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Circular Economy:
from Indicators and Data to Policy-making

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Acronyms

ACOR	Australian Council Of Recycling
BAU	Business As Usual
BOD	Biological Oxygen Demand
CE	Circular Economy
CFRP	Carbon Fiber Reinforced Polymer
CKP	Subsidy for circular value chain projects (Circulaire Ketenprojecten)
DMC	Domestic Material Consumption
CH_4	Methane
CO_2	Carbon Dioxide
CO_2-eq	Carbon Dioxide equivalent
COD	Chemical Oxygen Demand
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DANE	National Administrative Department of Statistics (of Colombia), Departamento Administrativo Nacional de Estadística
ECE	Economic Commission for Europe
EEA	European Environment Agency
EFTA	European Free Trade Association
ENEC	National Circular Economy Strategy (of Colombia), Estrategia Nacional de Economía Circular
EPR	Extended Producer Responsibility
EU	European Union
EUR	Euro
FAO	Food and Agriculture Organization
F-gases	Fluorinated gases
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IC&I	Industrial, Commercial and Institutional
ICT	Information and Communication Technology
IEA	International Energy Agency
ILO	International Labour Organization
IMF	International Monetary Fund
$MtCO_2eq$	Metric Tonne of Carbon Dioxide equivalent
N	Nitrogen
N_2O	Nitrous Oxide
NCCP	National Climate Change Policy (of Nigeria)

NDC	Nigeria's Nationally Determinate Contribution
NCEP	National Programme on Circular Economy (of The Netherlands)
NSO	National Statistical Office
NWMS	National Waste Management Strategy (of South Africa)
OECD	Organisation for Economic Co-operation and Development
P	Phosphorous
PV	Photovoltaic
R&D	Research and Development
R+D+I	Research, Development and Innovation
RMC	Raw Material Consumption
RVO	Enterprise Agency (of The Netherlands), Rijksdientst Voor Ondernemend
SDGs	Sustainable Development Goals
SEMARNAT	Ministry (Secretariat) of Environment and Natural Resources (of Mexico), Secretaría de Medio Ambiente y Recursos Naturales
SIEC	Information System about Circular Economy of Colombia, Sistema de Información sobre Económica Circular
SMART	Specific Measurable Achievable Relevant Timebound
SMEs	Small and Medium-sized Enterprises
SS	Suspended Solids
UAE	United Arab Emirates
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNITAR	United Nations Institute for Training and Research
UNSD	United Nations Statistics Division
WEEE	Waste Electrical & Electronic Equipment

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Foreword

Circular economy is key to sustainable development. The linear economy model currently prevailing has resulted in damages to ecosystems and has shown to be unsustainable. Transforming our world: the 2030 Agenda for sustainable development promotes the development and adoption of sustainable practices and innovations that lead to the conservation of resources while championing societal and economic growth.

Excessive extraction and consumption of the world's natural resources exacerbated by the impacts of climate change are leaving the planet's ecosystems shattered. Accelerating the shift towards circular economy is therefore important, as it promotes keeping the resources in the economy as much as possible and advocates for creative thinking in developing technologies and processes to extend lifecycles.

The guidelines for measuring circular economy were developed in 2023 with the aim of providing a statistical framework that guides governments and policymakers to measure progress towards the shift to a circular economy. This report, including real examples of circular economy policies implemented in various countries, in different sectors and at different levels showcases how statistical indicators can be used to monitor policies and assess their impacts.

We aim for this report to promote the need for evidence-based policies to guide the development of targeted policies and assess the impact of policies on the environment, the economy, and the society. As this report includes practical examples from countries, we hope that governments consider it as a guidance tool in developing targeted policies to move forward on a circular economy according to their national and sub-national particularities.

Jian Liu
Director, Early Warning and Assessment Division

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Executive Summary

This report aims to map data at national, regional, and global levels, for core Circular Economy Indicators based on the Guidelines for measuring circular economy to assess the availability and accessibility of circular economy indicators. The joint United Nations Economic Commission for Europe and the Organisation for Economic Cooperation and Development guidelines were prepared by the Task Force on Measuring Circular Economy established in February 2021 by the Conference of European Statisticians.

The report evaluates the importance of core indicators in targeted policy-making to advance the shift towards a circular economy and presents country examples of what has been achieved in selected countries. Instances of how circular economy indicators could be used in monitoring targeted policies include resources decoupling, impact decoupling (waste generation and management, greenhouse gas emissions from production activities, pollutants discharges from production activities to water bodies), taxes and government support to circular economy business models, government and business research and development expenditure on circular economy technologies, business investment in circular economy activities and circular economy sector.

Information is provided about the trends of the core indicators in a circular economy model to guide countries in their policymaking and monitoring of circular economy policies and activities. Actual examples from different countries of instruments that were adopted to support circular economy, as well as examples of national initiatives implemented for monitoring the different strategies and policies are presented in the report.

01

Introduction

1.1 Aim of the Report

This report aims to map data at national, regional, and global levels, for core Circular Economy (CE) Indicators of the Joint UNECE/OECD Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators (United Nations Economic Commission for Europe [UNECE] 2023). The guidelines were developed by a Task Force that was set-up in 2021 to assess the availability and accessibility of circular economy indicators, and was formed by a significant number of international organizations[1], including UNEP, and countries representatives. The members of the Task Force assessed the available information on circular economy, homogenised the concepts and definitions, as well as proposed an aspirational indicators framework that could be used by any country to assess their progress towards shifting to circular economy.

This report also aims to link the usefulness of core indicators in targeted policy-making to advance the shift towards a circular economy and presents country examples of what has been achieved in selected countries.

1.2 Circular Economy Core Indicators

The developed Guidelines contain a list of proposed circular economy indicators. These indicators are divided into three indicators categories, namely core, complementary and contextual indicators. This report focuses on the core set of indicators only.

Core indicators are defined as those indicators that could be used to assess countries advancement in their shift to circular economy, through including key circular economy elements, responding to main policy questions, and highlight possible changes required for further analysis or potential action. The core set is divided into (a) operational indicators, that are highly relevant, already measurable and countries have the willingness to report on in the short or medium term, and

1 The Task Force was formed of representatives from (alphabetical order) the European Environment Agency, Eurostat, OECD, UNECE, UNEP, and benefited from active contributions from FAO, IMF, UNITAR, UNSD.

(b) aspirational indicators which are highly relevant but are not yet measurable and methodological development are still required. These indicators are classified into multiple themes which in turn are grouped into frameworks, according to Table 1 below. Indicators are presented, in some instances, by more than one sub-indicator or by using a proxy. For instance, material consumption and productivity contains four sub-indicators (domestic material consumption, raw material consumption, material productivity and raw material productivity), while for the following four indicators (total waste generation, national recycling rate, GHG emissions from production activities and pollutant discharges from production activities to water bodies and share safely treated), proxy indicators are proposed in the methodology considering the unavailability of the initial indicators.

Six indicators are named "placeholders" as these are considered important areas to be assessed as part of the core indicators list, yet no current indicator or proxy is available that represents what is supposed to be measured.

Table 1 Overview of circular economy framework, related themes and the proposed core indicators

Framework	Themes	Proposed core indicators
Material life-cycle and value chain	The material basis of the economy	Material consumption and productivity a. Domestic Material Consumption (DMC) b. Raw Material Consumption (RMC) c. Material productivity d. Raw material productivity
	The circularity of material flows and the management efficiency of materials and waste	Total waste generation Proxy: Municipal waste generation
		Circular material use rate
		National recycling rate Proxy: Municipal waste recycling rate
		Waste going to final disposal
	Interactions with trade	none
Interactions with the environment	Natural resource implications	Placeholder: Natural resource index/depletion ratios
		Intensity of use of renewable freshwater resources

Framework	Themes	Proposed core indicators
	Environmental quality implications	GHG emissions from production activities Proxy: Total GHG emissions
		Pollutant discharges from material extraction and processing to water bodies and share safely treated Proxy: Total discharges to water bodies and share of total discharges safely treated
	Impacts on human health	Placeholder
Responses and actions	Support circular use of materials, promote recycling markets and optimize design	Taxes and government support for circular economy business models
	Improve the efficiency of waste management and close leakage pathways	Investments in waste management, waste collection and sorting
		Tax rate/tonne landfilled or incinerated
	Boost innovation and orient technological change for more circular material lifecycles	Government and business R&D expenditure on circular economy technologies
	Target setting and planning	Placeholder: distance to targets
	Strengthen financial flows for a circular economy and reduced leakage	Business investment in circular economy activities
	Inform, educate, train	Placeholder
Socio-economic opportunities for a just transition	Market developments and new business models	Gross value added related to circular economy sectors
		Jobs in circular economy sectors
	Trade developments	none
	Skills, awareness, and behavior	Placeholder
	Distributional aspects of circular economy policies	Placeholder

Source: (UNECE 2023) table 3 page 19

Considering that placeholders refer to indicators that are yet to be identified and defined, from the initial list of 21 core indicators, only the 15 core indicators not classified as placeholders are further considered in this report.

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Data Sources, Data Providers and Methodologies

2.1 Data Sources

To create a dataset for the core indicators of circular economy, different data sources were identified and selected according to the following criteria:

- Global international sources were selected as the primary source of information, due to the wider coverage in terms of data availability from countries/regions. The databases used are:
  - The United Nations SDG indicators database (United Nations Statistics Department [UNSD] 2023a)
  - The World Bank Open Data (World Bank [WB] 2023)
- Non-global international sources were selected in case global international sources were not available. The databases used are the following:
  - The OECD Database (Organisation for Economic Co-operation and Development [OECD] 2023). Following the same criterium of coverage previously mentioned, this database with wider coverage was considered as a primary source.
  - Eurostat Database (Eurostat 2023a)

To assess data availability by source, Table 2 presents the percentage of data available from each source when considering (a) core indicators only, (b) core indicators and proxies, and (c) core indicators, sub-indicators and proxies.

Table 2 Distribution of the different data sources in the CE core indicators dataset

Data source	% CE core indicators[2]	% CE core indicators and proxies[3]	% CE core indicators, sub-indicators and proxies[4]
United Nations	27%	40%	50%
World Bank	0%	7%	6%
OECD	9%	7%	6%
Eurostat	64%	46%	38%

Source: Author's calculations

2.2 Data Providers

In general, data used to populate the circular economy core indicators dataset have two main providers:

- Data provided by national institutions.
- Indicators estimated by international organizations using country data from different sources. In this case, existing data from some countries can be used to create a model that could be applied to all the regions and/or the global level, or country data are used to estimate other variables. The accuracy of data estimates is lower than for national data.

For most of the indicators, data are compiled by a national governmental agency. This agency differs depending on the theme of the indicator and the country's administrative organisation. Some examples of institutions at the national level are:

- Ministry of commerce
- Ministry of trade
- Ministry of industry
- Ministry of agriculture/livestock
- Ministry of environment
- Ministry of water resources
- National Statistical Office (NSO)
- Any other national agencies/ministries.

It is quite common that the official agency responsible for providing data to the different international organisations is the NSO as the responsible institution of the National Statistical System. This agency acts as the national official focal point and country counterpart and, in many cases, coordinates the data collection at national level.

Countries, through their focal points, provide data to different international institutions:

- The United Nations compiles data on the Sustainable Development Goals (SDGs) from its Member States through the respective custodian agencies. The United Nations Statistics Division, for example, sends the UNSD/UNEP Questionnaire on Environment Statistics to all countries except those that are covered by the Joint OECD/Eurostat Questionnaire.
- Eurostat compiles data sent by European countries (data are collected by countries at the national level), including member states of the European Union, member states of the European Free Trade Association (EFTA) and candidate countries.

2 The data availability considers only the 15 core circular economy indicators (not the proposed proxies).
3 The proportion shows the availability of 15 core indicators and 4 proxies (proxies are available with a better coverage than the original indicator).
4 The proportion shows the availability of 18 core indicators at sub-indicator level and 4 proxies (proxies are available with a better coverage than the original indicator).

- The OECD compiles and publishes data from OECD countries not working with Eurostat and, in some cases, from all the countries collaborating with the organization.

It is very important to consider that the coverage, in terms of number of countries, varies, as well as the response rate. While Eurostat receives data from a significant percentage of countries that the organization covers (due to existing legal obligation and/or commitment), the response rate for other international institutions can be as low as 50 per cent (e.g. the UNSD/UNEP Questionnaire on Environment Statistics, covering 193 countries).

Box 1 UNSD/UNEP Questionnaire on Environment Statistics, UNSD Questionnaire on Environment Statistics

"The Questionnaire on Environment Statistics is part of the biennial UNSD data collection from all countries except those that are covered by the Joint OECD/Eurostat Questionnaire. Definitions used are provided within each Questionnaire. From one collection cycle to the next, content may change slightly, for example, to meet new demand such as that related to the Sustainable Development Goal agenda. Any such changes are mentioned within the Introduction of the Questionnaire.

Countries' responses to the Questionnaire are invaluable for monitoring the progress of the below Sustainable Development Goal indicators:

- 6.3.1 Proportion of domestic and industrial wastewater flow safely treated;
- 6.4.1 Change in water-use efficiency over time;
- 6.4.2 Level of water stress; freshwater withdrawal as a proportion of available freshwater resources;
- 11.6.1 Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities);
- 12.3.1 (b) Food waste index;
- 12.4.2 Hazardous waste generated per capita; and proportion of hazardous waste treated, by type of treatment; and
- 12.5.1 National recycling rate, tons of material recycled.

The latest round of this Questionnaire was sent to countries in 2022 following 10 previous collection rounds. As much as possible, Questionnaires are sent on a regular biennial basis to a country's National Statistical Office and Ministry of Environment with request for countries to identify a single focal point for communications with UNSD."

(UNSD 2023b)

2.3 Existing International Methodologies

Some international institutions have developed methodologies that allow and help countries to calculate data related to circular economy indicators, as for example, the International Energy Agency (IEA), the Food and Agriculture Organization of the United Nations (FAO), UNSD, UNEP, OECD and Eurostat.

A standard international methodology is essential for having a harmonized dataset for every indicator and country. International definitions and concepts are key for further comparability between countries, allowing later regional and global data analysis. As previously mentioned, currently, international definitions are only available for a selected number of core indicators.

Generally, methodologies and guidelines developed are not limited to single data collection methods and it is the country's decision to choose from the different options, considering the cost of the data collection method, national capacities, and administrative organization. The best choice should be taken in terms of relevance, representativeness and reliability of the final data obtained.

The different options for data collection include:

- Surveys (census or sampling surveys): Ideally, when it is possible, countries are encouraged to use a national survey already existing (for example, adding a specific module) to reduce the cost of data collection. Surveys can use interview-based methods, a digital or physical (paper) questionnaires with quantitative and qualitative questions. Sampling surveys are commonly used to collect data from sectors with a large number of units (industries or households).
- Administrative sources: This is a lower cost option but the requirements for using administrative records as statistical data are still challenging for many countries.
- Modelling: When the previous options are not available, modelling tools can be used to estimate national data. In this case, not all countries have the capacity to adequately use modelling and the estimated data might not follow international standards, in terms of quality and accuracy.
- A combination of multiple options previously presented.

Independently of the data collection method used, countries are encouraged to always provide quality reports containing a description of the collection method applied.

It is very important to mention that implementing new data collection instruments is extremely costly (new surveys, new administrative systems and so on) and that national financial and human resources are usually limited. In addition to this, it is also relevant to consider that many countries lack the capacity to carry out new collection methods related to circular economy.

Finally, the value of conducting surveys lies within their regular use and maintenance. As a result, one-off surveys can have some punctual value to formulate circular economy policies, but they cannot be used as evidence base for policy monitoring over time.

