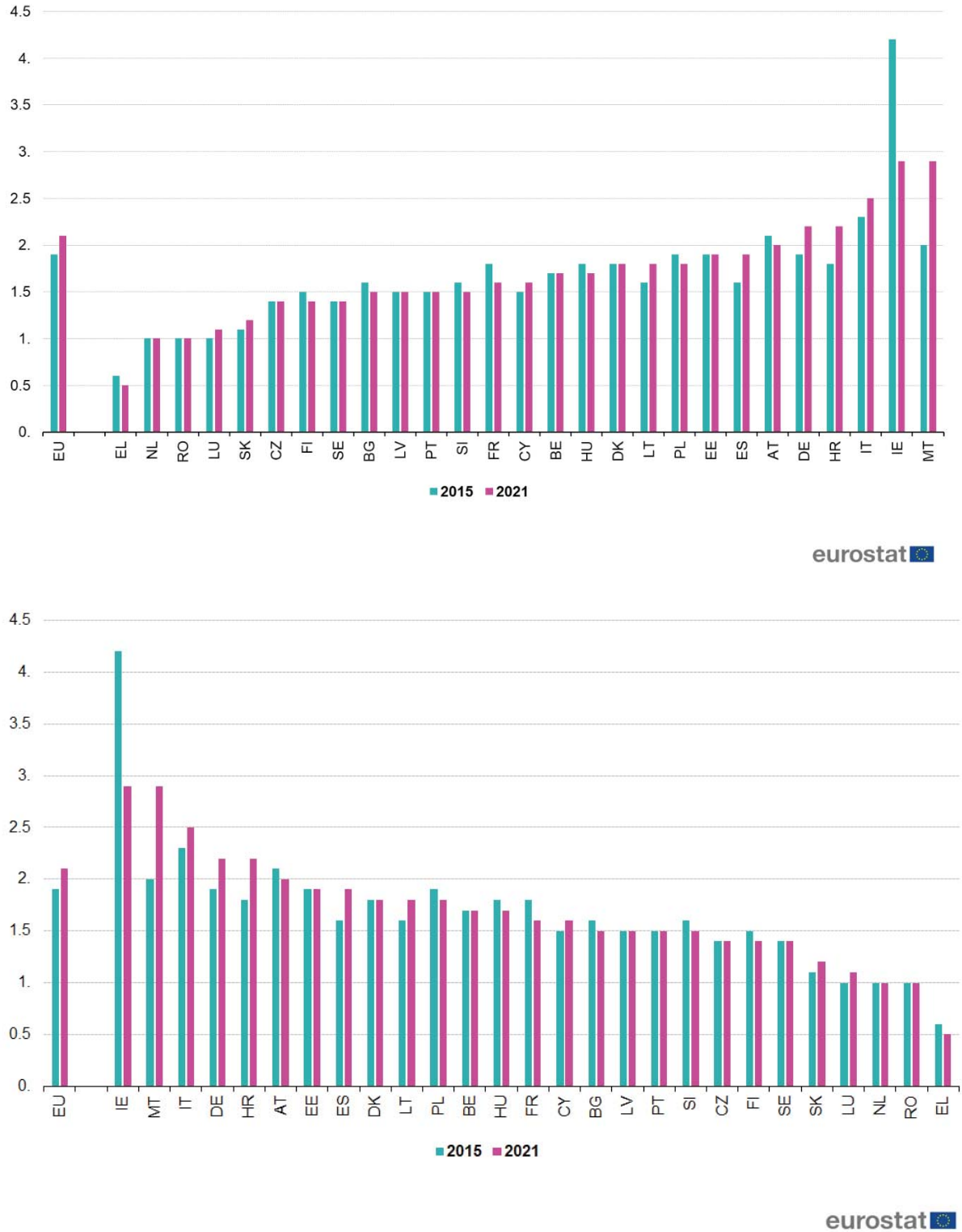
c) Gross value added

In 2021, the circular-economy sectors generated gross value added of around EUR 299 billion in the EU (i.e. around 2.1% of overall GDP in the EU). Gross value added in the circular-economy sectors increased by around 27% in the EU in 2015-2021, and slightly increased (by 10%) as a share of EU GDP.

Gross value added in the circular-economy sectors (as a share of GDP) differs greatly among the Member States. According to the latest available figures, Malta and Ireland have the highest share of gross value added as a percentage of GDP in circular-economy sectors, at 2.9% of GDP and they are followed by Italy with 2.5% and Croatia and Germany both with 2.2%.

In 2015-2021, the gross value added in circular-economy sectors increased by almost 115% in Malta, and by 73.1% in Lithuania. Malta also saw the highest increase in gross value added in circular-economy sectors as a share of GDP with an increase of 45 percentage points, followed by Croatia with an increase of 22 percentage points

Figure 5.8.3 Gross value added at factor cost in circular-economy sectors (% GDP), 2015 and 2021



Indicator description

- **Definition**: The indicator includes the following three variables: 'Private investments', 'Persons employed' and 'Gross value added'.

The indicator is calculated with a methodological framework according to the following three steps.

1. Conceptual framework. The delineation of economic activities related to the circular economy was determined by means of a sector classification based on the purpose of each sector.
2. The relevant activities were identified and matched against the integrated system of economic classification, drawing upon existing lists of goods and services for the environmental sector. This list presents the identified economic activities corresponding to the classifications seen in NACE, CPA and PRODCOM, and also features a suitable estimation procedure for each economic-activity code.
3. Delineation and data compilation. The estimation procedure and methods to compile the variables can be found in the report included in the annex of this staff working document.

- **Interpretation:** Based on the described procedure for data compilation, the following variables are calculated:
  a) gross investments in tangible goods, in million euro;
  b) persons employed, in full time equivalents (FTEs);
  c) gross value added, in million euro (at factor cost).

- **Data source:** Eurostat calculations based on official statistics such as structural business statistics (SBS), PRODCOM, national accounts, the Labour Force Survey and others. Data provider: Statistical Office of the European Union (Eurostat).
  SBS cover all activities of enterprises for sections B to N and division S95 of classification NACE Rev.2. The SBS variable of interest for the compilation of sector market output is the production value. This variable is available at NACE class level (four digits). The SBS also collect data on gross value added, number of employees, and gross fixed capital formation among others, which are drawn upon for the compilation of the sector accounts.
  National accounts are an important source for compiling sector statistics, and should provide the definitions and valuation principles for the characteristics (e.g. output, gross value added, employment) for the sector accounts.
  PRODCOM statistics (PRODuction COMmunautaire) provide data on both the physical volume of production and the monetary value of the production of manufactured goods from NACE sections B (mining and quarrying) and C (manufacturing) sold during the survey period. The main difference between SBS and PRODCOM is that SBS relates to economic activities (e.g. the activity of the producers), whereas PRODCOM relates to products (e.g. the output delivered by the producers). The national statistical institutes conduct surveys of enterprises to collect the data using the PRODCOM lists of products. Data on the value of the production sold are published.
  The Labour Force Survey provides estimates of labour-market characteristics such as employment, unemployment, inactivity, hours of work, occupation, economic activity and other labour-related variables, as well as important socio-demographic

characteristics, such as sex, age, education, household characteristics and regions of residence.

Other sources are also used to estimate gross value added as a share of GDP, such as: energy statistics, waste statistics, forestry statistics, climate-change statistics and transport statistics.

References

Business economy by sector – NACE Rev. 2 – Statistics Explained (europa.eu)
Structural business statistics – Statistics Explained (europa.eu)
Private investment and gross value added related to circular economy sectors- Eurostat (europa.eu) (cei_cie010)
Persons employed in circular-economy sectors – Eurostat (europa.eu) (cei_cie011)

5.9. Innovation

Patents related to waste management and recycling

Relevance for the circular economy

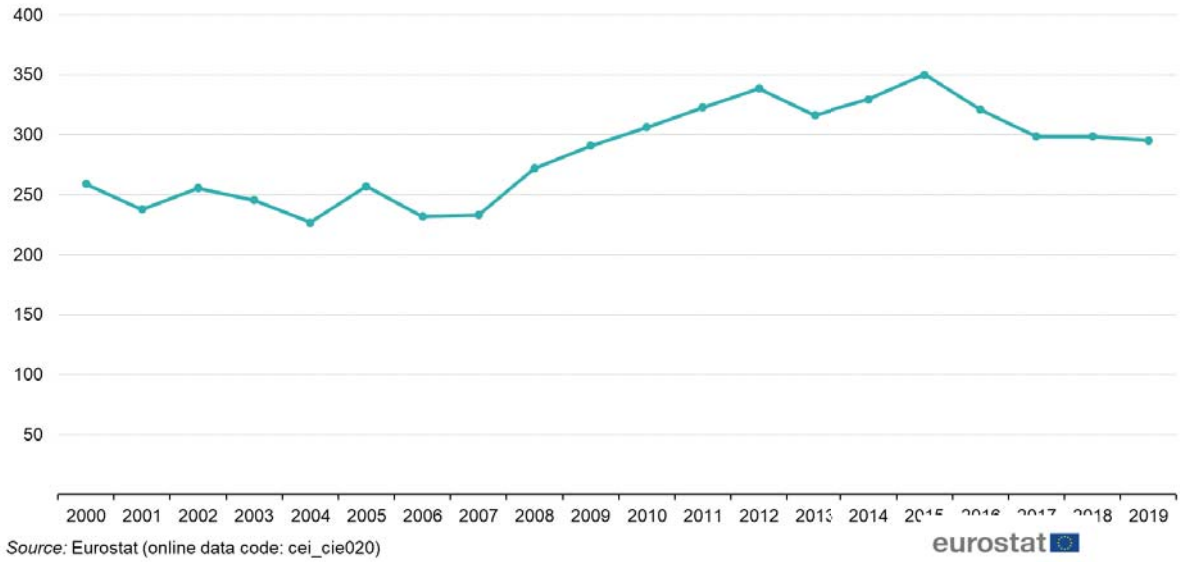
Innovation plays a key role in the transition towards a circular economy, and in the development of new technologies, processes, services and business models. Developing innovative techniques for waste collection, cleaner transportation and mobility, storage – and in particular for recycling of materials – will help to reduce the EU's dependence on imports of critical commodities. It will also improve the EU's resilience to potential disruptions to the supply of materials and will support the competitiveness of domestic industries.