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Data Availability

3.1 Circular Economy Core Indicators

Circular economy is a recent thematic topic, whose boundaries definition is still in progress, and many indicators are not yet well-defined. In general, the information required to populate the circular economy indicators covers different types of fields (economic, environmental and social), and some of the indicators try to measure complex phenomena and require multi-dimensional data.

Some of the indicators are completely new, and a standard, internationally adopted methodology is not yet available, while methodologies for other indicators have only been recently adopted in many countries. These two factors play an important role in terms of their availability rate.

To evaluate the availability of circular economy indicators, it is also relevant to consider that currently data collected for these indicators are scattered due to the lack of homogenized questionnaire that solely focus on circular economy.

As previously mentioned, only the 15 core indicators not classified as placeholders were considered. Table 3 shows the available core indicators highlighted in grey. Out of the initial 15 indicators, data for 12[5] of them are available (80 per cent).

5 Including proxy indicators due to the unavailability of the initial indicators or to complement them.

Table 3 Data availability for CE core indicators as of 21/10/2023

Framework	Proposed core indicators
Material life-cycle and value chain	Material consumption and productivity a. Domestic Material Consumption (DMC) b. Raw Material Consumption (RMC) c. Material productivity[6] d. Raw material productivity[7]
	Total waste generation Proxy: Municipal waste generation
	Circular material use rate
	National recycling rate *Proxy: Municipal waste recycling rate*
	Waste going to final disposal
Interactions with the environment	Intensity of use of renewable freshwater resources
	GHG emissions from production activities
	Proxy: Total GHG emissions
	Pollutant discharges from material extraction and processing to water bodies and share safely treated *Proxy: Total discharges to water bodies and share of total discharges safely treated*
Responses and actions	Taxes and government support for circular economy business models
	Investments in waste management, waste collection and sorting
	Tax rate/tonne landfilled or incinerated
	Government and business R&D expenditure on circular economy technologies
	Business investment in circular economy activities
Socio-economic opportunities for a just transition	Gross value added related to circular economy sectors
	Jobs in circular economy sectors

Source: Author's elaboration

The distribution of the available core indicators' data at geographical level is presented in Table 4, Table 5 and Table 6. In Table 4, for example, 17 per cent of the indicators from UNSD have data from more than 180 countries and for 8 per cent of the indicators from the World Bank.

Table 4 Proportion of available CE core indicators' data at country level and by data source[8]

Number of countries	UNSD	World Bank	OECD	Eurostat	Proportion of CE core indicators available at country level
≥ 180	17%	8%			25%
60 – 179	8%				8%
40 – 59	17 %				17 %
30 – 39					
20 – 29				50%	50 %
0 -19					

Source: Author's calculations

Table 5 and Table 6 present the distribution of the available core indicators' data at regional, sub-regional and global levels, according to the country groupings defined by the United Nations Statistics Division (UNSD 1999). It is important to note that, according to UNEP's World Environment Situation Room aggregation method, regional aggregates are calculated if data is available for more than 55 per cent of countries within the same region. The list of the regions and subregions is available in Annex I.

6 Material intensity data are available. Material productivity can be calculated as its inverse.
7 Raw material intensity data are available. Raw material productivity can be calculated as its inverse.

8 The percentage of available indicators' data considers proxy indicators as they have better coverage.

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Table 5 Proportion of available CE core indicators' data at regional level and by data source

Number of regions/ subregions	UNSD	World Bank	OECD	Eurostat	Proportion of CE core indicators available at regional level
All regions/ subregions (37)	8%				8%
20 – 36 regions/ subregions	8%	8%			16%
4 – 19 regions/ subregions					
1 – 3 regions/ subregions				50%	50 %
0 regions/ subregions	26%				26%

Source: Author's calculations

Table 6 Proportion of available CE core indicators' data at global level and by data source

UNSD	World Bank	OECD	Eurostat	Proportion of CE core indicators available at global level
17%	8%			25 %

Source: Author's calculations

In general, the highest share of data availability at global and regional levels originates from UNSD data, while Eurostat covers 27-28 countries. Eurostat data availability reflects the recent efforts made by the institution to have information about circular economy sectors and activities, using information from different statistical operations.

3.2 Circular Economy Variables

To adequately analyze the availability of the data, it is important to mention that only two core indicators are represented by one variable each and have one single unit of measurement each (Table 7).

Table 7 CE core indicators represented by only one variable.

CE core indicators	Variables
Circular material use rate	Circular material use rate
GHG emissions from production activities	Total GHG emissions

Source: Author's elaboration

In other cases, indicators data are available for different sectors, different intensities representations and/or different measurement units, or additional proxy is available, as shown in Table 8.

Table 8 CE core indicators represented by several variables with different disaggregation and measurement units

CE core indicators	Variables
Material consumption and productivity a. Domestic Material Consumption (DMC) b. Raw Material Consumption (RMC) c. Material productivity d. Raw material productivity	DMC
	DMC by raw material
	RMC
	RMC by raw material
	DMC/GDP
	DMC by raw material/GDP
	RMC/GDP

CE core indicators	Variables
Total waste generation	Total waste generation
	Total waste generation by sector
	Municipal waste generation (proxy)
National recycling rate *Proxy: Municipal waste recycling rate*	Recycling rate of all waste excluding major mineral waste
	Municipal waste recycling rate (proxy)
Intensity of use of renewable freshwater resources	Water stress
	Water stress by sector
Business investment in CE activities	Business investment on CE activities as percentage of the GDP
	Business investment on CE activities
Gross value added to CE sectors	Gross value added to CE sectors as percentage of the GDP
	Gross value added to CE sectors
Jobs in CE sectors	Jobs in CE sectors
	Proportion of jobs in CE sectors in total employment

Source: Author's elaboration

Two other indicators require calculations using several variables, as shown in Table 9. For example, investment in waste management is calculated by adding the amount of investments made by governments and by corporations.

Table 9 CE core indicators to be calculated from several variables

Core indicators	Variables
Waste going to final disposal = Waste going to landfill final disposal + Waste going to incineration without energy recovery	Waste (excluding major mineral waste) going to landfill final disposal
	Waste (excluding major mineral waste) going to incineration without energy recovery
Investment in waste management = Investment in waste management by governments + investment in waste management by corporations	Investment in waste management by governments
	Investment in waste management by corporations

Source: Author's elaboration

One additional indicator is represented by 14 variables to provide a better understanding of the initial indicator, as shown in Table 10.

Table 10 Variables identified to represent one core indicator

Core indicators	Variables
Pollutant discharges to water bodies and share of safely treated *Proxy: proportion of discharges safely treated*	Industrial discharges to water bodies
	Agricultural discharges to water bodies
	Industrial BOD discharged
	Industrial COD discharged
	Industrial N discharged
	Industrial P discharged
	Industrial SS discharged
	Agricultural BOD discharged
	Agricultural COD discharged
	Agricultural N discharged
	Agricultural P discharged
	Agricultural SS discharged
	Proportion of total discharges to water bodies safely treated *(proxy)*
	Proportion of industrial discharges to water bodies safely treated *(proxy)*

Source: Author's elaboration

Considering what has been presented above, 39 variables were selected for the 12 circular economy core indicators. Annex II shows the list of CE core indicators considered (excluding placeholder indicators) by theme, available variables for each indicator, sources selected, available time series and units of measurement.

The distribution of the available variables at geographical level is presented in Table 11, Table 12 and Table 13, as well as the data sources for the different groups of variables.

Table 11 Proportion of available variables at country level and by data source

Number of countries	UNSD	World Bank	OECD	Eurostat	Availability at country level
≥ 180	16%	3%			19%
60 – 179	5%				5%
40 – 59	8%				8%
30 - 39					
20 - 29			3%	31%	34%
0 -19	5%		29%		34%

Source: Author's calculations

Table 12 and Table 13 present the distribution of the available variables at regional, sub-regional and global levels, according to the country groupings defined by the United Nations Statistics Division (UNSD 1999). The list of the regions and subregions is available in Annex I.

Table 12 Proportion of available variables at regional level and by data source

Number of regions	UNSD	World Bank	OECD	Eurostat	Availability at regional level
All regions/ subregions (37)	10%				10%
20 – 36 regions/ subregions	5%	3%			8%
4 – 19 regions/ subregions					
1 – 3 regions/ subregions			3%	31%	34%
0 regions/ subregions	20%		28%		48%

Source: Author's calculations

Table 13 Proportion of available variables at global level and by data source

UNSD	World Bank	OECD	Eurostat	Availability at global level
20%	3%			23%

Source: Author's calculations

3.3 Circular Economy Core Indicators with Low Availability

Table 14 represents a special group of core indicators for which data availability could be improved. Such indicators could be considered as having (a) very complex methodology, so estimated data is only available at global level, (b) indicators whose data are currently only reported by countries to Eurostat, although methodology is globally available, and (c) indicators with no international methodology available due to a missing definition of circular economy boundaries.

In the first two instances, additional capacity building efforts to increase national capacities is needed to improve data availability at national level, focusing on methodology, including definitions, concepts, calculations and collection methods. The adoption of a standardized methodology through increased collaboration between international organizations, in line with the one already started and that has produced the guidelines on which this report is based, is needed for indicators with no international methodology available.

Table 14 Circular economy core indicators with low availability

Indicators with weak availability	Reason
Material consumption and productivity b. Raw material consumption (RMC) d. Raw material productivity	Complex methodology
Pollutant discharges from material extraction and processing to water bodies and share safely treated	Complex methodology and/or no formal obligation to supply data to any international institution
Circular material use rate	Data reported by countries to Eurostat and no formal obligation to supply data to any other international institution
National recycling rate	Data reported by countries to Eurostat and no formal obligation to supply data to any other international institution
Waste going to final disposal	Data reported by countries to Eurostat and no formal obligation to supply data to any other international institution
Investments in waste management, waste collection and sorting	Data reported by countries to Eurostat and no formal obligation to supply data to any other international institution
Business investment on CE activities	No international harmonised methodology is available and no formal obligation to supply data to any international institution
Gross value added related to CE sectors	No international harmonised methodology is available and no formal obligation to supply data to any international institution
Jobs in CE sectors	No international harmonised methodology is available and no formal obligation to supply data to any international institution

Source: Author's elaboration

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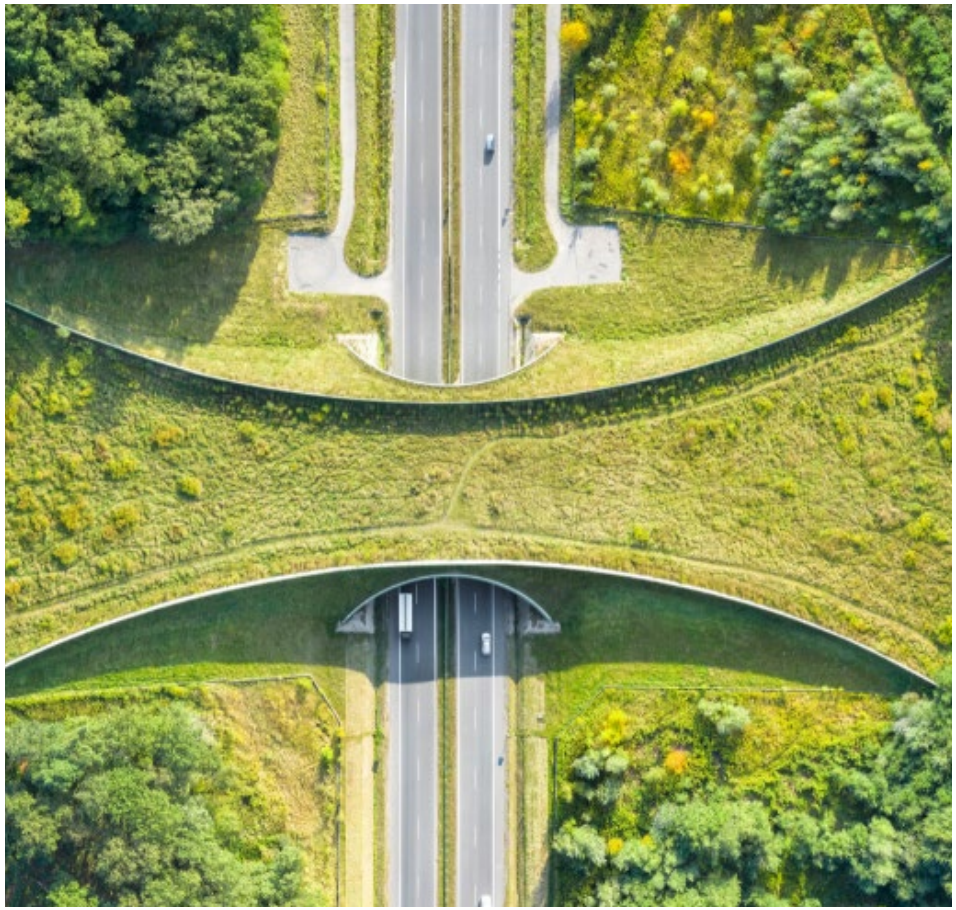
Data Gaps



4.1 Unavailable Circular Economy Core Indicators

Four out of the initial list of 15 circular economy core indicators are unavailable (as of October 2023). Considering proxy indicators, only 3 out of 15 indicators are not available. Regarding the various themes of the circular economy framework, data for 22 per cent of the themes are not available, as shown in Table 15.

Table 15 Circular economy core indicators availability by theme

Framework	Themes	Unavailable circular economy core indicators	Availability out of total proposed indicators
Material life-cycle and value chain	The material basis of the economy		1/1
	The circularity of material flows and the management efficiency of materials and waste		4/4
Interaction with the environment	Natural resource implications		1/1
	Environmental quality implications	GHG emissions from production activities	1/2
Responses and actions	Support circular use of materials, promote recycling markets, and optimize design	Taxes and government support for circular business models	0/1
	Improve the efficiency of waste management and close leakage pathways	Tax rate/tonne landfilled or incinerated	1/2

Framework	Themes	Unavailable circular economy core indicators	Availability out of total proposed indicators
	Boost innovation and orient technological change for more circular material lifecycles	Government and business R&D expenditure on circular economy technologies	0/1
	Strengthen financial flows for a circular economy and reduced leakage		1/1
Socio-economic opportunities for a just transition	Market developments and new business models		2/2

Source: Author's elaboration

Reasons for indicators' unavailability can be summarized as follows:

- Undetermined measurement boundaries for two indicators covering taxes and government support for circular economy business models and research and development expenditure on circular economy technologies. These indicators correspond to the block named responses and actions, which describes the policy and societal responses and actions to shift to a circular economy model.
- Lack of international organisation compiling this information at present or complex methodology, in the case of tax rate/tonne landfilled or incinerated and GHG emissions from production activities respectively.

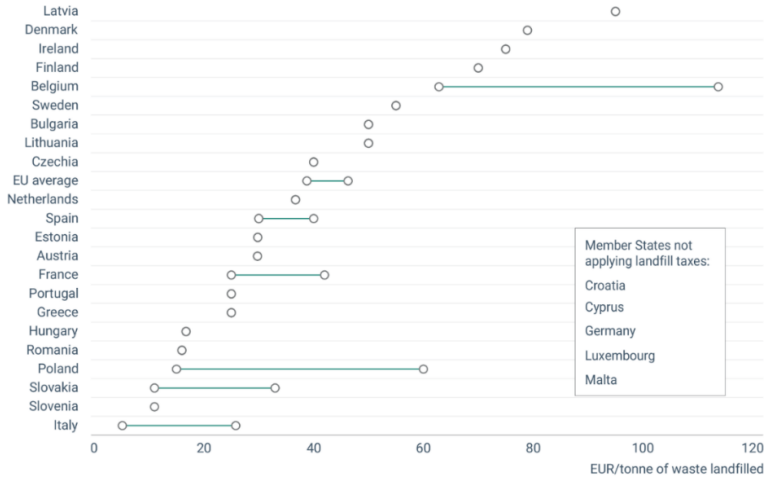
Box 2 Overview of landfill and incineration taxes on municipal waste used in EU Members States, 2023

The European Environment Agency (EEA) has published a technical note accompanying the EEA briefing "Economic instruments and separate collection – key instruments to increase recycling" (European Environment Agency [EEA] 2023a). The report analyses the use of landfill and incineration taxes in the different European countries and the results are presented in Figure 1 and Figure 2 below.

Landfill taxes

The use of landfill taxes is quite diverse among the European countries. 5 countries out of 27 do not apply any landfill taxes (Cyprus, Luxembourg, Croatia, Malta and Germany), while other countries apply different taxes depending on different criteria (type of waste, achieving the goals of recycling by municipalities…). In some cases, for example in Belgium, taxes can vary among regions too.

Figure 1 Overview of the landfill taxes on municipal waste used in EU Member States, 2023



Source: (EEA 2023b)

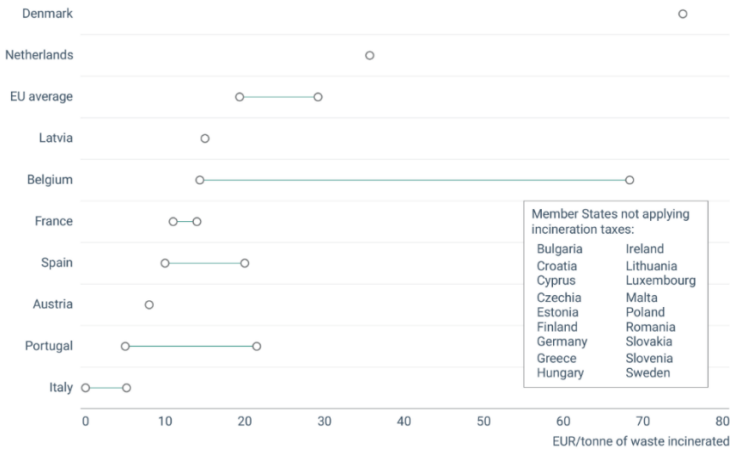
Box 2 Continued

Incineration taxes

Same as for the landfill taxes, the incineration taxes vary among the European countries and regions. 18 countries out of 27 do not use incineration taxes. Taxes in a country may vary depending on the type of waste (waste composition) and region.

Further details are available in the Technical note accompanying the EEA briefing 'Economic instruments and separate collection – key instruments to increase recycling' (EEA 2023a).

Figure 2 Overview of the taxes on the incineration of municipal waste used in EU Members States, 2023



Source : (EEA 2023c)

Circular economy indicators are particularly challenging because they refer to a new sector, their methodology is not yet well-defined, and data available from the different sources are scattered. And as a result, already existing data are not enough to fill the information gaps.

To produce the required information, countries need further capacity building to lessen challenges faced during the collection, treatment and dissemination of circular economy focused data. This could be done through the development of training material that focuses on improving data collection methods and better understanding of the international standardized methodologies for the collection and dissemination of circular economy indicators.

Countries are also encouraged to use existing international instruments that could help with data collection and dissemination such as the UNSD/UNEP Questionnaire on Environment Statistics and the Joint OECD/Eurostat Questionnaire. These instruments could be adapted to include more information about circular economy aspects. By including circular economy information into existing instruments, countries would be encouraged to collect and disseminate such data without increasing the reporting burden on national institutions.

Improving the understanding of countries on their progress towards shifting to circular economy is based on having regular collection of data. This would promote evidence-based policy-making and would provide basis for the development of targeted policies at national or sub-national levels.

05

Policy-making and the Use of Circular Economy Indicators

This section analyses how circular economy indicators can help countries to shift from a linear to a circular economy. The first part focuses on presenting examples of the different instruments that can be used at national level to promote the shift to a circular economy, while the second part discusses how core circular economy indicators can play an important role in developing and monitoring this process.

5.1 National Policy Strategies to Shift to A Circular Economy

This report is based on the definition proposed jointly by UNECE/OECD in the "Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators" (2023), as no single international definition of circular economy is available.

Box 3 Definition of circular economy

A circular economy can be defined as an economy where:

- The value of materials in the economy is maximised and maintained for as long as possible;
- The input of materials and their consumption is minimised; and
- The generation of waste is prevented, and negative environmental impacts reduced throughout the life-cycle of materials".

(UNECE 2023)

Developing a circular economy model at national level is a significant challenge for governments and a complex process, especially considering that the traditional production models are based on linear resource consumption, so structural changes are needed at national and local levels. In parallel to challenges linked to the implementation of a new production model, there are many opportunities arising from the development of a circular economy, that can result in benefits at

economic, social and environmental levels. Having said that, multiple stakeholders are fundamental in the shift to a circular economy:

- Governments as the creators of adequate conditions to promote changes at the production sector level and within the society.
- Businesses as producers of goods and services, and as the final responsible entity for decision making about production conditions and private investments, within the context of the regulatory environment.
- Consumers as their demand and behaviour have an important role in the shift to a circular economy as purchasers of the goods and services produced.

Related to the consumer's role on circular economy, "different studies around the world about consumption patterns, show that women tend to be more sustainable consumers and are more sensitive to environmental and health concerns. Women are more likely to recycle, minimise waste, buy organic food and eco-labelled products, and engage in water and energy saving initiatives at the household level. They also place a higher value on energy-efficient transport and, in general, have a higher preference for public transport than men. Women can therefore be key actors to move consumption towards more sustainable patterns. In this regard, public policies and new approaches to influence consumption decisions, such as behavioural insights should take into consideration a gender perspective" (OECD 2021).

There are different policy strategies that can be applied by governments to promote a circular economy model. Some of these strategies are introduced hereafter and are illustrated with examples from different countries. Implementation of such strategies requires a lengthy process and no universal solution is available. The different options should be adapted to each country considering its own economic, political, environmental, cultural and social characteristics.

Box 4 Consumers' role in Circular Economy

"Needs from consumers have the greatest impact on production and sales activities. When consumers take the lead in purchasing products with low environmental impact, companies are incentivized to develop environmentally friendly products. As a result, a wider range of environmental consumer choices will lead to even more environmentally friendly products and services. Consumers and businesses are "like two wheels of a cart" in the market as each depends on the other. Increased consumer and business awareness will play a significant role in the transition to a circular economy.

Of course, the most important element for promoting a circular economy is to enhance the environmental awareness of consumers. Consumers need to understand that they have a responsibility to actively purchase environmentally friendly products and to change their consumption patterns and lifestyles to incorporate higher circularity, through such behaviors as minimizing waste, with a perception that they are members of a circular economy system."

Circular Economy Vision 2020
(Japan, Ministry of Economy, Trade and Industry 2020)

a. Institutional framework

There are two main aspects to be considered in the case of an institutional framework. The first aspect relates to the institution(s) responsible for the shift to a circular economy model while the second relates to the coordination between the different institutions, in connection with circular economy policies.

Responsible institution: As circular economy is a cross-cutting policy, it is important to set up a responsible institution at national level in charge of following up on the shift to this new model. Such institution can be one (or multiple) existing institution(s) or a newly established one, and is expected to coordinate all efforts and initiatives in place, also at project level, to achieve the goal of shifting to a circular economy model. As the process is lengthy, this institution shall have

access to all the information about the evolution and advancements on circularity, which would allow for focusing all national efforts in the same direction and shall act according to real needs.

Coordination mechanisms: the importance of having coordination mechanisms at different administrative levels is to avoid duplicating efforts and to minimize costs. Both horizontal and vertical coordination are fundamental to optimise the results of the different institutions' policies. The form of these mechanisms can vary from working groups, commissions, task forces or other forms.

Box 5 Institutional framework - country example: The Netherlands

"The government is responsible for policy on the transition to a circular economy and is accountable to the House of Representatives in this regard.

Within the government the State Secretary for Infrastructure and Water Management is responsible for coordinating the transition. This means that the State Secretary takes initiatives to accelerate the transition in the whole of the Netherlands and in all sectors, working together with all policy partners in the area of the circular economy. The State Secretary also draws up this policy programme, sends it to Parliament and organises monitoring.

The members of the government at the line ministries most closely connected with this issue are each responsible for circularity within their own remit. For the current product chains it concerns the Ministry of the Interior and Kingdom Relations (construction, plus coordinating ministry for spatial planning), the Ministry of Economic Affairs and Climate (industry, plus coordinating ministry for climate), the Ministry of Agriculture, Nature and Food Quality (agriculture), the Ministry of Infrastructure and Water Management itself, and the Department of Foreign Trade and Development Cooperation. Once every two years, the State Secretary holds bilateral meetings with the ministers of these ministries on the progress made, to see whether any adjustments are needed."

National Circular Economy Programme (2023-2030)
(Kingdom of the Netherlands, Ministry of Infrastructure and Water Management 2023)

b. Policy framework

A defined policy framework allows governments to create a certain and clear environment for all administrators in general, and for the production sector in particular. The scope of this kind of instruments ranges from national strategies or plans that cover a great part of the economy, to sectoral plans or programmes that focus on one thematic area.

National strategy or plan: A general strategy for implementing circular economy at national level could simplify the development of other more specific and concrete instruments. This national strategy can be developed through several sectoral plans and/or other instruments and at different administrative levels. Examples of countries that have adopted national strategy or plan to encourage the shift toward circular economy are presented in Box 6, Box 7 and Box 8.

Box 6 Policy framework - country example: Colombia

In 2019, Colombia was the first country in Latin America to adopt a National Circular Economy Strategy (Estrategia Nacional de Economía Circular, ENEC).

"The Strategy aims to a new model of economic development that includes the continuous resources valorization, the closing of materials cycles, water and energy, the creation of new business models, the promotion of industrial symbiosis and consolidation of sustainable cities, in order, among other things, to optimize efficiency in the production and consumption of materials, and reduce the water and carbon footprint."

"The National Circular Economy Strategy prioritises six material and resources flows of major importance for the country: industrial and mass consumption products flows, packing material flows, biomass flows, energy sources and flows, water flows and building material flows".

Circular Economy National Strategy 2019
(Colombia, Ministerio de Ambiente y Desarrollo Sostenible and Ministerio de Comercio, Industria y Turismo 2019)

Box 7 Policy framework - country example: Spain

"In 2020, the Circular Economy Spanish Strategy was launched. This strategy contributes to Spain's efforts to achieve a sustainable, decarbonized economy, which uses resources efficiently and is competitive. This strategy will be materialized in successive triennial action plans.

The Strategy establishes the following goals for the year 2030:

- Reducing by 30% domestic material consumption in relation to national GDP, taking 2010 as a reference.
- Reducing waste by 15% with regard to 2010 waste levels.
- Reducing food waste throughout the entire food chain: 50% reduction per person in retail and households and 20% in production chains and supplies from 2020, thus advancing towards the Sustainable Development Goals (SDGs).
- Promoting reuse and reuse enabling activities until reaching 10% of municipal waste.
- Reducing greenhouse gas emissions to below 10 million tonnes of CO_2eq.
- Improving water use efficiency by 10%".

Circular Economy Spanish Strategy. España Circular 2030.
(Spain, Ministerio para la Transición Ecológica y el Reto Demográfico 2020a)

In addition to the Circular Economy Strategy, the Spain 2050 Strategy (España 2050) was adopted in 2021. The Spain 2050 Strategy identifies nine future targets, one of them being to "become a carbon neutral and sustainable society that is resilient in the face of climate change". Below is the list of goals relevant to achieve this target from the Spain 2050 Strategy.

- "Goal 21. Reduce our greenhouse gas emissions by 90% by 2050, meeting our commitment to achieve climate neutrality by the middle of the century (the remaining 10% will come from the absorption of carbon sinks).
- Goal 22. Drive the water transition as an essential pathway for adaptation to climate change, achieving a reduction in total water demand of 5% by 2030 and 15% by 2050.
- Goal 23. Reduce primary energy intensity by 36% by 2030 and 63% by 2050 compared to 2015 values.
- Goal 24. All electricity to be generated from renewable sources by 2050, with this percentage reaching 74% by 2030.
- Goal 25. Strengthen the role of environmental taxation, incorporating criteria that promote a just ecological transition into its design and application. Spain should reach the current average of European countries by 2030, and increase its ambition over the following two decades, in order to ensure that decarbonisation is completed, and the circular economy and environmental protection are strongly promoted.
- Goal 26. Increase the area of organic agricultural production to 25% by 2030, in line with the EU's Farm to Fork initiative, and to 60% by 2050.
- Goal 27. Increase wooded forest areas in order to protect biodiversity, improve ecosystem resilience and increase the capacity of carbon sinks, essential to achieving climate neutrality by 2050. Spain should adopt an average reforestation rate of 20,000 hectares per year during the period 2021-2050, compared to the current 15,000 hectares".

Spain 2050 Strategy
(Spain, Oficina Nacional de Prospectiva y Estrategia 2021)

Box 8 Policy framework - country example: Japan

In 1999, Japan approved the Circular Economy Vision, and it was "among the first countries in the world to make such a commitment, in order to cope with the pressing needs for waste disposal sites and other issues such as natural resource constraints."

Twenty years later, Japan adopted the Circular Economy Vision 2020 that "indicates a new direction in letting Japanese industries shift to new business models with higher circularity and to improve the resource efficiency of their businesses, while taking advantage of our industrial structure."

The Vision identifies key areas where the development of resource circulation systems is urgently needed. These areas are:

- "Plastics
- Textiles
- Carbon Fiber Reinforced Polymer (CFRP)
- Batteries
- Photovoltaic (PV) Pannels."

Circular Economy Vision 2020
(Japan, Ministry of Economy, Trade and Industry 2020)

Sectoral plans and policies: Specific aspects of circular economy can be covered by implementing sectoral plans and policies focused on the different pillars of circular economy. Box 9 and Box 10 present the South African and Colombian examples for policy frameworks at sectoral level.

Box 9 Policy framework – sectoral example: South Africa

National Waste Management Strategy (NWMS) 2020

"The National Waste Management Strategy has the concept of circular economy at its centre. The following are the outcomes that will be achieved through effective and efficient implementation of the NWMS 2020 by all stakeholders from all sectors of the society:

- Prevent waste, and where waste cannot be prevented ensure – 40% of waste diverted from landfills within 5 years; 55% within 10 years; and at least 70% within 15 years leading to Zero-Waste going to landfill;
- All South Africans live in clean communities with waste services that are well managed and financially sustainable; and
- Mainstreaming of waste awareness and a culture of compliance resulting in zero tolerance of pollution, litter and illegal dumping."

National Waste Management Strategy (NWMS) 2020
(South Africa, Department of Environment, Forestry and Fisheries 2020)

Box 10 Policy framework – sectoral example: Colombia

The National Plan for the sustainable management of single-use plastics 2021-2030

"The objective of the Plan is to implement a sustainable plastic management, based on instruments and actions of prevention, reduction, reuse, use, responsible consumption, generation of new business opportunities, linkages, jobs and technological developments, aims to protect natural resources and promote competitiveness." The Plan establishes a set of goals, so that by 2030 "100% of the single-use plastics in the market will be reusable, recyclable, or compostable."

Box 10 Continued

"The proposed actions included in the Plan are:

1. Not producing or using single-use plastics products.
2. Rethinking plastic products so they can be put in the market with better environmental characteristics (eco-design), substitution of materials to extend their lifetime, and facilitate cycles closing (recyclability, compostability).
3. Reducing: increasing the manufacturing efficiency by using less raw material.
4. Promoting products reuse by incorporating characteristics to extend their lifetime.
5. Reducing waste generation by actions about rational use and eco-design.
6. Increase the use of materials in a sustained way over time to reincorporate them into the production cycle or recovering their energy potential.
7. Discouraging the final disposal of materials in landfills."