The number of patent families in waste collection, transportation, storage and recycling gives an indication of the innovation activity in technologies for recycling and reuse of materials in both the EU and the world more broadly. Patent statistics are one of the indicator families widely used to assess technological progress in a specific industrial sector. They are widely accepted as output-oriented indicators on innovation.

Facts and figures

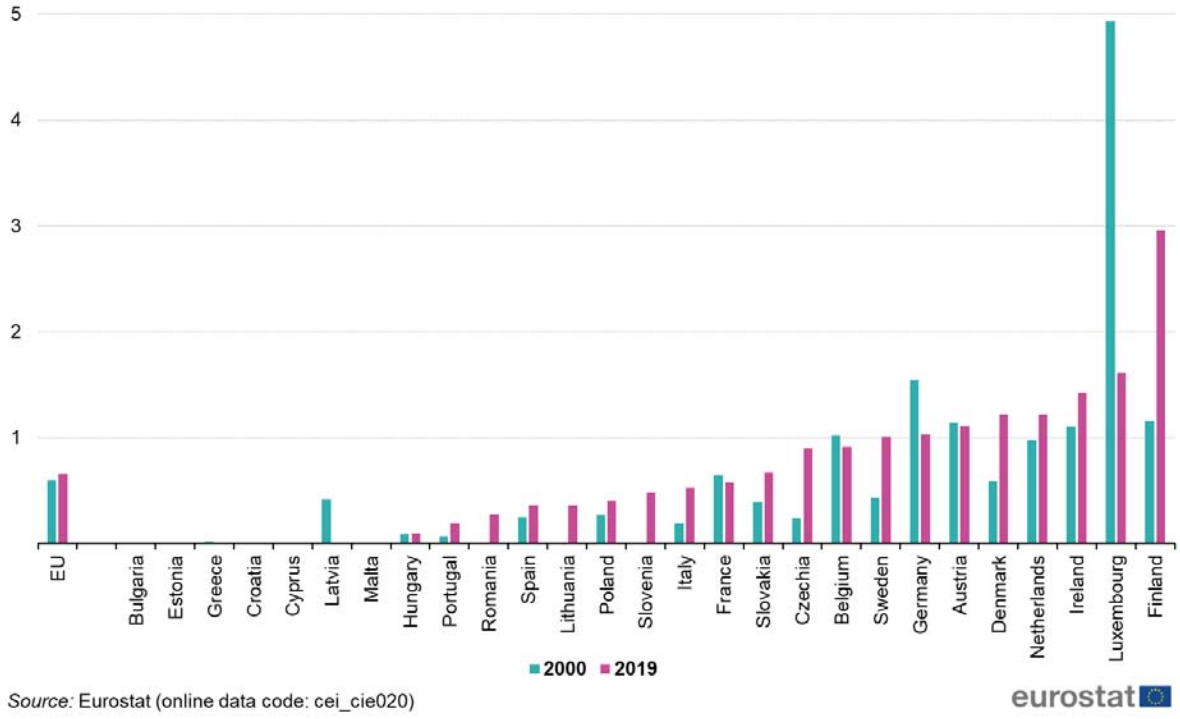
In the EU, the total number of annual patents filed that are related to recycling and secondary raw materials increased from 259 to 295 (+14%) between 2000 and 2019 (Figure 5.9.1).

Figure 5.9.1 EU patents related to waste management and recycling (number), 2000-2019



In the EU in 2019, the most patents per million inhabitants were filed in Finland, followed by Luxembourg, Ireland, the Netherlands, Austria and Germany.

Figure 5.9.2 Patents related to waste management and recycling (patents per million inhabitants), 2000-2019



Indicator description (definition, interpretation and data source)

- **Definition:** The indicator measures the number of patents related to recycling and secondary raw materials. The attribution of patents to recycling and secondary raw materials was made using the relevant codes in the Cooperative Patent Classification (CPC). The CPC scheme has been simplified, with codes reclassified to the relevant parent categories. The full list of changes is provided in the Cooperative Patent Classification website.
  The term 'patents' refers to patent families, which includes all documents relevant to a distinct invention (e.g. applications to multiple authorities), thus preventing multiple counting. A fraction of the family is allocated to each applicant and relevant technology.
- **Interpretation:** Although the indicator provides insight into the most relevant innovative recycling technologies, it does not cover all technologies related to waste management. It also does not include other services and business models in the circular economy. It must also be highlighted that not all relevant innovations are – or can be – patented.
- **Data source:** European Patent Office (EPO). Data provider: Data extracted by the European Commission JRC): Analysis of the online database PATSTAT, which is the Worldwide Patents Database managed by the EPO.

References

JRC, Monitoring R&I in Low-Carbon Energy Technologies

List of CPC codes used for indicator calculation
Patents related to recycling and secondary raw materials – Eurostat (europa.eu) (cei_cie020)

5.10. Global sustainability from the circular economy

a) Consumption footprint

Relevance for the circular economy

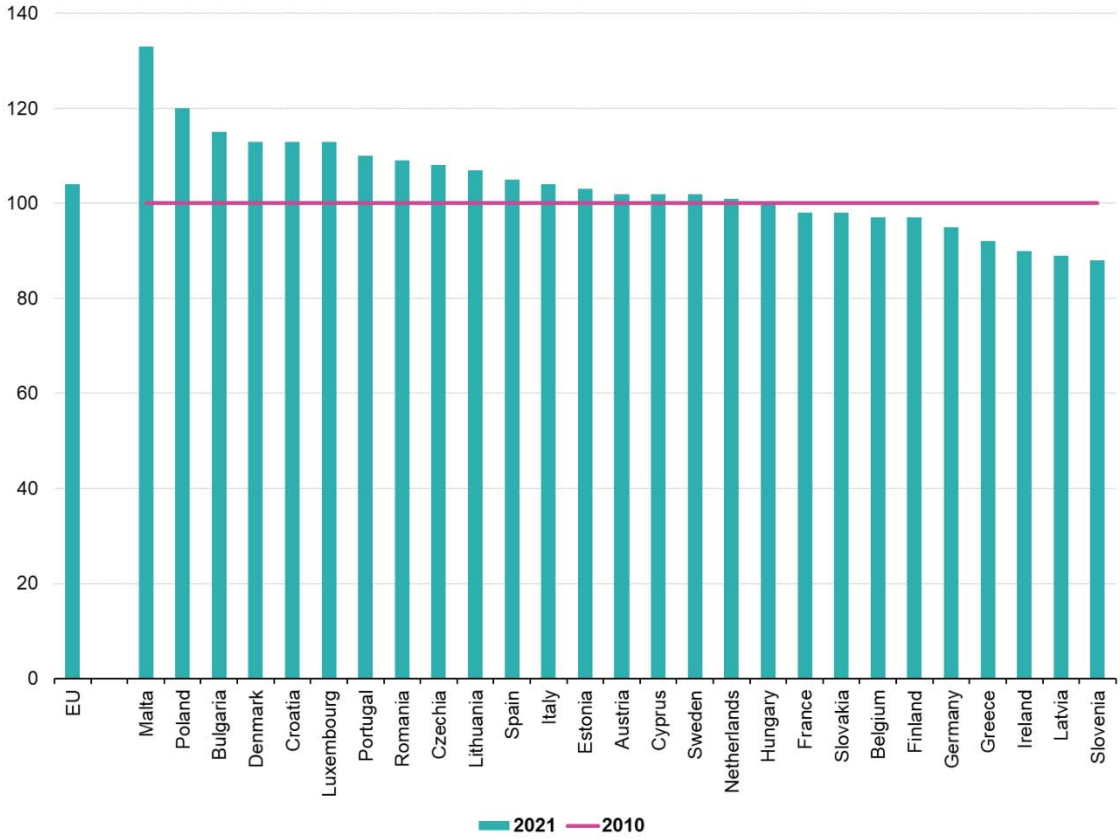
The Consumption Footprint[58] addresses the environmental impacts of consumption, considering both domestic and spill-over/transboundary environmental impacts through imported goods.. Circular-economy strategies to change both consumption patterns and the environmental profile of products might help to reduce the EU's consumption footprint. Such strategies could be strengthened by increasing trade aiming to maximise the potential of reusable products, recycling capacities and secondary raw materials.

Facts and figures

The EU's **consumption footprint** increased between 2010 and 2021 by 4%. This indicator is measured in the number of times that the planetary boundary has been transgressed. The Commission estimates that the EU has clearly transgressed planetary boundaries for four impacts (particulate matter, ecotoxicity in freshwater, climate change, and the use of fossil-based resources). The Commission remains uncertain as to whether we have transgressed planetary boundaries for the use of mineral and metal resources.