National Plan for the sustainable management of single-use plastics 2021-2030 (Colombia, Ministerio de Ambiente y Desarrollo Sostenible 2021)

c. Regulatory instruments

Laws at different administrative levels can be adopted to accelerate the shift to a circular economy. One example of this kind of instruments is a regulation about the implementation of Extended Producer Responsibility Schemes (EPR schemes) for certain product sectors, such as the example of France (Box 11).

Box 11 Regulatory instruments - country example: France

In France, in 1992, the fist EPR scheme about household packing was implemented. In 2018, there were already 14 compulsory EPR schemes in the country.

The first sectors where EPR schemes were applied included, in addition to household packing, paper, electrical and electronic equipment (WEEE), textile products, batteries and accumulators, chemicals, tyres, end-of-life vehicles, recreational or sports boats, punctured medical devices used by self-treatment patients, medicines for human use and furniture.

In 2020, the Law on the fight against waste and for the circular economy (Loi relative à la lutte contre le gaspillage et à l'économie circulaire), also named Anti-waste Law, was adopted. It extends the sectors where the implementation of EPR schemes is compulsory, including toys, cigarette butts, construction, and sporting and leisure equipment (Government of France 2020).

Since 1st January 2023, an EPR scheme has been introduced to tackle construction waste and to make manufacturers of construction products responsible for the waste generated.

According to the European Commission report "Construction and demolition waste management in France", "France's construction sector generates 42 million tonnes of waste annually and accounted for 26% of the country's CO_2 emissions (or 115 $MtCO_2e$) in 2016. These construction materials are sometimes thrown into illegal dump sites and pollute the environment. The removal of materials and clean-up of these dumpsites cost municipalities and taxpayers an estimated EUR 340 to 420 million." (Deloitte for the European Commission 2015).

France is one of the countries with a wider implementation of this system in the world and more sectors will be included in this system in the next few years, i.e., professional packaging, chewing gum and single-use sanitary textiles.

d. Markets instruments

There are different instruments that can be used to promote the shift to a circular economy model from the financial perspective. Examples of these instruments are taxes, tax reliefs, exemptions and subsidies for circular economy business models. Box 12 presents the example of market instruments adopted by Spain.

In parallel to studying new market instruments, it can be interesting to review the existing financial instruments, to validate their utility and to identify if some of them have harmful effects from a circular economy perspective.

Circular Economy public procurement is also an effective mean to promote the shift to a circular economy, as it allows governments to influence demand and at the same time increase their credibility in the process.

Box 12 Market investments - country example: Spain

The Circular Economy Spanish Strategy (España Circular 2030) describes different policies to be used to enhance the circular economy, including fiscal policy and taxation.

"Fiscal policy and its derived instruments are efficient and effective means of increasingly achieving environmental objectives and resolving the problems identified in the sectoral agendas, especially as a result of the regulatory changes to be introduced by the implementation of the Circular Economy Strategy in the field of waste.

In this sense, from the environmental perspective, it is considered that taxing pollution, excessive use of resources or non-appropriate waste management can result not only in income for the public treasury, but also in the protection and restoration of the environment, by encouraging favorable behaviors in terms of the use of resources, the generation of waste and its treatment.

Fiscal policy in Spain has a considerable margin for development, as it is one of the European member states with the lowest tax burden on the ▶

Box 12 Continued

environment, in relation to its GDP, this ratio being 1.86% compared to the European average of 2.44%. Therefore, it is plausible to apply finalist taxes to management options at the bottom of the waste hierarchy, such as landfilling or incineration. To be more effective, the proceeds should be used to prioritise the first options: prevention, separate recollections, and preparation for reuse and recycling.

Likewise, appropriate fiscal measures can play an important role and help to improve efficiency in the use of materials, the prevention of waste generation, especially food waste, the promotion of reusable products or products with better environmental performance, in terms of the circular economy, so that by 2030 the objectives of this Strategy are achieved."

Circular Economy Spanish Strategy. España Circular 2030
(Spain, Ministerio para la Transición Ecológica y el Reto Demográfico 2020b)

e. Information, awareness, education and training instruments about circular economy

The change from a linear to a circular economy requires the investment of different stakeholders, including the business sector, academia and society in general. It is essential to make available the information to all the actors so they can act at their corresponding level. At this point, it can be useful to use the circular economy indicators as a tool in the information process.

Circular economy awareness programs are initiatives that go further than simple information diffusion. They deliver key messages to target audiences about different aspects of circular economy, to provide the necessary information for promoting behavioral changes. Raising awareness as a part of educational activities targeted at the public is essential to support informed decision making by customers.

Box 13 Information, awareness, education and training instruments - country example: Australia

The Australian National Plastic Plan 2021 recognises that "Good decisions are based on good information". Following this premise, "the Australian Government has invested $20.6 million to create a waste data visualisation platform. The public-facing data repository will bring together data from a range of sources to provide nationally consistent real-time information. Understanding plastic volumes, value and movement through the economy will support effective decision making and create new economic opportunities for businesses."

In addition to this measure, the Plan "expands the Australian Plastics Recycling Survey to provide a comprehensive picture of the consumption, flow and recycling of plastics in Australia".

To complete the information tools, "CSIRO's National Circular Economy Roadmap for Plastics, Glass, Paper and Tyres: Pathways for unlocking future growth opportunities for Australia (the Roadmap) provides valuable information to support the circular economy. It will be used by governments, industry and researchers to inform future decisions on investment, policy development and research priorities."

National Plastic Plan 2021
(Australia, Department of Agriculture, Water and the Environment [DAWE] 2021)

Governments shall also ensure that the required skills to shift to a circular economy exist at national level for the business sector and the society. Several options regarding education and training are possible:

- Include circular economy into the curricula at the primary and secondary schools
- Technical training at higher level education
- Technical training to the business sector
- Upskilling and reskilling programmes to allow the shift to circular economy related jobs (e.g., redirecting coal mine workers to the renewable energy sector).

Box 14 Information, awareness, education and training instruments - country example: The United Arab Emirates

The United Arab Emirates (UAE) Circular Economy Policy identifies eight common core areas of focus that will support the transition to a circular economy across the various sectors prioritized based on their current role in the national economy and on their potential for stimulating and developing a UAE circular economy (sustainable manufacturing, green infrastructure, sustainable transportation and sustainable food production and consumption).

One of the common core areas is building awareness. The Policy considers that "awareness and capacity development adopting circular economy principles is to adopt a new way of thinking and implies systemic and pervasive change. Having grown up with linear production systems and consumption patterns, business executives and consumers seldom look for circular opportunities. Worse, inertia and resistance to change can also pose a significant barrier to the transition to a circular economy. Therefore, there is a clear need for initiatives to raise awareness and understanding on the concept and principles with public officials, business leaders and the public.

There is also a need to build capacity in areas important for the circular economy, including in design and planning of goods, services and systems and in applying and implementing new technologies, methodologies and business models. Capacity building and awareness initiatives may include trainings and workshops, development of manuals or guidelines, multi-stakeholder networking and knowledge sharing events, and information dissemination campaigns. While the transition to the circular economy will lead to overall benefits for society, there will be some sectors, companies and individuals that will be adversely affected by the change. Groups disadvantaged by the changes should also be targeted and helped through retraining and other forms of support."

Box 14 Continued

Examples of specific actions and initiatives proposed for the different sectors are:

- "Conduct capacity building workshops on applying circularity to the manufacturing sector in the UAE.
- Provide technical support and capacity building on technologies that can help manufacturers more efficiently collect, sort, separate, treat and use their waste.
- Conduct capacity building workshops on applying circularity to the infrastructure sector in the UAE.
- Magnify international cooperation and capacity building support in water efficiency, water harvesting, recycling, and reuse.
- Support the development and growth of businesses, bioeconomy entrepreneurs and business models that reduce food waste (for example by providing training and information on best practices including the better matching of supply and demand for food and the up-cycling of food)."

United Arab Emirates Circular Economy Policy 2021-2031 (Government of United Arab Emirates 2021)

5.2 Circular Economy Core Indicators as A Tool to Develop Targeted Policies Aiming at Accelerating the Shift to A Circular Economy

5.2.1 National Use of Circular Economy Indicators

Having information of a set of indicators is essential and can be used for a variety of purposes, to help in the process of shifting to a circular economy:

- Circular economy indicators give information about the initial situation of the economy at national level, so strategies, policies and plans can be formulated and/or adapted to real national conditions, circumstances and needs.
- Once policies are formulated, circular economy indicators can be used to track progress of the implementation of such policies against the different set objectives. As a result, progress can indicate the need for complementary policies to speed the shift or reevaluate the objectives by adjusting or reformulating existing policies.
- Circular economy indicators can also be used to inform the public about the initial situation and the progress achieved, in order to move towards a circular economy. This information process is very important because customers' product demand can also influence the production sector decisions.
- Academia's access to circular economy indicators data can also be a source of new projects, studies and proposals to promote the shift to a circular economy model.
- Finally, it is also relevant to add that circular economy indicators may allow to compare the results of the policies implemented in different countries. This can help governments to formulate or reformulate policies considering the success of the different measures applied in other countries with similar environmental, social and economic characteristics.

5.2.2 Policy-Making and Circular Economy Core Indicators

Circular economy core indicators can be used to develop different targeted policies to shift to a circular economy model. This section sheds the light on how circular economy is measured by topic, coupled with relevant indicators to each topic. Indicators are classified by colour (green or red) considering the impact of the indicator's value on successfully transitioning to a circular economy. Circular economy related policies should be monitored and their results should be assessed according to the circular economy core indicators trends.

Real examples of circular economy related instruments at national level are also presented to illustrate the practical use of such a set of indicators.

1. Resources decoupling

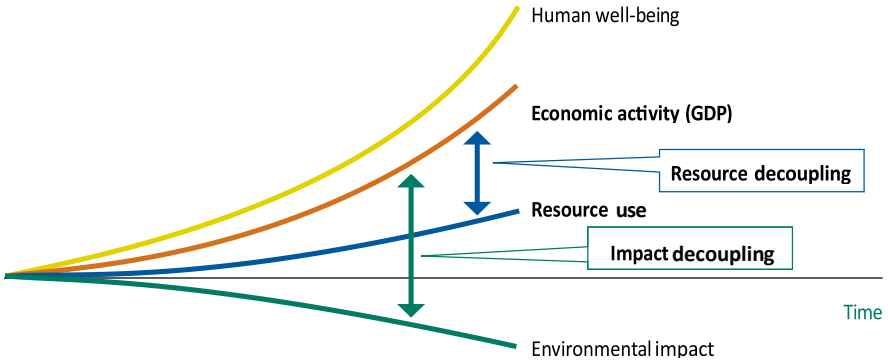
One of the main pillars of circular economy is decoupling the use of resources from economic growth. This is the reason why most national strategies and policies related to circular economy consider resource decoupling as a starting point to shift to a circular economy. With the aim of better understanding the scope of resource decoupling, Box 15 contains a brief explanation of this concept.

Box 15 Resource decoupling concept

Resource decoupling occurs when reducing the rate of use of resources per unit of economic activity. Resource decoupling leads to an increase in the efficiency with which resources are used (material, energy, water and/or land).

Figure 3 shows resource decoupling, comparing the gradient of economic output over time with the gradient of resource input; when the latter is smaller, resource decoupling is occurring.

Figure 3 Two aspects of 'decoupling'



Box 15 Continued

Resource decoupling can be relative, when the growth rate of resources used is lower than the growth rate of a relevant economic indicator (for example GDP), or absolute, when resource use declines, irrespective of the growth rate of the economic driver.

Resource decoupling seeks to alleviate the problem of resources scarcity as it reduces the rate of resource depletion, while raising resource productivity, and it is also a potential solution for resources with high environmental risks of extraction or use.

Decoupling natural resource use and environmental impacts from Economic Growth (United Nations Environment Programme [UNEP] 2011)

Core circular economy indicators that can be used to monitor the results of policies related to resource decoupling are presented in Table 16. This group contains the indicators that serve to assess or measure the use of raw materials and water, and the use of recycled materials.

In a circular economy, absolute resource decoupling occurs when material consumption (DMC, RMC) or water stress decreases, while in relative resource decoupling material and footprint productivities increase.

Circular material use rate gives information about material substitution. In a circular economy, the circular material use rate increases, as recycled materials are used in the production processes instead of primary raw materials.

Table 16 Circular economy core indicators related to resource decoupling

Framework	Themes	Proposed core indicators
Material life-cycle and value chain	The material basis of the economy	Material consumption and productivity
		a. Domestic Material Consumption (DMC) b. Raw Material Consumption (RMC)
		c. Material productivity d. Raw Material productivity
	The circularity of material flows and the management efficiency of materials and waste	Circular material use rate
Interactions with the environment	Natural resource implications	Intensity of use of renewable freshwater resources

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

Box 16 presents the example of the Netherlands with resource decoupling by presenting the objectives of their National Programme on Circular Economy.

Box 16 Resources decoupling - country example: The Netherlands

"The goal is for the Dutch economy to reduce the use of resources 50% by 2030 and to be completely circular by 2050. Considering these objectives, the National Programme on Circular Economy (NPCE) 2023-2030, contains four ways to make the Dutch economy circular:

1. **Reducing raw material usage:** using fewer (primary) raw materials by abstaining from the production or purchase of products, sharing products or making them more efficient ('narrow the loop'). This NPCE aims, for example, to achieve a significant increase in circular procurement across government. This covers everything from desks and chairs to roads and waterworks.
2. **Substituting raw materials:** replacing primary with secondary raw materials and sustainable bio-based raw materials (in high-value applications), or with other, more generally available raw materials with a lower environmental burden. An example is a mandatory percentage of recycled content.
3. **Extending product lifetime:** making longer and more intensive use of products and components through reuse and repair will slow demand for new raw materials ('slow the loop'). An example of a measure aimed at increasing longevity is the introduction, as of 2023, of a registry of repairers of electric and electronic goods, so that people can easily find a technician to repair their appliance or device;
4. **High-grade processing:** closing the loop by recycling materials and raw materials. This will not only reduce the amount of waste being incinerated or dumped, but ensure a more high-grade supply of secondary raw materials as well ('close the loop').

The National Circular Economy Programme (2023-2030) contains measures for each of these 4 approaches. It also contains measures for specific product groups, like furniture or homes, and supporting measures for specific focus areas such as education, circular procurement and circular business models."

National Circular Economy Programme (2023-2030)
(Kingdom of the Netherlands, Ministry of Infrastructure and Water Management 2023)

2. Impact decoupling

Another fundamental aspect of circular economy is impact decoupling, which is focused on the negative environmental impacts of the different stages of production and consumption activities. Box 17 details the concept of impact decoupling, while Table 17 covers the relevant core indicators that could be used to monitor impact decoupling.

Box 17 Impact decoupling concept

Impact decoupling occurs when increasing economic output while reducing negative environmental impacts (see Figure 3 Box 15). Environmental impacts include negative impacts produced during resources extraction (such as groundwater pollution due to mining or agriculture), production (such as land degradation and emissions), the use of commodities (for example transport resulting in CO_2 emissions), and during the post-consumption phase (as wastes).

Impact decoupling can be relative, when the growth rate of the environmental impact is lower than the growth rate of a relevant economic indicator (for example GDP), or absolute, if environmental impact declines, irrespective of the growth rate of the economic driver.

Impact decoupling implies a more efficient resource use and is commonly associated with pollution prevention and control. Reducing environmental impacts does not necessarily have a mitigating impact on resource scarcity or production costs and may even sometimes increase these (for example, when wastewater treatment is applied).

Impact decoupling is particularly important when the use of a resource threats human and/or ecosystem health (such as toxic emissions) and when technological solutions exist.

Decoupling natural resource use and environmental impacts from Economic Growth (UNEP 2011)

Circular economy core indicators that can potentially be employed for monitoring policies, programs and other instruments focused on developing a circular economy through impact decoupling measures are presented in Table 17. These indicators are, by definition, related to the environmental impacts linked to the production and consumption operations, such as waste generation, waste management, pollutants discharges to water bodies and air emissions.

Waste generation, GHG emissions and pollutant discharges to water bodies decrease in case of impact decoupling and a shift to a circular economy model. National recycling rate increasing correspond to an absolute impact decoupling, as well as the reduction of the amount of waste going to final disposal.

In a circular economy, waste going to final disposal should be minimized, while other alternatives as national recycling should be prioritized. Investments in waste management can be considered as a base to improve the national waste management system. Taxes on landfill and incineration can be applied to promote alternative waste management, as recycling, which accelerate the shift to a circular economy model.

Table 17 Circular economy core indicators related to impact decoupling

Framework	Themes	Proposed core indicators
Material life-cycle and value chain	The circularity of material flows and the management efficiency of materials and waste	Total waste generation
		National recycling rate
		Waste going to final disposal
Interactions with the environment	Environmental quality implications (effects of materials extraction, processing, use and end of life management on environmental conditions)	GHG emissions from production activities
		Pollutant discharges from material extraction and processing to water bodies and share safely treated
Responses and actions	Improve the efficiency of waste management and close leakage pathways	Investments in waste management, waste collection and sorting
		Tax rate/tonne landfilled or incinerated

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

2.1 Waste generation and management

In general, waste sectoral policies and regulations, considering the reduction of waste generated and waste finally disposed in landfills, are bases of a circular economy model. As a first step, waste prevention should be applied to all stages of the life cycle in terms of quantity and quality (hazardous character of wastes). Once the waste is generated, it can be recycled to maximise the value of the materials in the economy. Recycling requires available waste recycling facilities to attend to the different types of waste (prior investment is required) and that waste collection systems are operational with high geographic coverage.

In case recycling is not technically possible, waste can be incinerated with energy recovery. Landfill is considered as the last option, and should be avoided where possible, because in this case, waste has left the economy and could not be a potential resource anymore. Box 18 and Box 19 presents national and sub-national examples of waste generation and management in Australia and Ontario, Canada respectively.

Box 18 Waste generation and management - country example: Australia

"The National Waste Policy: Less waste, more resources (2018) embodies a circular economy, shifting away from 'take, make, use and dispose' to a more circular approach where we maintain the value of resources for as long as possible. The 2018 National Waste Policy provides a framework for collective action by businesses, governments, communities and individuals until 2030.

The following five principles underpin waste management, recycling and resource recovery in a circular economy.

1. Avoid waste:
   - Prioritise waste avoidance, encourage efficient use, reuse and repair.

▶

Box 18 Continued

   - Design products so waste is minimised, they are made to last and we can more easily recover materials.
2. Improve resource recovery:
   - Improve material collection systems and processes for recycling.
   - Improve the quality of recycled material we produce.
3. Increase use of recycled material and build demand and markets for recycled products.
4. Better manage material flows to benefit human health, the environment and the economy.
5. Improve information to support innovation, guide investment and enable informed consumer decisions".

National Waste Policy: less waste, more resources
(Australia, Department of Climate Change, Energy, the Environment and Water 2018)

The National Waste Policy is developed by the National Waste Policy Action Plan – Annexure (2022), which drives implementation of seven targets:

1. Ban on export of waste plastic, paper, glass, and tyres, commencing on the second half of 2020.
2. Reduce total waste generated in Australia by 10% per person by 2030.
3. 80% average resource recovery rate from all waste streams by 2030.
4. Significantly increase the use of recycled content by governments and industry.
5. Phase out problematic and unnecessary plastic by 2050.
6. Halve the amount or organic waste sent to landfill for disposal by 2030.
7. Make comprehensive, economy-wide and timely data publicly available to support better consumer, investment and policy decisions.

National Waste Policy Action Plan-Annexure
(Australia, Department of Climate Change, Energy, the Environment and Water 2022)

Box 19 Waste generation and management - city example: Ontaria, Canada

According to Ontario's food and organic waste Framework, Part A: Action Plan, 2018, "The Province of Ontario is shifting to a circular economy. To achieve our goals of zero waste and zero greenhouse gas emissions from the waste sector, the province will lead transformative change in how food and organic waste is managed.

The Framework strives towards the achievement of the following objectives:

1. Reduce food and organic waste: Preventing food from becoming waste is a critical first step and has the greatest positive impact on the environment, the economy and society. Rescuing surplus food when it occurs further reduces food waste and ensures that edible food does not end up as waste.
2. Recover resources from food and organic waste: Increasing resource recovery, in particular from multi-unit residential buildings and the industrial, commercial and institutional (IC&I) sector will help the province reach its goals of zero waste and zero greenhouse gas emissions from the waste sector.
3. Support resource recovery infrastructure: Turning food and organic waste into valuable end-products recognizes the economic benefits of a circular economy. It is important that Ontario has sufficient infrastructure capacity and innovative technologies to process food and organic waste into valuable resources.
4. Promote beneficial uses of recovered organic resources: Supporting endproducts and sustainable markets for recovered organic resources is critical. This includes supporting beneficial uses which promote soil health, crop growth and enhance carbon storage. Promoting end-products like renewable natural gas and electricity can help replace carbon-intensive fossil fuels."

Ontario's Food and Organic Waste Framework: Part A: Action Plan (Canada, Ontario Ministry of the Environment and Climate Change 2018)

2.2 GHG emissions from production activities

Greenhouse gas emissions contribute to climate change and refer to carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (F-gases) emissions. Electricity generation, transport, industrial production processes and agriculture are sources of GHG emissions linked to production activities. In a circular economy, GHG emissions are minimized to mitigate climate change. Policies and plans can be developed to control the emissions from the production of goods and services. They can be developed by implementing standards to limit emissions and by emissions permits regulations.

At policy-making level, examples of actions related to energy production and consumption that can be considered to reduce GHG emissions are:

- Increasing renewable energies use and reducing fossil fuels demand.
- Increasing energy efficiency, promoting the use of more efficient technologies in terms of energy consumption.
- Increasing energy conservation by reducing wasteful energy consumption. Improving operations and maintenance, implementation of user activity detection systems and off-peak scheduling energy consumption are some examples of measures that can be promoted.

Box 20 GHG emissions from production activities - country example: Nigeria

The overall objective of the National Climate Change Policy for Nigeria (NCCP) 2021-2030, "is to strengthen measures to reduce greenhouse gas emissions (direct and fugitive emissions), mainly from the energy (including power generation), oil and gas, biomass (agriculture, forest and land use), health, industry, transport, water and waste sectors." Hereunder, some examples of the measures included in the NCCP by sector:

"Energy sector

- Expand the production and use of renewable energy, particularly solar and wind, both on-grid and off-grid.

Box 20 Continued

- Promote energy efficiency and management activities that include new and innovative energy efficiency methodologies and techniques in power generation, including the use of gas-fired power stations, as well as retrofitting buildings and other infrastructure.
- Reduce transmission and distribution losses.
- Facilitate full transition to clean cooking fuel.
- Provide sustainable incentives and financial mechanisms to encourage and support the use of renewable sources of energy.
- Support cities in the country to undertake ambitious climate change mitigation actions.

Industry

- Pursue an alternative and sustainable path to industrialisation that takes advantage of innovations, technologies, and business models for improved energy efficiency in the industrial sector.
- Create and adopt green technology in industry and support low emission manufacturing systems.
- Accelerate industrial development utilizing energy mix with emphasis on renewables.
- Promote energy efficiency networks for industrial enterprises.
- Set efficiency benchmarks for manufacturing and businesses against international best practice for industrial energy usage.
- Support local research and development of ICT capabilities to promote energy "smart technologies".
- Promote appropriate financing mechanisms for climate-friendly and energy efficient investment projects.

Oil and gas sector

- Pursue low-carbon transition for oil and gas companies in the country.
- Support low-cost, technically feasible solutions to reduce methane emissions in oil and gas operations, including recovery and use of escaping gas.

Box 20 Continued

- Incentivize the deployment of natural gas as Nigeria's major fuel for power generation, industrialization, and domestic use, particularly cooking, towards stopping gas flaring.
- Facilitate sustainable regulatory frameworks and incentives, as well as financial mechanisms to end gas flaring by 2030.
- Investment and use of smart technologies in oil refining
- Reduce fugitive emissions in the sector."

The National Climate Change Policy for Nigeria 2021-2030
(Nigeria, Federal Ministry of Environment 2021)

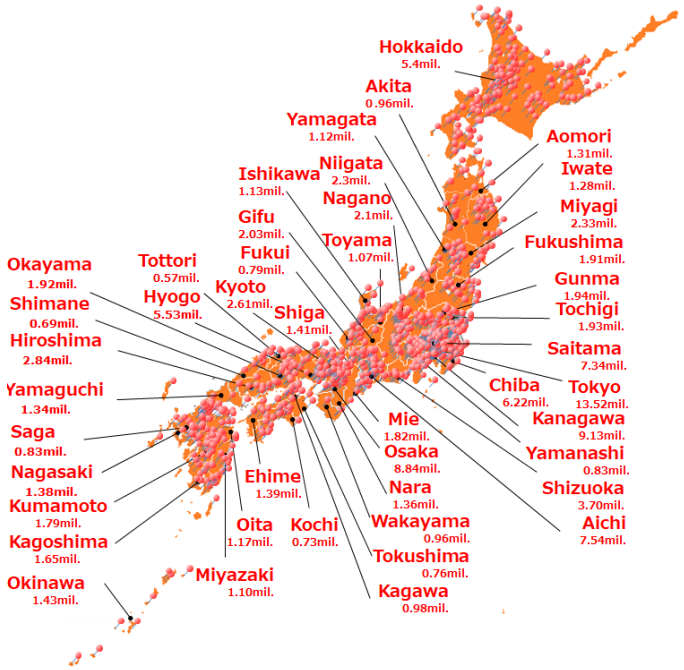
Nigeria's Nationally Determined Contribution (NDC) updated in 2021 "has unconditionally pledged a 20% emissions reduction below Business as Usual (BAU) by 2030, and a 47% conditional commitment which can be achieved with financial assistance, technology transfer and capacity building form the more advanced and more willing international partners."

Nigeria's Nationally Determined Contribution, 2021
(Nigeria, Federal Government of Nigeria 2021)

Box 21 GHG emissions from production activities - country example: Japan

In September 2023, in relation with the program 2050 Zero Carbon Cities in Japan, 991 local governments including Tokyo, Kyoto and Yokohama, announced their commitment to net zero carbon emissions by 2050. Figure 4 showcases the different prefectures and the population of each prefecture.

Figure 4 Japanese prefectures and their habitants (expressed in million people) where the 2050 Zero Carbon Cities initiative is going to be applied



Source: (Japan, Ministry of the Environment 2023)

2.3 Pollutants discharges from production activities to water bodies

In a circular economy, pollutants discharged to water bodies should be minimized as they are considered lost economic resources. Hazardous pollutants as heavy metals or pesticides are to be completely avoided, due to their harmful effects to the ecosystems and human health.

Prevention is the first step to prioritize in policy-making and requires industrial processes modifications and/or the use of more efficient technologies, in terms of materials consumption, when they are available. Reuse of effluents already generated is the second alternative to avoid pollutants discharged to the environment. Once wastewater is generated, wastewater treatments reduce pollutants discharged to water bodies. Advanced wastewater treatments including polishing (as chemical reduction, carbon filtering or membrane technologies) should be implemented when technically feasible.

According to The United Nations World Water Development Report 3: Water in a changing world (World Water Assessment Programme 2009), 70 per cent of industrial effluents in developing countries are disposed of without previous treatment so reducing pollutants discharges remains a big challenge at policy-making level.

Reducing pollutants discharges to water bodies in a circular economy context may require a combination of several instruments such as a legal framework (including standards to limit the amount of pollutants discharged and discharges permits regulation), action plans and investments. Public and private investments in wastewater treatment facilities need to be supported at policy-making level to enable the shift to a circular economy. Box 22 presents Mexico's efforts in regulating pollutants discharges to water bodies.

Box 22 Pollutants discharges from production activities to water bodies - country example: Mexico

The Official Mexican Standard NOM-001-SEMARNAT-2021 establishes "the permissible limits of pollutants in wastewater discharges into receiving bodies owned by the nation."

This Standard has been approved according to the National Development Plan 2019-2024. The Plan focuses among other objectives on the need "to guarantee the integral preservation of flora and fauna, a large part of the national territory will have been reforested and rivers, streams and lagoons will be recovered and cleaned up. The treatment of sewage and the proper management of waste will be widespread practices in the national territory and environmental awareness and the conviction of caring for the environment will have expanded in society."

The Standard is adopted based on the fact "that the volume and concentration of pollutant loads in receiving bodies have increased as a result of population growth and economic activities, which makes it necessary to modify the permissible limits of pollutants in wastewater discharges into receiving bodies for their conservation."

The Standard sets "the concentration of basic parameters, as well as pathogenic and parasitic contaminants, metals and cyanides for wastewater discharges to receiving bodies, must not exceed the value indicated as the permissible limit according to the type of receiving body" in different tables.

Official Standard NOM-001-SEMARNAT-2021, 2022
(Mexico, Secretaría de Medio Ambiente y Recursos Naturales 2022)

3. Taxes and government support to circular economy business models

Taxes, exemptions, subsidies, and other transfers can be used to support the shift to a circular economy model. The existence of these instruments and their implementation can be monitored by using the circular economy core indicators presented in Table 18.

The existence of taxes, exemptions and subsidies supporting circular business models at national level can accelerate the shift to a circular economy. Before the implementation of new market instruments, additional comprehensive analyses of existing ones will allow to identify if any of them have harmful effects for an effective circular economy transition. Box 23 presents the Netherland's experience in government support to circular economy.

Table 18 Circular economy core indicators related to taxes, exemptions and subsidies

Framework	Themes	Proposed core indicators
Responses and actions	Support circular use of materials, promote recycling markets and optimize design	Taxes and government support for circular business models

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

Box 23 Taxes relieves, exemptions and subsidies - country example: The Netherlands

According to the National Circular Economy Programme (NCEP) 2023-2023, "the market incentives based on the principle of 'the polluter pays' will help create a level playing field between the current linear economy and the circular economy. Examples of market incentives are price incentives (subsidies and taxes) which ensure that external effects are factored into the price.

The NCEP includes the use of existing and new tax and non-tax market incentives to improve the business case for circular products and services in a permanent manner compared to linear products and services, and to bring it in line with the R-ladder[1]. In this sense, the Programme proposed to phase out incentives that have a negative effect on the environment (so-called environmentally harmful subsidies).

Some examples of the measures proposed in the NCEP to be considered and/or used as tools to promote the shift to circular economy in different areas are:

- Levies for the use of primary fossil raw materials and subsidies for bio-based raw materials or secondary materials. At national level, the possibilities for taxing non-energetic use of primary fossil raw materials will be explored in order to stimulate the market for secondary raw materials. A tax on fossil raw materials will increase the market price and reduce demand and, on the other hand, a subsidy for bio-based raw materials or secondary materials will promote demand by reducing the price. This will form an incentive for circular innovations and business models and will thus reinforce the national market for secondary raw materials and for products and services with a circular design.
- Subsidies to the public information body Milieu Centraal for the implementation of the Sustainable Consumption framework programme in order to provide independent information to citizens to improve their sustainable and circular action perspective.
- Specific payments to municipal authorities for circular craft centres with the aim of realising a network of circular craft centres with nationwide coverage by 2030.
- Subsidies for professional support offered to repair volunteers (i.e. in repair cafés).
- Increasing the waste tax in 2027-2029 in order to make recycling a more rewarding alternative.
- Incentives for increased reuse and recycling of wind turbines.