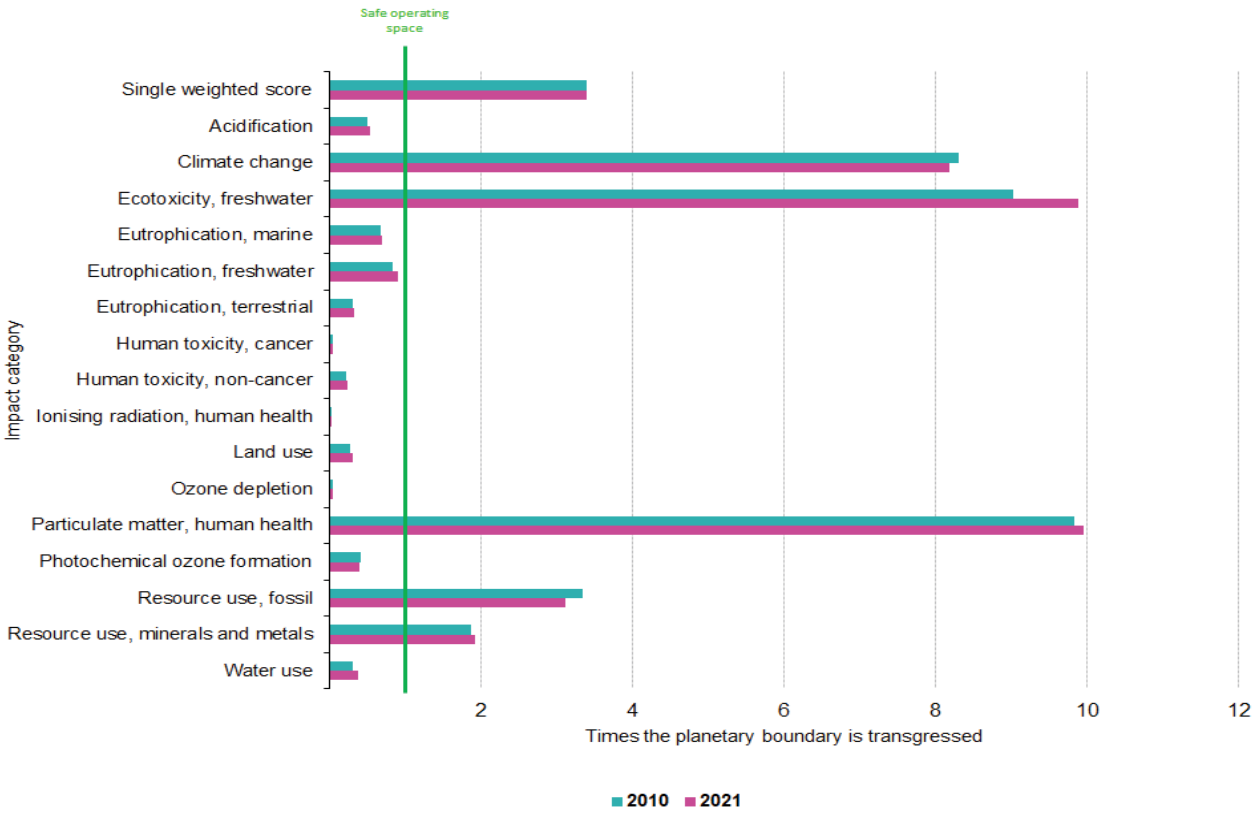
Figure 5.10.1 Consumption footprint (single score) (2010 = 100), 2021

[58] Sanye Mengual, E., and Sala, S., Consumption Footprint and Domestic Footprint: Assessing the environmental impacts of EU consumption and production, EUR 31390 EN, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-76-61754-9, doi:10.2760/218540, JRC128571.



Source: Joint Research Centre. Republished by Eurostat (online data code: cei_gsr010)

Figure 5.10.2 – Assessment of the EU's consumption footprint against planetary boundaries (including individual indicators and single score), 2010-2021



Source: Joint Research Centre. Re-published by Eurostat (online data code: cei_gsr010)

Indicator description

- **Definition:** The indicator estimates the environmental impacts of overall EU and individual Member State consumption by combining data on consumption intensity and the environmental impacts of the life cycle of representative products.
  The consumption footprint is a set of 16 indicators based on lifecycle assessments (also available individually). The purpose of these indicators is to quantify the environmental impacts of consumption at EU and Member State level. The consumption footprint is based on a combination of: (i) emissions to air, soil and water; and (ii) the resources used along the lifecycle of roughly 160 representative products (and the consumption intensities of those products) in 5 areas of consumption (food, mobility, housing, household goods, and appliances). This combination is then analysed using the environmental-footprint impact-assessment method[59],, which translates emissions and resource consumption into potential environmental impacts.

[59] Saouter, E., Biganzoli, F., Ceriani, L., Versteeg, D., Crenna, E., Zampori, L., Sala, S, Pant, R. (2018). Environmental Footprint: Update of Life Cycle Impact Assessment Methods – Ecotoxicity freshwater, human

- **Interpretation:** This indicator captures changes in the environmental impacts due to consumption patterns. The consumption perspective of the indicator considers both domestic production/consumption and trade (imports and exports) by assessing the entire supply-chain of products. The indicator gives insight into: (i) the environmental impacts of consumption; (ii) the contribution made to overall consumption impact by different areas of consumption; and (iii) the contribution made to overall consumption impact by different products. This makes it possible to assess the decoupling of environmental impacts from economic growth and evaluate current environmental impacts against planetary boundaries, i.e. science-based ecological thresholds.
- **Data source:** JRC.
  Consumption Footprint Platform on Lifecycle Assessment

References

Sanye Mengual, E., and Sala, S., Consumption Footprint and Domestic Footprint: Assessing the environmental impacts of EU consumption and production, EUR 31390 EN, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-76-61754-9, doi:10.2760/218540, JRC128571.
JRC Science for policy report: Consumption and Domestic Footprint
Consumption Footprint Platform – Introduction and policy context
European platform on lifecycle assessment
Consumption footprint – Eurostat (europa.eu) (cei_gsr010)

---

toxicity cancer, and non-cancer. EUR 29495 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-79-98182-1, doi: 10.2760/178544, EC- JRC114227.

b) GHG emissions from production activities

Relevance for the circular economy

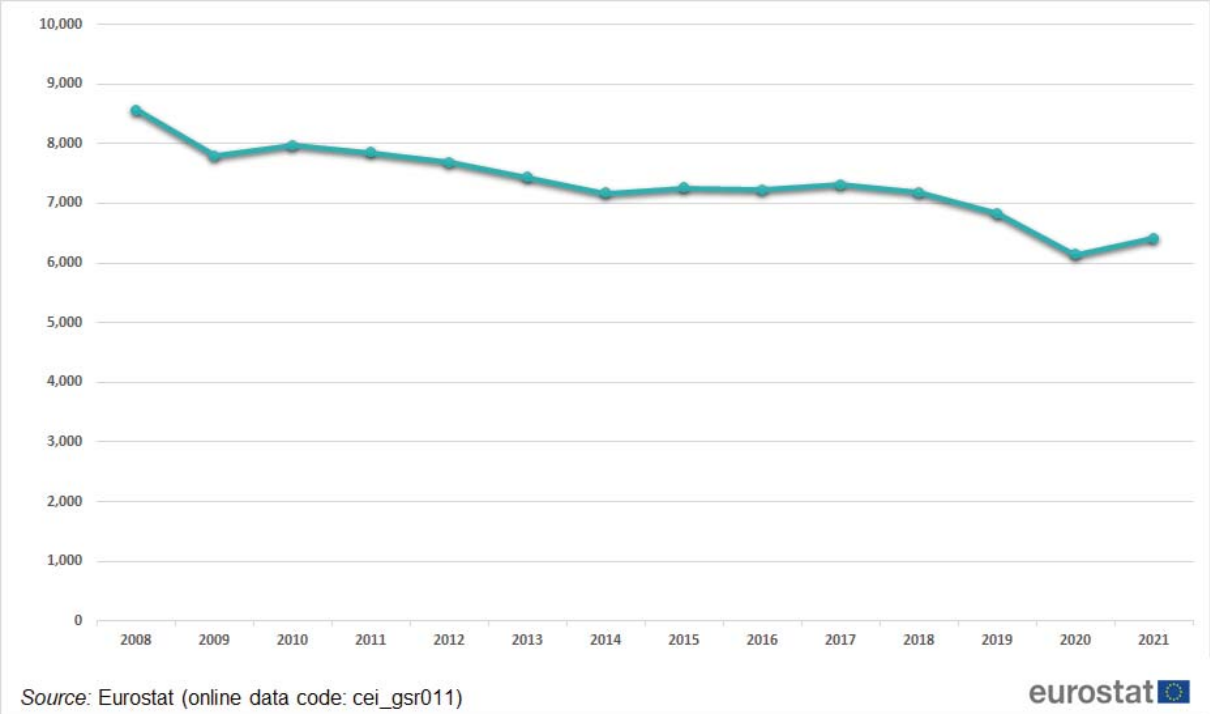
The circular economy is interlinked with climate change mitigation. Extractions of natural resources along the production chain are responsible for some emissions of GHGs. Waste creates GHGs, either directly (e.g. if waste is incinerated or landfilled) or indirectly (if the used products cannot be reused, repaired, or recycled., etc and thus we need to manufacture new products). A circular economy with greater use of secondary raw materials produces fewer GHG emissions. The EU's ambition is to reduce EU GHG emissions by at least 55% by 2030, compared to 1990 levels, and to reach climate neutrality (no net emissions of GHGs) by 2050.

To achieve our decarbonisation objectives, emissions must be reduced **in all sectors**, from industry to energy, and from transport to farming.

Facts and figures

GHG emissions generated by economic producers in the EU have decreased in recent years, falling **from 8.6 tonnes per inhabitant in 2008 to 6.4 tonnes per inhabitant in 2021**.