The NCEP also includes the support to the "Subsidy for circular value chain projects" (in Dutch: Circulaire Ketenprojecten or CKP) with a focus on small and medium-sized enterprises (SMEs). This subsidy has been available annually since 2020 for SMEs that want to make a value chain (or part thereof) circular as part of a consortium of three to six SMEs. This way, businesses can receive a subsidy for hiring an independent process supervisor, for example. The scheme has been set up based on knowledge from the Circular Netherlands Accelerator and is being implemented by the Netherlands Enterprise Agency (RVO), on behalf of the Ministry of Infrastructure and Water Management. Until 2022, 575 entrepreneurs have been supported in 138 circular value chain projects."

National Circular Economy Programme (2023-2030)
(Kingdom of the Netherlands, Ministry of Infrastructure and Water Management 2023)

1 R-ladder refers to a circularity model in which R-strategies are ranked according to their increase level of circularity (R1 Refuse and Rethink, R2 Reduce, R3 Re-use, R4 Repair, refurbish, remanufacture and repurpose, R5 Recycling and R6 Recover).

4. Government and business R&D expenditure on circular economy technologies

Investment in Research and Development (R&D) allows to adapt and adopt existing circular economy technologies as well as to develop new ones, which at the end, allows to boost the competitiveness of the production sector. Governments can directly invest in R&D to develop circular economy technologies and/or promote R&D in the private sector using financing instruments as funds.

Investment in R&D by the business sector depends on several factors that can be supported at policy-making level:

- The adoption of circular economy technologies by the private sector requires that information about the existing technologies is available, as in some cases enterprises are unaware of technological advancements.
- The technical expertise to use new technologies is expected to exist at company level, and it can be supported by governments through capacity building programmes.
- The financial resources must be available either in the own company or by public financial instruments, as loans or grants.

The combination of these three aspects is often critical, especially for Small and Medium Enterprises (SMEs). Policy-making should support enterprises considering that investments require an internal decision-making process within enterprises where future benefits are perceived as higher than cost increases, so the enterprises do not lose their competitive edge.

Table 19 contains the circular economy core indicator related to R&D expenditure on circular economy technologies and Box 24 presents Spain's effort in that regard. Increasing investments in circular economy technologies supports the shift to a circular economy model.

Table 19 Circular economy core indicator related to R&D expenditure on circular economy technologies

Framework	Themes	Proposed core indicators
Responses and actions	Boost innovation and orient technological change for more circular material lifecycles	Government and business R&D expenditure on CE technologies:

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

Box 24 Government and business R&D expenditure - country example: Spain

The Circular Economy Spanish Strategy 2030 stablishes eight action lines, from which three of them have an inter-sectoral approach. One of these three inter-sectorial action lines is Research and Innovation, aiming to "promote both public and corporate research and innovation initiatives, especially under public-private partnerships, as drivers of change and transition towards a sustainable social and productive model, which is based on creation and transfer of knowledge and adoption of new technologies".

According to the Strategy "research, innovation and competitiveness policies must be put at the service of the acquisition, development, and application of knowledge skills in technologies and innovation of processes, services and business models. In this regard, it is important to promote public funding of research, public-private collaboration and to encourage business investment in Research, Development and Innovation (R+D+i) and direct access to financial instruments such as loans, grants and venture capital to promote the creation of technology-based companies, thus allowing the generation of added value to the Spanish economy as a whole, increasing its domestic competitiveness and also the competitiveness of its exports".

Circular Economy Spanish Strategy. España Circular 2030. (Spain, Ministerio para la Transición Ecológica y el Reto Demográfico 2020b)

5. Business investment in circular economy activities

Business investment in circular economy activities can be promoted by governments and supported by a loans/grants/tax credits system. This financial support is especially important in the case of SMEs as they usually have less capacity for investment and access to private financing.

Table 20 presents the circular economy core indicator related to business investment and Box 25 presents the United Arab Emirates' efforts in that regard. In general, increasing business investments on circular economy activities represents a collective effort to increase circularity.

Table 20 Circular economy core indicator related to business investment on circular economy activities

Framework	Themes	Proposed core indicators
Responses and actions	Strengthen financial flows for a circular economy and reduced leakage	Business investment in CE activities

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

Box 25 Business investment - country example: The United Arab Emirates

According to the United Arab Emirates (UAE) Circular Economy Policy 2021-2031, "since circular economy projects apply new technologies and business models, many in the financial sector argue that their projects are inherently risky and often not bankable. Consequently, inadequate access to financing poses a potential barrier to the widespread adoption by the private sector of more circular practices.

Box 25 Continued

The government can play a key role in removing these barriers by collaborating with the finance industry to identify specific barriers and potential solutions and also through public private partnership arrangements. Moreover, the government could also directly provide financing, for example at early-stage development of new technologies, where the financial sector may be unwilling this could be through new or existing funds.

The United Arab Emirates (UAE) Circular Economy Policy identifies four priority sectors based on their current role in the national economy and on their potential for stimulating and developing a UAE circular economy. These are:

- Sustainable Manufacturing
- Green Infrastructure Sustainable
- Transportation
- Sustainable food production and consumption

The economic incentives related to promote business investment on circular economy activities for the four sectors include, among other:

- Assess the potential for incentivizing (through rewards/penalties) circular economy practices in the manufacturing sector and for adopting pollution prevention technologies.
- Develop financial instruments, programs, and investment schemes that strengthen the links between financial institutions and food producers and manufacturers to implement circular economy principles.
- Analyse how financial incentives or penalties could be used to encourage the uptake of new technologies and methodologies that will increase resource efficiency."

United Arab Emirates Circular Economy Policy 2021-2031 (Government of United Arab Emirates 2021)

6. Circular economy sector

Expanding the circular economy sector is a challenge for governments but also presents several opportunities related to the increase of gross value added of these sectors and is perceived as a source of newly created jobs. Jobs in waste management or renewable energies are just a couple of examples. New job opportunities have a socially direct positive impact, in terms of alleviating poverty and improving health. In addition, according to the World Employment Social Output: the changing nature of jobs (International Labour Organization [ILO] 2015), as women are more often segregated into jobs with low pay, low security and limited social mobility, the rise of new jobs as part of the shift to a circular economy offers an opportunity to empower women. Polices for moving towards a more circular economy can be designed to encourage gender equality.

Table 21 contains the circular economy core indicators related to the circular economy sectors and Box 26 presents Australia's experience in this area. In both cases, increasing values of the indicators are related to the implementation of a circular economy model.

Table 21 Circular economy core indicators related to circular economy sectors

Framework	Themes	Proposed core indicators
Socio-economic opportunities for a just transition	Market developments and new business models	Gross value added related to CE sectorss
		Jobs in CE sectors

Source: Author's elaboration

Note: indicators are classified by colour according to their ideal trend for a circular economy transition. Green colour represents that the indicator should increase while red colour corresponds to indicators that should decrease to reach a circular economy model.

Box 26 Circular economy sector - country example: Australia

According to the National Waste Policy: Less waste, more resources (2018), "moving to a more circular economy has the potential to create new jobs and benefit the economy overall".

In 2018, around 50,000 people were directly employed in waste related activities, including employees in the waste and material recovery industries, the business sector and local governments in Australia.

The Policy assumes that "for every 10,000 tonnes of waste that is recycled, 9.2 jobs are created, compared with 2.8 jobs if the same amount of waste was sent to landfill (according to the Access Economics Pty Limited report on Employment in waste management and recycling (Australia, Access Economics Pty Limited for the Department of Environment, Water, Heritage and the Arts, 2009))."

National Waste Policy: less waste, more resources
(Australia, Department of Climate Change, Energy, the Environment and Water 2018)

The recent published report Fact Sheet: Economic Contribution of the Australian Recycling Industry (2023), summarizes the achievements of the recycling industry in the country including:

- "The recycling industry contributed almost $19 billion to the Australian economy and provided nearly 95,000 jobs in 2021–2022.
- $465 in net economic activity is created for every tonne of material recycled.
- Collective industry turnover of over $14.6 billion.
- Contributed $5.1 billion in direct economic activity and an additional $5.8 billion indirect value-add to GDP through flow-on demand for goods and services.
- Over $1 billion invested in land, buildings, plant and equipment and vehicles in 2021–22.
- One job is supported for every 431 tonnes of material recycled.
- 30,606 direct jobs to Australians and another 25,709 indirect jobs through flow-on activity.

Box 26 Continued

- Provides for one in every 142 jobs in the Australian economy.
- Pays over $2.5 billion in wages and salaries and an additional $253 million in superannuation.
- Higher average employee livelihood in the recycling sector of $82,618, compared to the Australian average weekly earnings of $69,103.
- Recycling industry employment grew by 68.8 per cent compared to Australia's nationwide employment growth of 17.4 per cent over the same period.
- 1,828 recycling businesses operating in Australia.
- The recycling sector's value-add in current prices grew by 117 per cent over the past decade – significantly faster than Australia's gross domestic product of 45.8 per cent over the same period.
- The recycled materials delivered into the economy create further benefit, with usage of recycled materials valued at $7.9 billion in 2021–22 and providing an estimated 37,920 jobs".

Fact Sheet: Economic Contribution of the Australian Recycling Industry (Australian Council Of Recycling (ACOR) 2023)

5.3 Examples of the Use of Circular Economy Core Indicators for Policy Monitoring

Some countries have introduced a set of indicators to monitor the implementation of their circular economy strategies and/or policies. In some cases, a monitoring system has also been put in place to provide the information not only to the institutions responsible for policy monitoring but also to the public. This section includes some real national examples of the use of the circular economy core indicators for policy monitoring. Box 27 presents Spain's indicators for monitoring circular economy, Box 28 highlights Colombia's information system about circular economy while Box 29 describes the United Arab Emirates indicators set to monitor circular economy.

Box 27 Indicators for monitoring the Spanish Circular Economy Strategy: Spain

The Spanish Circular Economy Strategy 2030 includes the following 10 strategic guidelines:

1. "Protection of the environment
2. Product life cycle
3. Waste hierarchy
4. Reduction of food waste
5. Production efficiency
6. Sustainable consumption
7. Communication and awareness
8. Employment for the circular economy
9. Research and innovation
10. **Indicators:** Promoting the adoption of common, transparent and accessible indicators that enable to know the degree of implementation of circular economy initiatives, especially their social and environmental impact."

The Spanish Strategy contains 27 indicators for monitoring the results of its implementation. Indicators are categorized in 5 groups:

1. Producers and consumers
2. Waste management
3. Secondary raw material
4. Competitiveness and innovation
5. Greenhouse Gas Emissions in the waste sector

The indicators proposed in the Strategy that correspond to circular economy core indicators are:

1. Domestic Material Consumption (DMC)
2. Municipal waste generation per capita
3. Waste generation (excluding major mineral waste) per GDP
4. Municipal waste recycling rate
5. Recycling rate of all waste excluding major mineral waste

Box 27 Continued

6. Circular material use rate
7. Share of jobs in circular economy sectors in total employment
8. Share of gross value added of circular economy sectors

The proposed indicators cover 42 per cent of the circular economy core indicators proposed in the Joint UNECE/OECD Guidelines for measuring circular economy Part A: conceptual framework, statistical framework and indicators.

Monitoring indicators are presented in Annex II of the Strategy which includes metadata information, such as indicator's name, unit of measurement, data source, frequency, initial and final date of available data, last data available.

Circular Economy Spanish Strategy
(Spain, Ministerio para la Transición Ecológica y el Reto Demográfico 2020a)

Box 28 Continued

6. Share of gross value added of recycling sector
7. Share of industrial wastewater safely treated
8. Share of waste from the manufacturing sector going to landfill final disposal

The SIEC is an online platform that includes metadata for each indicator, including institutional contact information of the data source, indicator information (indicator's name, description, calculation, unit of measurement, data source, statistical operation, classifications used, scope, target population, geographic coverage, period of reference, date of starting data, dissemination information, data series available, frequency, dissemination channels), and additional information if required.

Information system about circular economy (SIEC)
(Colombia, Departamento Administrativo Nacional de Estadística (DANE) 2023)

Box 28 An Information System about Circular Economy: Colombia

The National Administrative Department of Statistics of Colombia (DANE) has created an Information System about Circular Economy (SIEC), with 51 indicators, which aims to be used as a tool for monitoring the shift to a circular economy. The proposed indicators cover 42 per cent of the circular economy core indicators proposed in the Joint UNECE/OECD Guidelines for measuring circular economy Part A: conceptual framework, statistical framework and indicators.

The indicators included in the SIEC that correspond to circular economy core indicators are:

1. National recycling rate
2. Waste going to landfill as a final disposal
3. Waste generation per capita and by type of waste
4. GHG emissions from production activities
5. Circular use rate

Box 29 Indicators for monitoring circular economy: United Arab Emirates

The United Arab Emirates Circular Economy Policy (2021-2031) includes 21 potential indicators that could be used to monitor progress. Indicators are classified in 5 groups as shown below.

1. Economic performance indicators
2. Performance indicators in resource productivity
3. Performance indicators for renewable energy and Greenhouse Gas Emissions
4. Performance indicators in waste generation
5. Resource productivity indicators

The indicators included in the UAE Circular Economy Policy that correspond to circular economy core indicators are:

- Domestic Material Consumption per unit of GDP
- CO_2 emission per unit of GDP

Box 29 Continued

- Municipal solid waste generation intensity (Kilograms/person/day)
- Percentage of recycled waste as proportion of the total waste generated (hazardous and non-hazardous).

These indicators cover 25 per cent of the circular economy core indicators proposed in the Joint UNECE/OECD Guidelines for measuring circular economy Part A: conceptual framework, statistical framework and indicators.

"The policy will be developed by a detailed implementation plan for the transition to a circular economy that will identify Specific Measurable Achievable Relevant Timebound (SMART) targets. The plan will also allocate clear roles and responsibilities to key stakeholders, including responsibility for monitoring and evaluating progress using key performance indicators."

United Arab Emirates Circular Economy Policy 2021-2031
(Government of United Arab Emirates 2021)

National examples show that some countries are already making efforts to monitor their shift to a circular monitoring evidence based, but as harmonized international methodologies are yet to be adopted, the different proposals are not comparable.

International institutions are highly encouraged to step-up the work on developing the missing methodologies to calculate circular economy indicators and instruments for their data collection. This would allow countries to use harmonized framework for measuring their transition to a circular economy and present a robust basis for policy-makers to develop targeted policies.

06

Conclusions

Shifting from a linear to a circular economy model is a complex, lengthy and challenging process. It requires countries to undergo structural changes and intensive technical support. There is no universal solution to apply due to the varied national economic, political, environmental, social, and cultural conditions of countries. Having information about baselines and progress achieved is key for a successful transition.

Some countries have already adopted national strategies, policies, plans and other regulations to promote the shift to a circular economy. Some of these initiatives contain circular economy indicators for monitoring their implementation, but due to the lack of harmonized methodologies and indicators sets, these initiatives are unfortunately not comparable.

International harmonized methodologies and indicators sets for measuring circular economy are key in this transition. The Guidelines for measuring circular economy (part A) adopted in 2023 is a cornerstone in this effort. It includes sets of circular economy indicators, covering many economic, environmental and social aspects, aiming to measure very simple as well as very complex phenomena, and requiring simple to multi-dimensional data.

Analyzing the current existing data related to circular economy, based on the core indicators proposed in the Guidelines, indicates that some international methodologies are available as well as some international instruments for collecting countries data. Nevertheless, due to the complexity and novelty of the topic, available methodologies and data collecting instruments are not specific for circular economy. Hence, leading to scattered and incomplete data.

Different measures are required to fully populate an international circular economy indicators database. At national level, efforts are needed to increase data availability for circular economy indicators for which methodologies currently exist. Capacity building mechanisms should be set up by international organisations to strengthen national technical skills and support countries in their data production. In parallel, international organizations are encouraged to further collaborate to develop and adopt methodologies of indicators that are not currently available. In addition, including circular economy information in the existing data reporting instruments from countries ensures the reduction of the additional data reporting burden.

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Annexes

Annex I. List of Geographic Regions and Sub-Regions

The country groupings are based on the geographic regions defined under the Standard Country or Area Codes for Statistical Use (known as M49) of the United Nations Statistics Division (UNSD 1999). A complete list of countries included in each region and subregion and country group is available from the United Nations Statistics Division (UNSD 2023c).

M49 code	Region and subregions name
1	World
2	Africa
5	South America (M49)
9	Oceania
11	Western Africa (M49)
13	Central America (M49)
14	Eastern Africa (M49)
15	Northern Africa
17	Middle Africa (M49)
18	Southern Africa (M49)
19	Americas
21	Northern America
29	Caribbean (M49)
30	Eastern Asia
34	Southern Asia
35	South-eastern Asia
39	Southern Europe (M49)
53	Australia and New Zealand
54	Melanesia (M49)

M49 code	Region and subregions name
57	Micronesia (M49)
61	Polynesia (M49)
62	Central Asia and Southern Asia
142	Asia
143	Central Asia
145	Western Asia
150	Europe
151	Eastern Europe (M49)
154	Northern Europe (M49)
155	Western Europe (M49)
199	Least Developed Countries (LDCs)
202	Sub-Saharan Africa
419	Latin America and the Caribbean
432	Landlocked Developing Countries (LLDCs)
513	Northern America and Europe
543	Oceania excluding Australia and New Zealand
722	Small Island Developing States (SIDS)
747	Western Asia and Northern Africa
753	Eastern Asia and South-eastern Asia

Table of Content

Annex II. List of Available Variables Related to Circular Economy Core Indicators

Indicators are highlighted in green when they have a positive trend to circular economy and in red when the relation is negative (more explanations in section 5.2).

Material Life-cycle and Value Chain

Theme	Proposed core indicator	Disaggregated indicator	Selected variable	Source	Unit	Serie
The material basis of the economy	Material consumption and productivity	Production-based domestic material consumption (DMC)	Production-based domestic material consumption (DMC)	(UNSD 2023d)	Tonnes	2000 - 2019
			Production-based DMC by type of raw material	(UNSD 2023d)	Tonnes	2000 - 2019
		Demand-based raw material consumption (RMC) (material footprint)	Demand-based raw material consumption (RMC) (material footprint)	(UNSD 2023d)	Tonnes	2000 - 2019
		Production-based material productivity (GDP/DMC)	Production-based material intensity (DMC/ GDP)	(UNSD 2023d)	Kilograms per constant 2015 United States dollars	2000 - 2019
			Production-based material intensity by raw material (DMC by raw material /GDP)	(UNSD 2023d)	Kilograms per constant 2015 United States dollars	2000 - 2019
		Demand-based raw material productivity (GDP/ RMC)	Demand-based raw material intensity (RMC/ GDP)	(UNSD 2023d)	Kilograms per constant 2015 United States dollars	2000 - 2019
The circularity of material flows and the management efficiency of materials and waste	Total waste generation	Total waste generation	Total waste generation	(UNSD 2023d)	Tonnes	2000-2021
			Total waste generation by sector	(UNSD 2023d)	Tonnes	2000-2021
		Municipal waste generation (proxy)	Municipal waste generation	(UNSD 2023d)	Tonnes	2000-2021
	Circular material use rate	Share of recycled materials in material consumption	Circular material use rate	(Eurostat 2023a)	Percentage (%)	2010-2021
	National recycling rate	National recycling rate	Recycling rate of all waste excluding major mineral waste	(Eurostat 2023a)	Percentage (%)	2010-2020
		Municipal waste recycling rate (proxy)	Municipal waste recycling rate (proxy)	(UNSD 2023d)	Percentage (%)	2010-2019
	Waste going to final disposal		Waste (excluding major mineral waste) going to landfill final disposal (D1, D5, D12)	(Eurostat 2023a)	Tonnes	2010-2020
			Waste (excluding major mineral waste) going to incineration without energy recovery (D10)	(Eurostat 2023a)	Tonnes	2010-2020

Interactions with the Environment

Theme	Proposed core indicator	Disaggregated indicator	Selected variable	Source	Unit	Serie
Natural resource implications	Intensity of use of renewable freshwater resources		Water stress	(UNSD 2023d)	Percentage (%)	2000-2020
			Water stress by sector	(UNSD 2023d)	Percentage (%)	2000-2020
Environmental quality implications	GHG emissions from production activities	GHG emissions from production activities		No data		
		Total GHG emissions (proxy)	Total GHG emissions	(WB 2023)	Kilo-tonnes CO_2 equivalent	2000-2020
	Pollutant discharges from material extraction and processing to water bodies and share safely treated	Pollutant discharges from production activities to water bodies	Industrial discharges to water bodies	(OECD 2023)	Million m^3/year	2000-2021
			Agricultural discharges to water bodies	(OECD 2023)	Million m^3/year	2000-2021
			Industrial BOD discharged	(OECD 2023)	1000 Kg O_2/day	2005-2021
			Industrial COD discharged	(OECD 2023)	1000 Kg O_2/day	2005-2020
			Industrial N discharged	(OECD 2023)	1000 Kg/day	2010-2020
			Industrial P discharged	(OECD 2023)	1000 Kg/day	2010-2020
			Industrial SS discharged	(OECD 2023)	1000 Kg/day	2010-2020
			Agricultural BOD discharged	(OECD 2023)	1000 Kg O_2/day	2000-2021
			Agricultural COD discharged	(OECD 2023)	1000 Kg O_2/day	2000-2021
			Agricultural N discharged	(OECD 2023)	1000 Kg/day	2000-2021
			Agricultural P discharged	(OECD 2023)	1000 Kg/day	2000-2021
			Agricultural SS discharged	(OECD 2023)	1000 Kg/day	2000-2021
		Percentage of discharges safely treated (proxy)	Proportion of total discharges to water bodies safely treated (proxy)	(UNSD 2023d)	Percentage (%)	2015
			Proportion of industrial discharges to water bodies safely treated (proxy)	(UNSD 2023d)	Percentage (%)	2015

Responses and Actions

Theme	Proposed core indicator	Disaggregated indicator	Selected variable	Source	Unit	Serie
Support circular use of materials, promote recycling markets and optimize design	Taxes and government support for circular business models			No data		
Improve the efficiency of waste management and close leakage pathways	Investments in waste management, waste collection and sorting		Investments in waste management by general governments	(Eurostat 2023a)	Millions constant 2015 United States dollars	2014-2021
			Investments in waste management by corporations as specialist and secondary producers	(Eurostat 2023a)	Millions constant 2015 United States dollars	2014-2021
Boost innovation and orient technological change for more circular material lifecycles	Government and business R&D expenditure on CE technologies			No data		
Strengthen financial flows for a circular economy and reduced leakage	Business investment on CE activities		Business investment in circular economy activities as percentage of the GDP	(Eurostat 2023a)	Percentage (%)	2005-2021
			Business investment in circular economy activities	(Eurostat 2023a)	Millions constant 2015 United States dollars	2005-2021

Socio-economic Opportunities for A Just Transition

Theme	Proposed core indicator	Disaggregated indicator	Selected variable	Source	Unit	Serie
Market developments and new business models	Gross value added related to circular economy sectors		Gross value added to circular economy sectors as percentage of the GDP	(Eurostat 2023a)	Percentage (%)	2005-2021
			Gross value added to circular economy sectors	(Eurostat 2023a)	Millions constant 2015 United States dollars	2005-2021
	Jobs in circular economy sectors		Jobs in circular economy sectors	(Eurostat 2023a)	Full-time equivalent	2005-2021
			Proportion of jobs in circular economy sectors in total employment	(Eurostat 2023a)	Percentage (%) in full-time equivalent	2005-2021

Annex III. Circular Economy Core Indicators Metadata (At Variable Level)

This Annex presents the content of the circular economy dataset, including an explanation about its structure, the steps followed at the dataset consolidation and the metadata information for each variable.

III.1 Dataset structure

The dataset is divided into two parts. The first one includes general information for each variable, containing 7 items as shown in the Table III. 1.

Table III. 1 Variable information

Categories	Description
Variable	Variable name
Unit	Unit of measurement
Data source	Institution where the data are extracted from.
Date of data extraction	Date when the data were extracted, or data will be updated.
Nature	Information on the classification used regarding the nature of the data. The possible categories are: E: estimated data N: non-relevant C: country data G: global monitoring data CA: country adjusted data. The category N (non-relevant) includes the regional data calculated according to the UN methodology.
Type of product	If applicable, the type of product lists the categories of products used.
Sector	If applicable, this refers to the different categories of sectors used.

After the presentation of the variable, the second part of the dataset contains the series of data according to structure presented in Table III. 2.

Table III. 2 Items of the data series

Items	Description
GeoAreaName	Corresponds to the name of the country or the region.
GeoAreaCode	Corresponds to the classification of the United Nations for countries and regions.
Unit	Unit of measurement
Year	Year of measurement
Sector	If applicable, corresponds to the activity sector
Nature	The nature of the data is classified as follows: E: estimated data N: non-relevant C: country data G: global monitoring data CA: country adjusted data. The category N (non-relevant) includes the regional data calculated according to the UN methodology.
Notes	Additional information about data when available. For example, break in time series or information about the classification used.

III.2 Dataset consolidation steps

Once data are extracted from the original dataset, the consolidation of the CE dataset is made as follows:

1. As a first step, the dataset starts in the year 2000, so data available before this year are not included. Data before the year 2000 can be consulted in the original dataset.
2. Secondly, when a cell is empty in the dataset, it means that there is no data available for the country for this year.
3. When the value of the variable is zero, it is represented by "0".
4. Data flags are separated into information about the nature of the data and additional information (notes).
5. To harmonize the unit of measurement, monetary data are presented in constant 2015 United States dollars. The exchange rates used to convert euros to constant 2015 United States dollar are the period average exchange rates, and they are presented in the following Table III. 3. The exchange rates were taken from the International Monetary Fund (International Monetary Fund [IMF] 2023).

Table III. 3 Period average exchanges rates

Year	Exchange rate (period average) Euros to US dollar
2005	1.25
2006	1.25
2007	1.37
2008	1.47
2009	1.39
2010	1.33
2011	1.39
2012	1.28

6. At the next step, countries are identified by the GeoArea Code (M49 code) according to United Nations methodology "Standard Country or Area Codes for Statistical Use" (UNSD 1999).
7. Finally, country data are aggregated following the UNEP aggregation methodology. This aggregation is calculated at sub-regional, regional, and global level and for special countries groups. Aggregates calculation is done by sum or average and only when more than 55 per cent of the data are available.
8. Calculated regional aggregates are assigned with N (non-relevant) nature, according to the United Nations methodology.

III.3 Circular economy variables metadata

This section presents the metadata information for each variable:

1. Production-based domestic material consumption (DMC)
2. Production-based domestic material consumption (DMC) by type of raw material
3. Demand-based raw material consumption (RMC) (material footprint)
4. Production-based material intensity (Domestic Material Consumption DMC /GDP)
5. Production-based material intensity by raw material (Domestic Material Consumption by raw material/GDP) DMC by raw material/GDP
6. Demand-based raw material intensity (RMP/GDP)
7. Total waste generation
8. Total waste generation by sector
9. Municipal waste generation
10. Circular material use rate
11. Recycling rate of all waste excluding major mineral waste
12. Municipal waste recycling rate
13. Waste (excluding major mineral waste) going to landfill final disposal (D1, D5, D12)
14. Waste (excluding major mineral waste) going to incineration without energy recovery (D10)
15. Water stress: Intensity of use of renewable freshwater resources (abstraction over available renewable stocks)
16. Water stress by sectors

17. Total GHG emissions
18. Industrial discharges to water bodies
19. Agricultural discharges to water bodies
20. Industrial BOD discharged to water bodies
21. Industrial COD discharged to water bodies
22. Industrial N discharged to water bodies
23. Industrial P discharged to water bodies
24. Industrial SS discharged to water bodies
25. Agricultural BOD discharged to water bodies
26. Agricultural COD discharged to water bodies
27. Agricultural N discharged to water bodies
28. Agricultural P discharged to water bodies
29. Agricultural SS discharged to water bodies
30. Proportion of total discharges to water bodies safely treated
31. Proportion of industrial discharges to water bodies safely treated
32. Investments in waste management by general governments
33. Investments in waste management by corporations as specialists and secondary producers
34. Business investment in circular economy activities (percentage of GDP)
35. Business investment in circular economy activities (Millions constant 2015 United States dollars)
36. Gross value added to circular economy sector as percentage of the GDP
37. Gross value added to circular economy sector
38. Jobs in circular economy sectors
39. Proportion of jobs in circular economy sectors in total employment

1. Production-based domestic material consumption (DMC)

Data source: UNSD – SDG 8.4.2 – SDG 12.2.2
Date of data extraction: 12/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-02.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-02.pdf
Serie: 2000-2019
Unit: Tonnes

Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definition, concepts, and calculation *(according to United Nations methodology)*:

"Domestic Material Consumption (DMC) is a standard material flow accounting (MFA) indicator and reports the apparent consumption of materials in a national economy" (UNSD 2023d).

"DMC measures the amount of materials that are used in economic processes. It does not include materials that are mobilized for the process of domestic extraction but do not enter the economic process. It measures the total amount of material (biomass, fossil fuels, metal ores and non-metallic minerals) directly used in an economy and based on accounts of direct material flows, i.e., domestic material extraction and physical imports and exports" (United Nations Statistics Division (UNSD), 2023).

"Domestic Material Consumption (DMC) reports the amount of materials that are used in a national economy. It is a territorial (production-side) indicator. DMC also presents the amount of material that needs to be handled within an economy, which is either added to material stocks of buildings and transport infrastructure or used to fuel the economy as material throughput. It describes the physical dimension of economic processes and interactions. It can also be interpreted as long-term waste equivalent" (UNSD 2023d).

Domestic Material Consumption (DMC) is calculated as:

DMC =DE + IM - EX,

Where:

DMC – domestic material consumption;
DE – domestic extraction of materials;
IM – direct imports;
EX – direct exports

2. Production-based domestic material consumption (DMC) by type of raw material

Data source: UNSD - SDG 8.4.2 SDG 12.2.2
Date of data extraction: 25/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-02.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-02.pdf
Serie: 2000-2019
Unit: Tonnes of raw material
Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definition, concepts, and calculation *(according to United Nations methodology):*

"Domestic Material Consumption (DMC) is a standard material flow accounting (MFA) indicator and reports the apparent consumption of materials in a national economy" (UNSD 2023d).

"DMC measures the amount of materials that are used in economic processes. It does not include materials that are mobilized for the process of domestic extraction but do not enter the economic process. It measures the total amount of material (biomass, fossil fuels, metal ores and non-metallic minerals) directly used in an economy and based on accounts of direct material flows, i.e., domestic material extraction and physical imports and exports" (UNSD 2023d).

"Domestic Material Consumption (DMC) reports the amount of materials that are used in a national economy. It is a territorial (production-side) indicator. DMC also presents the amount of material that needs to be handled within an economy, which is either added to material stocks of buildings and transport infrastructure or used to fuel the economy as material throughput. It describes the physical dimension of economic processes and interactions. It can also be interpreted as long-term waste equivalent" (UNSD 2023d).