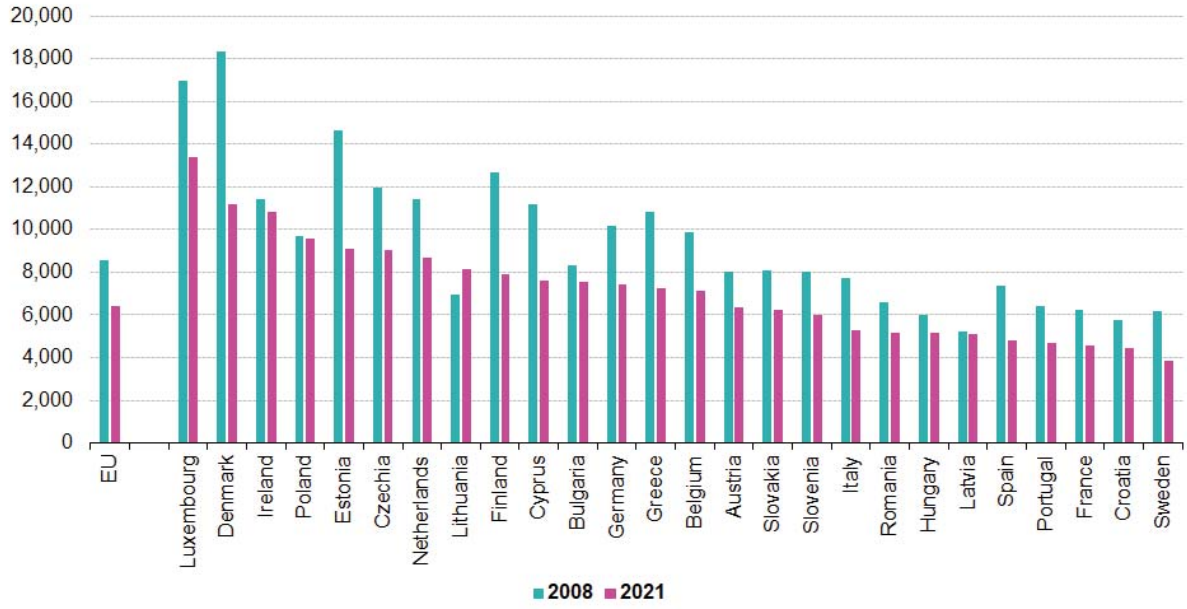
Figure 5.10.3 EU GHG emissions from production activities (kg CO_2-equivalent per capita), 2008-2021



Among the EU Member States, the volume of GHGs emitted by various producers varies considerably. These differences are partly due to different economic structures and different mixes of renewable and non-renewable energy sources. In 13 EU Member States, manufacturing was the main emitter of GHGs in 2021, while in 8 other Member States businesses supplying electricity, gas, steam and air conditioning were the main emitters. In a further 3 countries Member States, transportation and storage activities were the main source of GHG emissions.

In 2021, all Member States have reduced their GHG emissions from production activities, measured in kg CO2-equivalents per capita, compared with 2008 levels, except for Ireland, Lithuania and Luxembourg.

Figure 5.10.4 GHG emissions from production activities (kg CO_2-equivalents per capita), 2008 and 2021



Note: Sorted on 2021 data
All values are estimates except for Sweden
Source: Eurostat (online data code: cei_gsr011)

eurostat

Indicator description

- **Definition:** GHGs are carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and three types of fluorinated gases (hydrofluorocarbons or HFCs), namely perfluorocarbons (PFCs), sulfur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).
  The indicator includes emissions of GHGs in the EU by all emitting economic activities, including international transport, and excluding emissions by households for heating, transportation and other purposes.

- **Interpretation:** The indicator is measured in kilograms of CO_2 equivalent per capita. Each GHG has a different capacity to cause global warming, depending on its radiative properties, molecular weight, and the length of time it remains in the atmosphere. The global-warming potential of each gas is calculated in relation to a given weight of carbon dioxide for a set time period (for the purpose of the Kyoto Protocol, a period of 100 years). The weighting factors currently used are the following: carbon dioxide=1, methane=25, nitrous oxide=298, and sulfur hexafluoride=22 800. Hydrofluorocarbons and perfluorocarbons comprise a large number of different gases that have different global-warming potentials.
- **Data source:** Air-emissions accounts based on Regulation (EU) No 691/2011 of the European Parliament and of the Council on European environmental-economic accounts. This data source classifies the GHG by emitting economic activities This indicator only includes the GHG by economic producers. Air emission accounts are suited for integrated environmental-economic analyses such as calculating emission intensities or 'footprints'. Data provider: Statistical Office of the European Union (Eurostat), based on data reported by national authorities.

  Air-emissions accounts by NACE Rev. 2 activity – Eurostat (europa.eu) (env_ac_ainah_r2).

References

Greenhouse-gas emission statistics – air-emissions accounts – Statistics Explained (europa.eu)
Climate change – driving forces – Statistics Explained (europa.eu)
SDG 13 – Climate action – Statistics Explained (europa.eu)
Greenhouse-gas emissions from production activities – Eurostat (europa.eu) (cei_gsr011)

5.11. Resilience from the circular economy

a) Material import dependency

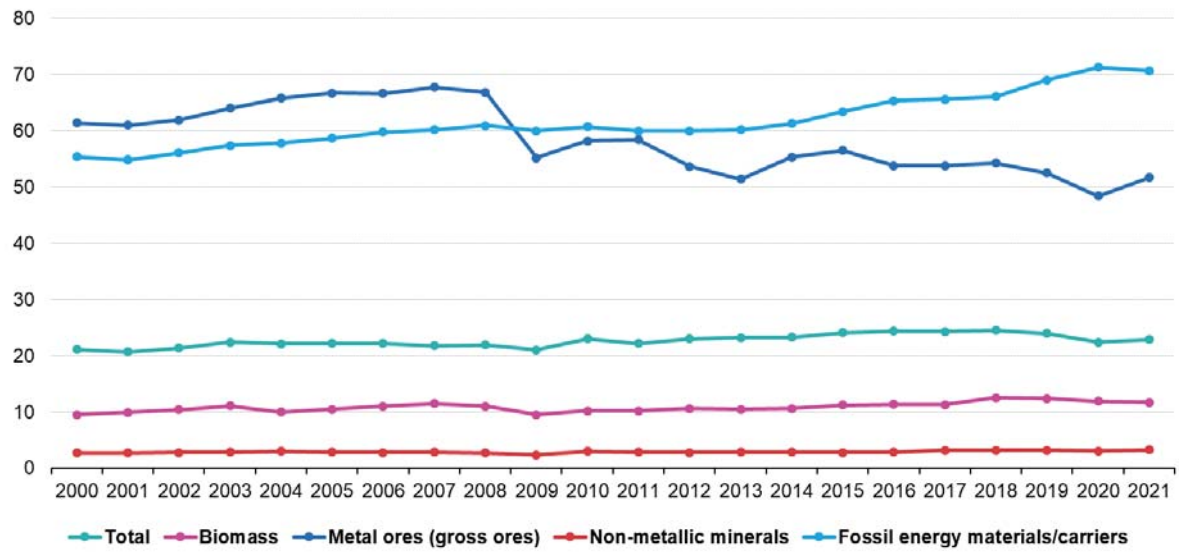
Relevance for the circular economy

'Material import dependency' is the extent to which an economy relies upon imports to meet its material needs. The EU's material import dependency has long been a topic of discussion. The current geopolitical events highlight the vital importance of controlling and decreasing de-risking import dependency, especially forfor fossil-energy materials. Energy security tops the EU's agenda and the circular use of materials can reduce the risks faced by the EU and increase the automomy of the EU and its resilience against supply chain disruptions.

Facts and figures

In 2021, the **EU's material import dependency was 22.9%,** up from 21.1% in 2000. The EU economy is almost self-sufficient in the supply of non-metallic minerals (construction materials) and biomass, with import dependencies in these categories of just over 3% and around 12% respectively. For metal ores and fossil-energy materials, the EU is highly dependent on imports from the rest of the world (around 52% and almost 71% respectively). The largest increase in material import dependency between 2000 and 2021 was for biomass and fossil-energy materials.

Figure 5.11.1 EU material-import dependency, by material category (percentage), 2000-2021



Note:
2020 and 2021 values are provisional estimates
Source: Eurostat (online data code: env_ac_mid)

eurostat

Indicator description

- **Definition:** This dataset is calculated as the ratio of imports over direct material inputs expressed as a percentage. This ratio is calculated for all the materials and for four

categories of materials: biomass, metal ores, non-metallic minerals and fossil energy materials.

- **Interpretation:** Material import dependency cannot be negative or higher than 100%. Values equal to 100% indicate that there were no domestic extractions during the reference year.
- **Data source:** Environmental-economic accounts, material-flow accounts based on Regulation (EU) No 691/2011 of the European Parliament and of the Council. Data provider: Statistical Office of the European Union (Eurostat).
  Material import dependency – Eurostat (europa.eu) (env_ac_mid)

References

Material flow accounts and resource productivity – Statistics Explained (europa.eu)
Physical imports and exports – Statistics Explained (europa.eu)
Material import dependency – Eurostat (europa.eu) (cei_gsr030)

b) EU self sufficiency for raw materials

Relevance for the circular economy

Raw materials are essential for the functioning of the EU's economy. A wide variety of industrial sectors depend on the secure supply of raw materials, typically through a diversified mixture of domestic extraction, recycling and imports. The EU's circular-economy action plan targets specific actions in the area of CRMs. CRMs are materials that are of high economic importance for the EU and vulnerable to supply disruption. In certain cases, their extraction also causes significant environmental impacts, and so their critical economic importance can also have significant environmental policy implications. Increasing the recovery of CRMs is one of the key challenges to be addressed in the move to a more circular economy.

The composite indicator provides the weighted average as a benchmark at the disaggregated level of data for each type of material. It also provides interesting insights into the differences between materials (for example, the EU is much more self-sufficient in certain CRMs than in others).

Facts and figures

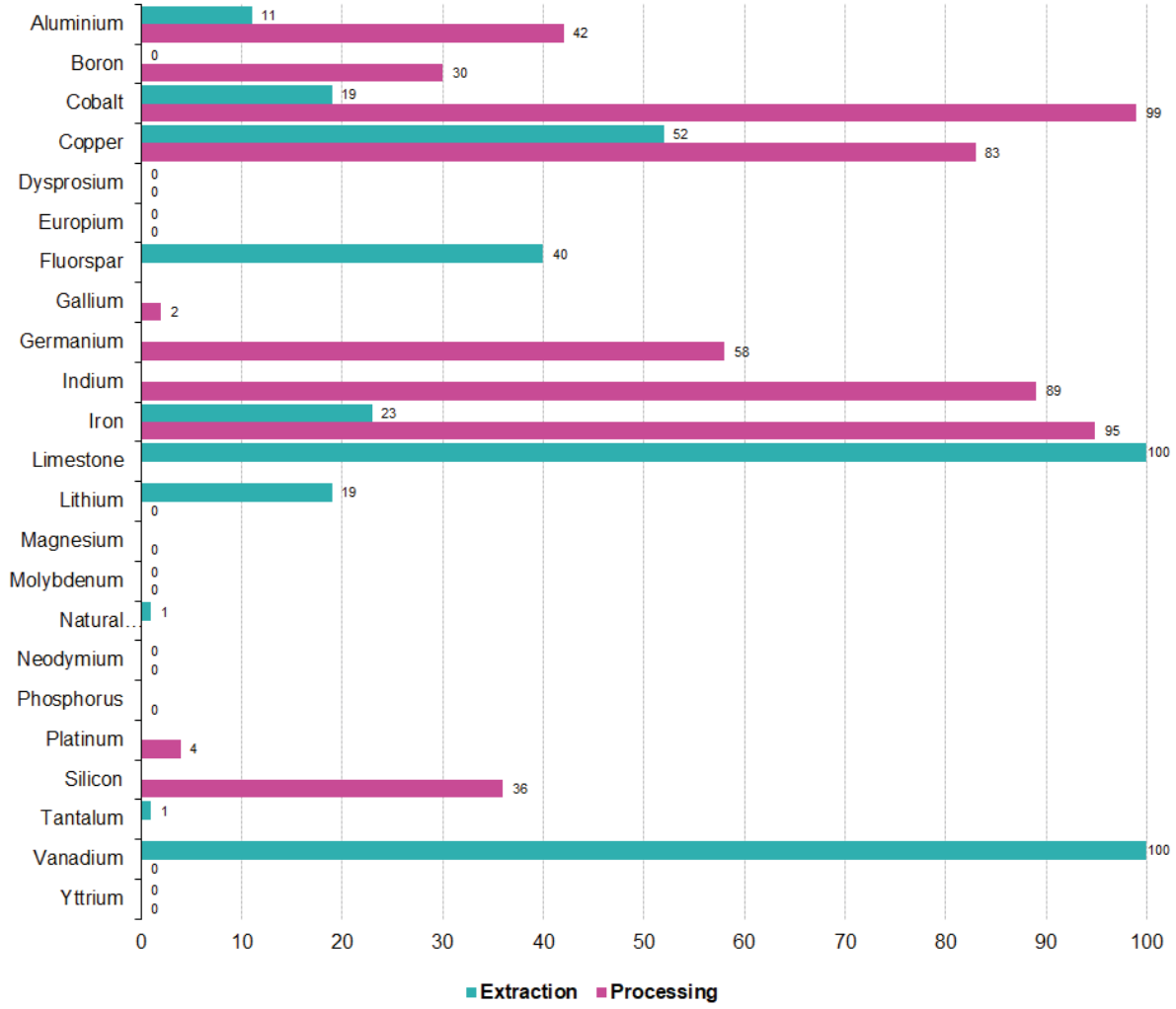
The EU's degree of self-sufficiency is different for each raw material. For some raw materials such as copper or limestone, the EU is largely self-sufficient. This is also the case for most non-metallic minerals[60].

At the extraction stage, for a number of bulk materials, (such as aluminium, copper or iron), the **EU's self-sufficiency at the extraction phase varies between 11% and 52%.** For some of these materials, the EU's self-sufficiency for processing stands at between 50% and 100%. For fluorspar and indium, the EU is 100% self-sufficient for processing, and the EU is almost 95% self-sufficient for processing iron.

For most CRMs, there is a major supply risk, typically linked to geopolitical risks in some countries. In most cases, the supply from recycling for these materials is relatively low compared to total demand (see indicator 7a). This is mostly because primary extraction is often more economic than recycling, since these materials are used in very small quantities (making collection and separation costly) and/or because it is often difficult to recycle these materials at sufficient degrees of purity.

[60] See also the Raw Materials Scoreboard, indicator 3 on share of imports.

Figure 5.11.2 Self-sufficiency for selected raw materials (percentage), 2022



Source: Joint Research Centre. Re-published by Eurostat (online data code: cei_gsr020)

Indicator description

- **Definition:** The self-sufficiency indicator measures the degree to which the EU is independent from the rest of the world for the supply of several raw materials.
  The indicator is calculated based on **yearly quantity data for domestic production, exports and imports**, using the formula: **self-sufficiency = 1 - (net) import reliance**, where import reliance (IR) is defined in the EU Critical Raw Materials methodology as net imports/(net imports+domestic production):

$$\text{Import Reliance (IR)} = \frac{\text{Net Import}}{\text{Apparent Consumption}} = \frac{\text{Import} - \text{Export}}{\text{Domestic production} + \text{Import} - \text{Export}}$$

The computations for the self-sufficiency indicator have been conducted at the first **two stages** of the value chain: **extraction (E) and processing (P)** for most of the materials.
The values of the self-sufficiency indicator could range from 0% to 100%, in the same interval as import reliance, since any value outside this range cannot be interpreted (there is no such thing as negative self-sufficiency, nor can self-sufficiency exceed 100% for a specific material).

- **Interpretation**: For certain raw materials, the EU is more self-sufficient than for others. The data source makes it possible to disaggregate self sufficiency by material. Due to increasing demand for certain materials (such as silicon, copper, tellurium and indium), even if 100% of materials were recycled, the EU would still not be self-sufficient.
  The indicator should be considered in a broader context of potential supply disruption in economically sensitive key areas. Self-sufficiency for raw materials, in combination with an analysis of the source countries for these materials, can help to assess supply risks for these materials.
- **Data source:** JRC based on production data and trade data.
  - **Production data**, taken from the specialised international data providers: World Mining Data and British Geological Survey. In these sources, production is available by material and country. Data at EU level has been computed by summing-up the production data of individual Member States.
  - **Trade data**, taken from COMEXT (source: Eurostat) – the quantity of imports and exports for each raw material. At EU level, extra-EU trade data are used. To calculate the indicator at Member State level, the individual country data for imports and exports are used.

Data provider: JRC

References

Critical raw materials (europa.eu)
Raw materials information system
EU self-sufficiency for raw materials – Eurostat (europa.eu) (cei_gsr020)

6. Annexes

Annex 1 - Member States acronyms

AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	The Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

Annex 2 - List of good and services for the indicator "private investment, jobs and gross value added related to circular economy sector"

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Filter Gravel for water and wastewater filtration	08.12	Operation of gravel and sand pits; mining of clays and kaolin	08.12.12	Granules, chippings and powder; pebbles, gravel	08121210	Gravel and pebbles of a kind used for concrete aggregates, for road metalling or for railway or other ballast; shingle and flint
Collection of waste resulting from the extraction of raw materials;	09	Mining support service activities	09.90.19	Support services to other mining and quarrying n.e.c.	0710	Mining of iron ores
Collection of waste resulting from the extraction of raw materials;	09	Mining support service activities	09.90.19	Support services to other mining and quarrying n.e.c.	0729	Mining of other non-ferrous metal ores
Paper recycling	17.1	Manufacture of pulp, paper and paperboard	17.1	Manufacture of pulp, paper and paperboard	171	Manufacture of pulp, paper and paperboard
Ozone for water desinfection	20.11	Manufacture of industrial gases	20.11.11	Hydrogen, argon, rare gases, nitrogen and oxygen	20111170	Oxygen
Chlorine for water desinfection	20.13	Manufacture of other inorganic basic chemicals	20.13.21	Metalloids	20132111	Chlorine
Recyclate from waste plastic	20.16	Manufacture of plastics in primary forms	20.16.1	Polymers of ethylene, in primary forms	201610	Polymers of ethylene, in primary forms
Recyclate from waste plastic	20.16	Manufacture of plastics in primary forms	20.16.4	Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and	201640	Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
				other polyesters, in primary forms		other polyesters, in primary forms
Recyclate from waste plastic	20.16	Manufacture of plastics in primary forms	20.16.51	Polymers of propylene or of other olefins, in primary forms	201651	Polymers of propylene or of other olefins, in primary forms
Recyclate from waste plastic	20.16	Manufacture of plastics in primary forms	20.16.54	Polyamides, in primary forms	201654	Polyamides, in primary forms
Activated carbon for water filtering purposes	20.59	Manufacture of other chemical products n.e.c.	20.59.54	Activated carbon	205954	Activated carbon
Retreading of tyres	22.11	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	22.11.2	Retreaded pneumatic tyres, of rubber	221120	Retreaded pneumatic tyres, of rubber
Camel-back strips for retreading rubber tyres	22.11	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres	22.11.16	Camel-back strips for retreading rubber tyres	221116	Camel-back strips for retreading rubber tyres
Manufacture of reclaimed rubber in primary forms or in plates, sheets or strip;	22.19	Manufacture of other rubber products	22.19.1	Reclaimed rubber in primary forms or in plates, sheets or strip	221910	Reclaimed rubber in primary forms or in plates, sheets or strips
Sewage infrastructure: sieve/trench drain strainer/Perforated buckets and similar articles used to filter water at the entrance to sewage drains;	22.29	Manufacture of other plastic products	22.29.26	Fittings for furniture, coachwork or the like, of plastics; statuettes and other ornamental articles, of plastics	22292630	Perforated buckets and similar articles used to filter water at the entrance to drains, of plastic
Recycled glass	23.13	Manufacture of hollow glass	23.13	Hollow glass	2313	Manufacture of hollow glass
Lime for waste water treatment plant; Flue gas desulfurization of thermal treatment plants	23.52	Manufacture of lime and plaster	23.52.1	Quicklime, slaked lime and hydraulic lime	23521035	Slaked lime

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Concrete sewage pipes	23.61	Manufacture of concrete products for construction purposes	23.61	Concrete products for construction purposes	236111	Tiles, flagstones, bricks and similar articles, of cement, concrete or artificial stone
Melting of iron wastes (not in 38.3): Basic iron and steel and ferro-alloys	24.10	Manufacture of basic iron and steel and of ferro-alloys	24.1	Basic iron and steel and ferro-alloys	24101100	Pig iron and spiegeleisen in pigs, blocks or other primary forms
Melting of iron wastes (not in 38.3): Basic iron and steel and ferro-alloys	24.10	Manufacture of basic iron and steel and of ferro-alloys	24.1	Basic iron and steel and ferro-alloys	24101420	Remelting scrap ingots of iron or steel (excluding products whose chemical composition conforms to the definitions of pig iron, spiegeleisen, or ferro-alloys)
Material recovery: Production of secondary aluminium by electrorefining from residuals and waste materials (not in 38.3)	24.42	Aluminium production	24.42	Aluminium	2442	Aluminium production
Material recovery: Production of secondary copper by electro-refining from residuals and waste materials (not in 38.3)	24.44	Copper production	24.44	Copper	2444	Copper production
Material recovery: non-FE metals	24.45	Other non-ferrous metal production	24.45.3	Other non-ferrous metals and articles thereof; cermets; ash and residues, containing metals or metallic compounds	2445	Other non-ferrous metal production
Tubes and pipes for sewage system	24.51	Casting of iron	24.51.20	Tubes, pipes and hollow profiles of cast-iron	245120	Tubes, pipes and hollow profiles of cast-iron
Tubes and pipes for sewage system	24.51	Casting of iron	24.51.30	Tube or pipe fittings, of cast-iron	245130	Tube or pipe fittings, of cast-iron

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Parts for sewage infrastructure	25.99	Manufacture of other fabricated metal products n.e.c.	25.99.29	Other articles of base metal n.e.c.	25992913	Articles of non-malleable cast iron, n.e.c.
Waste water treatment: hydrological analysis appliances	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.12	Theodolites and tachymetres (tachometers); other surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances	265112	Theodolites and tachymetres (tachometers); other surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances
Waste water treatment: Appliances for chemical and physical examination of waste water; instruments for waste analysis and treatment	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.5	Instrument for checking other physical characteristics	265151	Hydrometers, thermometers, pyrometers, barometers, hygrometers and psychrometers
Waste water treatment: Appliances for chemical and physical examination of waste water; instruments for waste analysis and treatment	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.5	Instrument for checking other physical characteristics	265152	Instruments for measuring or checking the flow, level, pressure or other variables of liquids and gases
Waste water treatment: Appliances for chemical and physical examination of waste water; instruments for waste analysis and treatment	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.5	Instrument for checking other physical characteristics	265153	Instruments and apparatus for physical or chemical analysis n.e.c.
Waste water treatment: Appliances for chemical and physical examination of waste water;	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.4	Instruments for measuring electrical quantities or ionising radiations	26514100	Instruments and apparatus for measuring or detecting ionising radiations

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
instruments for waste analysis and treatment						
Instruments for waste analysis and treatment; Sensors for material efficient production	26.51	Manufacture of instruments and appliances for measuring, testing and navigation	26.51.66	Measuring or checking instruments, appliances and machines n.e.c.	26516690	Measuring or checking instruments, appliances and machines n.e.c.
Pumps for use in wastewater treatment	28.13	Manufacture of other pumps and compressors	28.13.13	Other rotary positive displacement pumps for liquids	281313	Other rotary positive displacement pumps for liquids
Pumps for use in wastewater treatment	28.13	Manufacture of other pumps and compressors	28.13	Other pumps and compressors	281314	Other centrifugal pumps for liquids; other pumps
Pumps for use in wastewater treatment	28.13	Manufacture of other pumps and compressors	28.13.12	Other reciprocating positive displacement pumps for liquids	28131280	Positive displacement reciprocating pumps, diaphragm
Pumps for use in wastewater treatment	28.13	Manufacture of other pumps and compressors	28.13.13	Other rotary positive displacement pumps for liquids	28131380	Positive displacement pumps, rotary (including peristaltic, rotary lobe and helical rotor pumps) (excluding hydraulic units, gear pumps, vane pumps, screw pumps)
Parts for pumps for use in wastewater treatment	28.13	Manufacture of other pumps and compressors	28.13.31	Parts of pumps; parts of liquid elevator	28133100	Parts of pumps for liquids and for liquid elevators
Reloading facility, waste conveying system	28.22	Manufacture of lifting and handling equipment	28.22.17	Pneumatic and other continuous action elevators and conveyors, for goods or materials	282217	Pneumatic and other continuous action elevators and conveyors, for goods or materials
Reloading facility, waste conveying system	28.22	Manufacture of lifting and handling equipment	28.22.18	Other lifting, handling, loading or unloading machinery	28221840	Lifting, handling, loading or unloading machinery, n.e.s.

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Waste processing: Manufacture of weighing machinery	28.29	Manufacture of other general-purpose machinery n.e.c.	28.29.31	Weighing machines for industrial purposes; scales for continuous weighing of goods on conveyors; constant weight scales and scales for discharging a predetermined weight	282931	Weighing machines for industrial purposes; scales for continuous weighing of goods on conveyors; constant weight scales and scales for discharging a predetermined weight
Machinery and apparatus for filtering or purifying water	28.29	Manufacture of other general-purpose machinery n.e.c.	28.29.12	Filtering or purifying machinery and apparatus, for liquid	28291230	Machinery and apparatus for filtering or purifying water
Manufacture of machinery and apparatus for filtering or purifying gases and liquid	28.29	Manufacture of other general-purpose machinery n.e.c.	28.29.82	Parts of centrifuges; parts of filtering or purifying machinery and apparatus for liquids or gases	28298250	Parts for filtering and purifying machinery and apparatus, for liquids or gases (excluding for centrifuges and centrifugal dryers)
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.41	Manufacture of metal forming machinery	28.41.11	Machine tools for working metal by removal of material by laser, ultrasonic, water-jet and the like	284111	Machine tools for working metal by removal of material by laser, ultrasonic, water-jet and the like
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.41	Manufacture of metal forming machinery	28.41.12	Machining centres, unit construction machines and multi-station transfer machines, for working metal	284112	Machining centres, unit construction machines and multi-station transfer machines, for working metal
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.41	Manufacture of metal forming machinery	28.41.21	Lathes for removing metal	284121	Lathes for removing metal

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.41	Manufacture of metal forming machinery	28.41.24	Machine tools for planing, sawing, cutting-off or otherwise cutting metal	284124	Machine tools for planing, sawing, cutting-off or otherwise cutting metal
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.41	Manufacture of metal forming machinery	28.41.3	Other machine tools for working metal	284133	Forging or die-stamping machines and hammers; hydraulic presses and presses for working metal n.e.c.
Metal scrap processing machines	28.41	Manufacture of metal forming machinery	28.41.3	Other machine tools for working metal	28413261	Shearing machines, incl. presses, not numerically controlled, for working metal (excl. machines for working flat metal products and combined punching and shearing machines)
Machinery for metal recovery: Mechanical engineering product to classify, separate and sort wastes	28.49	Manufacture of other machine tools	28.49.1	Machine tools for working stone, wood and similar hard materials	284912	Machine tools for working wood, cork, bone, hard rubber, hard plastics or similar hard materials; electroplating machinery
Reloading facility, waste conveying system	28.91	Manufacture of machinery for metallurgy	29.91.11	Converters, ladles, ingot moulds and casting machines; metal-rolling mills	289111	Converters, ladles, ingot moulds and casting machines; metal-rolling mills
Facilities to agglomerate, compress, mix, metal pellet wastes	28.91	Manufacture of machinery for metallurgy	28.91.11	Converters, ladles, ingot moulds and casting machines; metal-rolling mills	28911153	Mills for rolling metal tubes, hot or combination hot and cold metal-rolling mills

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Machines for waste treatment: Mechanical engineering product to classify, separate and sort wastes	28.92	Manufacture of machinery for mining, quarrying and construction	28.92.4	Machinery for sorting, grinding, mixing and similar treatment of earth, stone, ores and other mineral substances	28924030	Sorting, screening, separating, washing machines; crushing, grinding, mixing, kneading machines excluding concrete/mortar mixers, machines for mixing mineral substances with bitumen
Machinery for retreading pneumatic tyres or plastic recyclate	28.96	Manufacture of plastics and rubber machinery	28.96.10	Machinery n.e.c. for working plastics and rubber or for the manufacture of products from these materials	28961060	Machinery for moulding or retreading pneumatic tyres or for moulding or otherwise forming inner tubes of rubber or plastics
Machinery for plastic recovery: Mechanical engineering product to classify, separate and sort wastes	28.96	Manufacture of plastics and rubber machinery	28.96.10	Machinery n.e.c. for working plastics and rubber or for the manufacture of products from these materials	28961093	Mixers, kneaders and agitators, for preparing rubber or plastics
Machinery for plastic recovery: Mechanical engineering product to classify, separate and sort wastes	28.96	Manufacture of plastics and rubber machinery	28.96.10	Machinery n.e.c. for working plastics and rubber or for the manufacture of products from these materials	28961095	Cutting, splitting and peeling machines for working rubber or plastics or for the manufacture of products from these materials
Machinery for wood and paper waste	28.99	Manufacture of other special-purpose machinery n.e.c.	28.99.31	Dryers for wood, paper pulp, paper or paperboard; non-domestic dryers n.e.c.	28993130	Dryers for wood, paper pulp, paper or paperboard
Mechanical engineering product for disassembly, waste shredding, screening and classifying	28.99	Manufacture of other special-purpose machinery n.e.c.	28.99.39	Aircraft launching gear; deck-arrestors or similar gear; tyre balancing equipment; special-purpose machinery n.e.c.	28993915	Machines and mechanical appliances, having individual functions, for mixing, kneading, crushing, grinding, screening, sifting,

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
						homogenising, emulsifying or stirring (excluding robots)
Vehicles for wastewater treatment, vehicles for sewer cleaning, trucks for waste collection;Manufacture of vehicles for wastewater treatment, vehicles for sewer cleaning, trucks for waste collection; Refuse collection vehicles, street sweepers and cleaners	29.10	Manufacture of motor vehicles	29.10.59	Special-purpose motor vehicles n.e.c.	29105990	Other special-purpose motor vehicles n.e.c.
Heavy-duty vehicle bodywork for refuse collection vehicles	29.10	Manufacture of motor vehicles	29.10.5	Special-purpose motor vehicles	29201050	Bodies for lorries, vans, buses, coaches, tractors, dumpers and special purpose motor vehicles including completely equipped and incomplete bodies, vehicles for the transport of â‰¥ 10 persons
Heavy-duty vehicle bodywork for refuse collection vehicles	29.20	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	29.20.21	Containers specially designed for carriage by one or more modes of transport	29202100	Containers specially designed and equipped for carriage by one or more modes of transport (including containers for transporting fluids)
Conversion and reconstruction of ships, floating platforms and structures;	30.11	Building of ships and floating structures	30.11.9	Conversion, reconstruction and fitting out services of ships, floating platforms and structures; sub-contracted operations as part of	30119100	Conversion and reconstruction of ships, floating platforms and structures

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
				manufacturing of ships and floating structures		
Reconditioning of railway and tramway locomotives and rolling-stock	30.20	Manufacture of railway locomotives and rolling stock	30.20.9	Reconditioning and fitting out services ("completing") of railway and tramway locomotives and rolling-stock; sub-contracted operations as part of manufacturing of railway locomotives and rolling stock	30209100	Reconditioning of railway and tramway locomotives and rolling-stock
Reconditioning of aircraft: civilians	30.30	Manufacture of air and spacecraft and related machinery	30.30.60	Overhaul and conversion services of aircraft and aircraft engines	30306070	Reconditioning of aircraft: civilians
Reconditioning of civil aircraft engines	30.30	Manufacture of air and spacecraft and related machinery	30.30.60	Overhaul and conversion services of aircraft and aircraft engines	30306030	Reconditioning of civil aircraft engines
Reconditioning of civil helicopters	30.30	Manufacture of air and spacecraft and related machinery	30.30.60	Overhaul and conversion services of aircraft and aircraft engines	30306050	Reconditioning of civil helicopters
Repair of fabricated metal products, machinery and equipment	33.11	Repair of fabricated metal products	33.11	Repair of fabricated metal products	3311	Repair of fabricated metal products
Repair of fabricated metal products, machinery and equipment	33.12	Repair services of machinery	33.12	Repair services of machinery	3312	Repair of machinery
Repair of fabricated metal products, machinery and equipment	33.13	Repair services of electronic and optical equipment	33.13	Repair services of electronic and optical equipment	3313	Repair of electronic and optical equipment

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Repair of fabricated metal products, machinery and equipment	33.14	Repair services of electrical equipment	33.14	Repair services of electrical equipment	3314	Repair of electrical equipment
Repair of fabricated metal products, machinery and equipment	33.15	Repair and maintenance services of ships and boats	33.15	Repair and maintenance services of ships and boats	3315	Repair and maintenance of ships and boats
Repair of fabricated metal products, machinery and equipment	33.16	Repair and maintenance services of aircraft and spacecraft	33.16	Repair and maintenance services of aircraft and spacecraft	3316	Repair and maintenance of aircraft and spacecraft
Repair of fabricated metal products, machinery and equipment	33.17	Repair and maintenance services of other transport equipment	33.17	Repair and maintenance services of other transport equipment	3317	Repair and maintenance of other transport equipment
Repair of fabricated metal products, machinery and equipment	33.19	Repair services of other equipment	33.19	Repair services of other equipment	3319	Repair of other equipment
Installation of waste systems and conveyors	33.20	Installation of industrial machinery and equipment	33.20.38	Installation services of industrial machinery and equipment for plastic and rubber production	332038	Installation services of industrial machinery and equipment for plastic and rubber production
Installation of waste systems and conveyors	33.20	Installation of industrial machinery and equipment	33.20.39	Installation services of other special-purpose machinery	332039	Installation services of other special-purpose machinery
Installation of waste, waste-water systems and conveyors	33.20	Installation of industrial machinery and equipment	33.20.2	Installation services of general-purpose machinery	33202920	Installation of pumps and compressors
Installation of waste, waste-water systems and conveyors	33.20	Installation of industrial machinery and equipment	33.20.2	Installation services of general-purpose machinery	33202960	Installation of general purpose machines and apparatus for weighing, filtration, distillation, packaging, bottling, spraying, steam/sand blasting, calendering
Installation of waste	33.20	Installation of industrial	33.20.32	Installation services of metal	33203200	Installation services of

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
systems and conveyors		machinery and equipment		forming machinery		metalworking machine tools
Installation of waste systems and conveyors	33.20	Installation of industrial machinery and equipment	33.20.33	Installation services of industrial machinery and equipment for metallurgy	33203300	Installation of machinery for metallurgy
Planning and installation of industrial process control equipment; installation services in waste management	33.20	Installation of industrial machinery and equipment	33.20.6	Installation services of industrial process control equipment	33206000	Design and assembly of industrial process control equipment and automated production plants
Sewerage services: e.g. collecting, transporting and treating wastewater; operation, maintenance and cleaning of sewer systems;Provision of sewerage services: e.g. collecting, transporting and treating wastewater; operation, maintenance and cleaning of sewer systems; Sewage	37.0	Sewerage	37.0	Sewerage services; sewage sludge	na	
Collection of waste	38.1	Waste collection	38.1	Waste; waste collection services	na	
Waste treatment (excluding landfill, incineration and nuclear waste treatment) (not otherwise included in 38.3 due to primary allocation)	38.2	Waste treatment and disposal	38.21.1	Non-hazardous waste treatment for final disposal services	na	

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Waste treatment (excluding landfill, incineration and nuclear waste treatment) (not otherwise included in 38.3 due to primary allocation)	38.2	Waste treatment and disposal	38.21.29	Other non-hazardous waste disposal services	na	
Waste treatment (excluding landfill, incineration and nuclear waste treatment) (not otherwise included in 38.3 due to primary allocation)	38.2	Waste treatment and disposal	38.21.3	Waste organic solvents	na	
Waste treatment (excluding landfill, incineration and nuclear waste treatment) (not otherwise included in 38.3 due to primary allocation)	38.2	Waste treatment and disposal	38.21.5	Pellets of municipal waste	na	
Materials recovery	38.3	Materials recovery	38.3	Materials recovery services; secondary raw materials	na	
Remediation activities and other waste management services	39.00	Remediation activities and other waste management services	39.00	Remediation services and other waste management services	na	
Maintenance and repair of water networks (utility)	42.21	Construction of utility projects for fluids	42.21.1; 42.21.2	Utility constructions for fluids	na	
Maintenance and repair of water networks (pipelines)	42.21	Construction of utility projects for fluids	42.21.12; 42.21.22	Local pipelines for fluids	na	
Construction work for sewage systems (utility)	42.21	Construction of utility projects for fluids	42.21.13	Sewage and water treatment plants	na	

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Construction work for sewage systems (pipelines)	42.21	Construction of utility projects for fluids	42.21.22	Construction works for local pipelines, including ancillary works	na	
Construction work for waste treatment plants	42.21	Construction of utility projects for fluids	42.21.23; 42.21.24	General construction services of sewage and water treatment plants	na	
Construction work for waste treatment plants	42.99	Construction of other civil engineering projects n.e.c.	42.99.19; 42.99.29	Other civil engineering constructions n.e.c.	na	
Maintenance and repair services for reducing water losses	43.22	Plumbing, heat and air-conditioning installation	43.22.12	Heating, ventilation and air conditioning installation works	na	
Maintenance and repair of motor vehicles	45.20	Maintenance and repair of motor vehicles	45.20.1	Maintenance and repair services of cars and light goods motor vehicles	na	
Maintenance and repair of motor vehicles	45.20	Maintenance and repair of motor vehicles	45.20.2	Maintenance and repair services of other motor vehicles	na	
Wholesale of waste and scrap	46.77	Wholesale of waste and scrap	46.77	Wholesale trade services of waste and scrap	na	
Retail sale of second-hand goods in stores (ecl. Antics)	47.79	Retail sale of second-hand goods in stores	47.00.92	Retail trade services of second-hand books	na	
Retail sale of second-hand goods in stores (ecl. Antics)	47.79	Retail sale of second-hand goods in stores	47.00.99	Retail trade services of other second-hand goods	na	
Architectural services for wastewater and waste management projects	71.11	Architectural activities	71.11	Architectural services	na	
Engineering services for sewerage and drainage projects	71.12	Engineering activities and related technical consultancy	71.12.16	Engineering services for water, sewerage and drainage projects	na	

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Engineering services for waste management projects;	71.12	Engineering activities and related technical consultancy	71.12.15	Engineering services for waste management projects (hazardous and non-hazardous)	na	
Rental and leasing of cars and light motor vehicles	77.11	Rental and leasing of cars and light motor vehicles	77.11	Rental and leasing services of cars and light motor vehicles	na	
Rental and leasing of trucks	77.12	Rental and leasing of trucks	77.12	Rental and leasing services of trucks	na	
Renting and leasing of recreational and sports goods	77.21	Rental and leasing of recreational and sports goods	77.21	Rental and leasing services of recreational and sports goods	na	
Renting of video tapes and disks	77.22	Rental of video tapes and disks	77.22	Rental services of video tapes and disks	na	
Renting and leasing of other personal and household goods	77.29	Rental and leasing of other personal and household goods	77.29	Rental and leasing services of other personal and household goods	na	
Renting and leasing of agricultural machinery and equipment	77.31	Rental and leasing of agricultural machinery and equipment	77.31	Rental and leasing services of agricultural machinery and equipment	na	
Renting and leasing of construction and civil engineering machinery and equipment	77.32	Rental and leasing of construction and civil engineering machinery and equipment	77.32	Rental and leasing services of construction and civil engineering machinery and equipment	na	
Renting and leasing of office machinery and equiment (including computers)	77.33	Rental and leasing of office machinery and equipment (including computers)	77.33	Rental and leasing services of office machinery and equipment (including computers)	na	
Renting and leasing of water transport equipment	77.34	Rental and leasing of water transport equipment	77.34	Rental and leasing services of water transport equipment	na	
Renting and leasing of air transport equipment	77.35	Rental and leasing of air transport equipment	77.35	Rental and leasing services of air transport equipment	na	

Circular Economy Sector: good or service description	NACE Rev. 2 (2008)	NACE Description	CPA (2008)	CPA Description	PRODCOM (2019)	Prodcom Description
Renting and leasing of other machinery, equipment and tangible goods n.e.c.	77.39	Rental and leasing of other machinery, equipment and tangible goods n.e.c.	77.39	Rental and leasing services of other machinery, equipment and tangible goods n.e.c.	na	
Library and archive services	91.01	Library and archives activities	91.01	Library and archive services	na	
Repair of computers and peripheral equipment	95.11	Repair of computers and peripheral equipment	95.11	Repair services of computers and peripheral equipment	na	
Repair of communication equipment	95.12	Repair of communication equipment	95.12	Repair services of communication equipment	na	
Repair of consumer electronics	95.21	Repair of consumer electronics	95.21	Repair services of consumer electronics	na	
Repair of household appliances and home and garden equipment	95.22	Repair of household appliances and home and garden equipment	95.22	Repair services of household appliances and home and garden equipment	na	
Repair of footwear and leather goods	95.23	Repair of footwear and leather goods	95.23	Repair services of footwear and leather goods	na	
Repair of furniture and home furnishings	95.24	Repair of furniture and home furnishings	95.24	Repair services of furniture and home furnishings	na	
Repair of watches, clocks and jewellery	95.25	Repair of watches, clocks and jewellery	95.25	Repair services of watches, clocks and jewellery	na	
Repair of other personal and household goods	95.29	Repair of other personal and household goods	95.29	Repair services of other personal and household goods	na	
Washing and (dry-)cleaning of textile and fur products (partially)	96.01	Washing and (dry-)cleaning of textile and fur products	96.01	Washing and (dry-)cleaning services of textile and fur products	na	

Annex 3 - List of CPC codes for the indicator "Number of patents related to waste management and recycling

CPC COOPERATIVE PATENT CLASSIFICATION

Y **GENERAL TAGGING OF NEW TECHNOLOGICAL DEVELOPMENTS; GENERAL TAGGING OF CROSS-SECTIONAL TECHNOLOGIES SPANNING OVER SEVERAL SECTIONS OF THE IPC; TECHNICAL SUBJECTS COVERED BY FORMER USPC CROSS-REFERENCE ART COLLECTIONS [XRACs] AND DIGESTS**
(NOTES omitted)

Y02 **TECHNOLOGIES OR APPLICATIONS FOR MITIGATION OR ADAPTATION AGAINST CLIMATE CHANGE**
(NOTES omitted)

Y02W **CLIMATE CHANGE MITIGATION TECHNOLOGIES RELATED TO WASTEWATER TREATMENT OR WASTE MANAGEMENT**

10/00 **Technologies for wastewater treatment**
10/10 . Biological treatment of water, waste water, or sewage
10/20 . Sludge processing
10/30 . Wastewater or sewage treatment systems using renewable energies
10/33 . . using wind energy
10/37 . . using solar energy
10/40 . Valorisation of by-products of wastewater, sewage or sludge processing

30/00 **Technologies for solid waste management**
30/10 . Waste collection, transportation, transfer or storage, e.g. segregated refuse collecting, electric or hybrid propulsion
30/20 . Waste processing or separation
30/30 . Landfill technologies aiming to mitigate methane emissions
30/40 . Bio-organic fraction processing; Production of fertilisers from the organic fraction of waste or refuse
30/50 . Reuse, recycling or recovery technologies
30/52 . . Mechanical processing of waste for the recovery of materials, e.g. crushing, shredding, separation or disassembly
30/56 . . of vehicles
30/58 . . Construction or demolition [C&D] waste
30/60 . . Glass recycling
30/62 . . Plastics recycling; Rubber recycling
30/64 . . Paper recycling
30/66 . . Disintegrating fibre-containing textile articles to obtain fibres for re-use
30/74 . . Recovery of fats, fatty oils, fatty acids or other fatty substances, e.g. lanolin or waxes
30/78 . . Recycling of wood or furniture waste
30/80 . . Packaging reuse or recycling, e.g. of multilayer packaging (bio-packaging Y02W 90/10)
30/82 . . Recycling of waste of electrical or electronic equipment [WEEE]
30/84 . . Recycling of batteries or fuel cells
30/91 . . Use of waste materials as fillers for mortars or concrete

90/00 **Enabling technologies or technologies with a potential or indirect contribution to greenhouse gas [GHG] emissions mitigation**
90/10 . Bio-packaging, e.g. packing containers made from renewable resources or bio-plastics

Annex 4. Key characteristics of circular economy monitoring indicators

Indicator and area	Unit(s)	Data Provider	Fequency of data collection	Timeliness	Available countries	First year	Most recent year
Production and consumption							
1. Material consumption							
a) Material Footprint	Tonnes per capita	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2008 (2000 EU)	2020
b) Resource productivity	- Index, 2000=100 - Euro per kilogram, chain linked volumes (2015) - Purchasing power standard (PPS) per kilogram	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2000	2021
2. Green public procurement	- Number - Percentage of GDP	European Commission (Eurostat)	Every year	t-1 year	EU + MS	(1)	
3. Waste generation		European Commission (Eurostat)					
a) Total waste generation per capita	kg per capita	European Commission (Eurostat)	Every 2 years	t-2 year	EU + MS	2004	2020
b) Generation of waste excluding major mineral wastes, per GDP unit	kg per thousand euro, chain linked volumes (2010)	European Commission (Eurostat)	Every 2 years	t-2 year	EU + MS	2004	2020
c) Generation of municipal waste (per capita)	kg per capita	European Commission	Every year	t-1 year	EU + MS	2000	2021

Indicator and area	Unit(s)	Data Provider	Fequency of data collection	Timeliness	Available countries	First year	Most recent year
		(Eurostat)					
d) Food waste	Kg fresh mass per capita	European Commission (Eurostat)	Every year	T – 2 year	EU + MS	2020	2020
e) Generation of packaging waste per capita	Kg per capita	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2000	2020
f) Generation of plastic packaging waste per capita	Kg per capita	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2000	2020
Waste management							
4. Overall recycling rates							
a) Recycling rate of municipal waste	Percentage	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2000	2021
b) Recycling rate of all waste excluding major mineral waste	Percentage	European Commission (Eurostat)	Every 2 years	t-2 year	EU + MS	2010	2020
5. Recycling rates for specific waste streams							
a) Recycling rate of overall packaging waste	Percentage	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2000	2020
b) Recycling rate of plastic packaging waste	Percentage	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2000	2020
c) Recycling rate of E-waste separately collected	Percentage	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2005	2020
Secondary raw materials							

Indicator and area	Unit(s)	Data Provider	Fequency of data collection	Timeliness	Available countries	First year	Most recent year
6. Contribution of recycled materials to raw materials demand							
a) Circular material use rate	Percentage	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2004	2021
b) End-of-life recycling input rates for raw materials	Percentage	European Commission (DG GROW, Joint Research Centre)	Every 3 years	t-1 year	EU level	2013	2022
7. Trade in recyclable raw materials							
a) Imports from non-EU countries	- Tonne - Thousand euro	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2004	2021
b) Exports to non-EU countries	- Tonne - Thousand euro	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2004	2021
c) Intra EU trade (imports from EU countries)	- Tonne - Thousand euro	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2004	2021
Competitiveness and innovation							
8. Private investment, jobs and gross added value related to circular economy sectors							
a) Private investments	- Million euro - Percentage of GDP	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2005	2021

Indicator and area	Unit(s)	Data Provider	Fequency of data collection	Timeliness	Available countries	First year	Most recent year
b) Employment	- Number - Percentage of total employment	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2005	2021
c) Gross added value	- Million euro - Percentage of GDP	European Commission (Eurostat)	Every year	t-2 year	EU + MS	2005	2021
9. Innovation							
a) Patents related to waste management and recycling	- Number - Number per million inhabitants	European Commission (Joint Research Centre based on PATSTAT)	Every year	t-4 year	EU + MS	2000	2019
Global sustainability and resilience							
10. Global sustainability from circular economy							
a) Consumption footprint	- Index (2010=100) - Number of planetary boundaries - Per capita	European Commission (Joint Research Centre)	Every year	t-2 year	EU + MS	2010	2021
b) GHG emissions from production activities	Kg per capita	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2000	2021
11. Resilience from circular economy							
a) Material import dependency	Percentage	European Commission (Eurostat)	Every year	t-1 year	EU + MS	2000	2021
b) EU self-sufficiency for raw materials	Percentage	European Commission	Every 3 years	t-2 year	EU level	2011	2022

Indicator and area	Unit(s)	Data Provider	Fequency of data collection	Timeliness	Available countries	First year	Most recent year
		(DG GROW, Joint Research Centre)					

Note (1) : first data on green public procurement will become available in 2024 with reference year 2023.