"Domestic Material Consumption (DMC) is calculated as:

DMC =DE + IM - EX,

Where:

DMC – domestic material consumption;
DE – domestic extraction of materials;
IM – direct imports;
EX – direct exports" (UNSD 2023d).

The categories used to calculate DMC by type of raw materials for SDG 8.4.2 and 12.2.2 are (UNSD 2023d):

ALP	Total or no breakdown
BIM	Biomass
COL	Coal
CPR	Crop residues
CRO	Crops
FEO	Ferrous ores
FOF	Fossil fuels
GAS	Natural gas
GBO	Grazed biomass and fodder crops
MEO	Metal ores
NFO	Non-ferrous ores
NMA	Non-metallic minerals: industrial or agricultural dominant
NMC	Non-metallic minerals: construction dominant
NMM	Non-metallic minerals
ONT	Oil shale and tar sands
PET	Petroleum
WCH	Wild catch and harvest
WOD	Wood

3. Demand-based raw material consumption (RMC) (material footprint)

Data source: UNSD - SDG 8.4.1 SDG 12.2.1
Date of data extraction: 9/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-01.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-01.pdf
Serie: 2000-2019
Unit: Tonnes
Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definitions, concepts and calculation *(according to United Nations methodology):*

"Material Footprint (MF) is the attribution of global material extraction to domestic final demand of a country. The total material footprint is the sum of the material footprint for biomass, fossil fuels, metal ores and non-metallic minerals" (UNSD 2023d).

"Material footprint of consumption reports the amount of primary materials required to serve final demand of a country and can be interpreted as an indicator of the material standard of living/level of capitalization of an economy" (UNSD 2023d).

Material footprint by type of raw material (tonnes) is calculated as:

MF= DE+ RMEIM – RMEEX

Where:

MF – material footprint;
DE – domestic extraction of materials;
RMEIM – raw material equivalent of imports;
RMEEX – raw material equivalents of exports

"Domestic Material Consumption (DMC) and Material Footprint (MF) need to be looked at in combination, as they cover the two aspects of the economy, production and consumption. The DMC reports the actual amount of material in an economy, MF the virtual amount required across the whole supply chain to service final demand. A country can, for instance, have a very high DMC because it has a large primary production sector for export or a very low DMC because it has outsourced most of the material intensive industrial process to other countries. The material footprint corrects for both phenomena" (UNSD 2023d).

4. Production-based material intensity (Domestic Material Consumption DMC /GDP)

Data source: UNSD - SDG 8.4.2 SDG 12.2.2
Date of data extraction: 10/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-02.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-02.pdf
Serie: 2000-2019
Unit: Kilograms per constant 2015 United States dollars
Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definition, concepts and calculation *(according to United Nations methodology)*:

"Domestic Material Consumption (DMC) is a standard material flow accounting (MFA) indicator and reports the apparent consumption of materials in a national economy" (UNSD 2023d).

"DMC measures the amount of materials that are used in economic processes. It does not include materials that are mobilized for the process of domestic extraction but do not enter the economic process. It measures the total amount of material (biomass, fossil fuels, metal ores and non-metallic minerals) directly used in an economy and based on accounts of direct material flows, i.e., domestic material extraction and physical imports and exports" (UNSD 2023d).

"Domestic Material Consumption (DMC) reports the amount of materials that are used in a national economy. It is a territorial (production-side) indicator. DMC also presents the amount of material that needs to be handled within an economy, which is either added to material stocks of buildings and transport infrastructure or used to fuel the economy as material throughput. It describes the physical dimension of economic processes and interactions. It can also be interpreted as long-term waste equivalent" (UNSD 2023d).

Domestic Material Consumption (DMC) is calculated as:

DMC =DE + IM - EX,

Where:

DMC – domestic material consumption;
DE – domestic extraction of materials;
IM – direct imports;
EX – direct exports

Domestic material consumption per unit of GDP is calculated as:

DMC per GDP = DMC / GDP in constant 2015 United States Dollars

As per the Joint UNECE/OECD Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators, the core indicator is **material productivity** and it can be calculated as:

Material productivity = GDP in constant 2015 United States Dollars / DMC = 1 / Material intensity

5. Production-based material intensity by raw material (Domestic Material Consumption by raw material/GDP) DMC by raw material/ GDP

Data source: UNSD - SDG 8.4.2 SDG 12.2.2
Date of data extraction: 10/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-02.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-02.pdf
Serie: 2000-2019
Unit: Kilograms per constant 2015 United States dollars
Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definition, concepts and calculation ***(according to United Nations methodology):***

"Domestic Material Consumption (DMC) is a standard material flow accounting (MFA) indicator and reports the apparent consumption of materials in a national economy" (UNSD 2023d).

"DMC measures the amount of materials that are used in economic processes. It does not include materials that are mobilized for the process of domestic extraction but do not enter the economic process. It measures the total amount of material (biomass, fossil fuels, metal ores and non-metallic minerals) directly used in an economy and based on accounts of direct material flows, i.e., domestic material extraction and physical imports and exports" (UNSD 2023d).

"Domestic Material Consumption (DMC) reports the amount of materials that are used in a national economy. It is a territorial (production-side) indicator. DMC also presents the amount of material that needs to be handled within an economy, which is either added to material stocks of buildings and transport infrastructure or used to fuel the economy as material throughput. It describes the physical dimension of economic processes and interactions. It can also be interpreted as long-term waste equivalent" (UNSD 2023d).

Domestic Material Consumption (DMC) is calculated as:

DMC =DE + IM - EX

Where:

DMC – domestic material consumption;
DE – domestic extraction of materials;
IM – direct imports;
EX – direct exports

The categories used to calculate DMC by type of raw materials for SDG 8.4.2 and 12.2.2 are (UNSD 2023d):

ALP	Total or no breakdown
BIM	Biomass
COL	Coal
CPR	Crop residues
CRO	Crops
FEO	Ferrous ores
FOF	Fossil fuels
GAS	Natural gas
GBO	Grazed biomass and fodder crops
MEO	Metal ores
NFO	Non-ferrous ores
NMA	Non-metallic minerals: industrial or agricultural dominant
NMC	Non-metallic minerals: construction dominant
NMM	Non-metallic minerals
ONT	Oil shale and tar sands
PET	Petroleum
WCH	Wild catch and harvest
WOD	Wood

Domestic material consumption by raw material per unit of GDP is calculated as:

DMC by raw material per GDP = DMC by raw material / GDP in constant 2015 United States Dollars

As per the Joint UNECE/OECD Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators, the core indicator is material productivity by raw material and it can be calculated as:

Material productivity by raw material = GDP in constant 2015 United States Dollars/ DMC by raw material = 1 / Material intensity by raw material

6. Demand-based raw material intensity (RMP/GDP)

According to the Joint UNECE/OECD report "Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators", in the absence of reliable data on net or gross national income, GDP can be used as a proxy for calculating the demand-based indicator.

Data source: UNSD - SDG 8.4.1 SDG 12.2.1
Date of data extraction: 12/09/2023)
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-08-04-01.pdf
https://unstats.un.org/sdgs/metadata/files/Metadata-12-02-01.pdf
Serie: 2000-2019
Unit: Kilograms per constant 2015 United States dollars
Data providers: National Statistical Offices
Data compilers: UNEP, OECD and EUROSTAT.

Definition, concepts and calculation *(according to United Nations methodology):*

"Material Footprint (MF) is the attribution of global material extraction to domestic final demand of a country. The total material footprint is the sum of the material footprint for biomass, fossil fuels, metal ores and non-metallic minerals" (UNSD 2023d).

"Material footprint of consumption reports the amount of primary materials required to serve final demand of a country and can be interpreted as an indicator of the material standard of living/level of capitalization of an economy" (UNSD 2023d).

Material footprint by type of raw material (tonnes) is calculated as:

MF= DE+ RMEIM – RMEEX

Where:

MF – material footprint;
DE – domestic extraction of materials;
RMEIM – raw material equivalent of imports;
RMEEX – raw material equivalents of exports

Material footprint per unit of GDP is calculated as:

MF per GDP = MF / GDP in constant 2015 United States Dollars

As per the Joint UNECE/OECD Guidelines for measuring circular economy part A: conceptual framework, statistical framework and indicators, the core indicator is raw material productivity and it can be calculated as:

Raw material productivity = GDP in constant 2015 United States Dollars / Material footprint = 1 / Raw material intensity

7. Total waste generation

Data source: UNSD – SDG 12.4.2
Date of data extraction: 14/12/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-12-04-02.pdf
A full methodology for this indicator is available in the document "Global Chemicals and Waste Indicator Review Document" (UNEP, 2021) https://www.unep.org/resources/publication/global-chemicals-and-waste-indicator-review-document
Serie: 2000-2021
Unit: Tonnes
Data providers: National Statistical Systems and relevant ministries.
Data compilers: UNSD, UNEP, OECD and EUROSTAT.

Definition and concepts *(according to United Nations methodology):*

"**Total waste generated** is the total amount of waste (both hazardous and non-hazardous) generated in the country during the year" (UNSD 2023d).

8. Total waste generation by sector

Data source: UNSD – SDG 12.4.2
Date of data extraction: 14/12/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-12-04-02.pdf
A full methodology for this indicator is available in the document "Global Chemicals and Waste Indicator Review Document" (UNEP, 2021) https://www.unep.org/resources/publication/global-chemicals-and-waste-indicator-review-document
Serie: 2000-2021
Unit: Tonnes
Data providers: National Statistical Systems and relevant ministries.
Data compilers: UNSD, UNEP, OECD and EUROSTAT.

Definition and concepts *(according to United Nations methodology):*

"**Total waste generated** is the total amount of waste (both hazardous and non-hazardous) generated in the country during the year" (UNSD 2023d).

Disaggregation by sectors: Sectorial disaggregated data are provided to show the respective contribution of the different sectors to waste generation, and therefore the relative importance of actions needed to contain waste generation in the different sectors.

Sectors are defined following the International Standard Industrial Classification of All Economic Activities (ISIC), Rev.4. coding:

ISIC4_A	Agriculture, forestry and fishing
ISIC4_B	Mining and quarrying
ISIC_C	Manufacturing
ISIC_D	Electricity, gas, steam and air conditioning supply
ISIC_F	Construction
ISIC4_S	Other service activities
ISIC4_T	Activities of households as employers, undifferentiated goods- and services-producing activities of households for own use.

9. Municipal waste generation

Data source: UNSD – SDG 12.4.2
Date of data extraction: 14/12/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-12-04-02.pdf
A full methodology for this indicator is available in the document "Global Chemicals and Waste Indicator Review Document" (UNEP, 2021) https://www.unep.org/resources/publication/global-chemicals-and-waste-indicator-review-document
Serie: 2000-2021
Unit: Tonnes
Data providers: National Statistical Systems and relevant ministries.
Data compilers: UNSD, UNEP, OECD and EUROSTAT.

Definition and concepts *(according to United Nations methodology):*

"**Municipal waste or municipal solid waste (MSW)** includes waste originating from households, commerce, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes bulky waste (e.g. waste from parks and gardens maintenance, waste from stress cleaning services (street sweepings, litter containers content, market cleansing waste), if managed as waste" (UNSD 2023d).

10. Circular material use rate

Data source: Eurostat
Date of data extraction: 17/10/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_srm030/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_srm030_esmsip2.htm
Serie: 2010-2021
Unit: Percentage (%)
Data providers: National institutions.
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat methodology):*

"**The circular material use rate**, also called 'Circularity rate', measures in percentage the share of material recycled and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. The Circularity rate is thus defined as the ratio of the circular use of materials (U) to the overall material use (M)" (Eurostat 2023b).

"**The overall material use** is measured by summing up the aggregate domestic material consumption (DMC) and the circular use of materials (M = DMC + U)" (Eurostat 2023b).

"**Waste recycled in domestic recovery plants** comprises the recovery operations R2 to R11 as defined in the Waste Framework Directive 2008/98/EC" (Eurostat 2023b).

"**The circular use of materials** is approximated by the amount of waste recycled in domestic recovery plants (RCV_R), minus imported waste destined for recycling (IMPw), plus exported waste destined for recycling abroad (EXPw)" (Eurostat 2023b).

The circular material use rate is calculated as follows:

$$CMU = \frac{U}{M} = \frac{(RCV\_R - IMP_w + EXP_w)}{DMC + (RCV\_R - IMP_w + EXP_w)}$$

Where:

CMU: Circular Material Use rate
U: use of materials
M: Overall material use
RCV_R: amount of waste recycled in domestic recovery plants
IMPw: amount of imported waste bound for recycling
EXPw: amount of exported waste bound for recycling
DMC: Domestic Material Consumption

11. Recycling rate of all waste excluding major mineral waste

Data source: Eurostat
Date of data extraction: 19/10/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_wm010/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_wm010_esmsip2.htm
Serie: 2010-2020
Unit: Percentage (%)
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

"**Recycled waste** is waste treated, which was sent to recovery operation other than energy recovery and backfilling (for simplification referred to as recycling)" (Eurostat 2023b).

"**Waste excluding major mineral waste** covers both hazardous (hz) and non-hazardous (nh) waste from all economic sectors and from households, including waste from waste treatment (secondary waste) but excluding most mineral waste. Major mineral waste is excluded in order to avoid situations where trends in ordinary waste generation can be drowned out by massive fluctuations in the generation of wastes in the mineral extraction and transformation sector. This also permits more meaningful comparison across countries, as mineral waste accounts for very substantial quantities in countries characterized by major mining and construction sectors" (Eurostat 2023b).

"**Recycling rate of all waste** includes waste treated in domestic plants plus waste sent out of the country for recycling minus waste imported and treated in domestic recycling plants. The indicator reflects the treatment of national waste, no matter where it takes place, and it excludes the waste that is imported" (Eurostat 2023b).

Recycling rate of all waste excluding major mineral waste is calculated as follows:

Recycling rate = (RCV_R / TRT) × 100

Where:

RCV_R: Recycled waste
TRT: Total waste treated excluding major mineral waste

12. Municipal waste recycling rate

Data source: UNSD – SDG 12.5.1
Date of data extraction: 14/09/2023)
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-12-05-01.pdf
Serie: 2000-2021
Unit: Percentage (%)
Data providers: National Statistical Systems and relevant ministries.
Data compilers: UNSD, UNEP, OECD and Eurostat.

Definitions, concepts and calculation *(according to United Nations methodology):*

Municipal waste recycling rate can be defined as the quantity of municipal waste recycled in the country plus quantities of municipal waste exported for recycling minus municipal waste imported intended for recycling out of total municipal waste generated in the country. Note that recycling includes codigestion/anaerobic digestion and composting/aerobic process, but not controlled combustion (incineration) or land application.

"**Recycling** is defined under the UNSD/UNEP Questionnaire on Environment Statistics and further for the purpose of these indicators as "Any reprocessing of waste material […] that diverts it from the waste stream, except reuse as fuel. Both reprocessing as the same type of product, and for different purposes should be included. Recycling within industrial plants i.e., at the place of generation should be excluded." For the purpose of consistency with the Basel Convention reporting and correspondence with EUROSTAT reporting system, Recovery operations R2 to R12 listed in Basel Convention Annex IV, are to be considered as 'Recycling' under the UNSD reporting for hazardous waste. Total waste generated is the total amount of waste (both hazardous and non-hazardous) generated in the country during the year" (UNSD 2023d).

"**Municipal Solid Waste (MSW)** includes waste originating from households, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes bulky waste (e.g., old furniture, mattresses) and waste from selected municipal services, e.g., waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste), if managed as waste" (UNSD 2023d).

Municipal waste recycling rate = (Municipal waste recycled + Municipal waste exported intended for recycling – Municipal waste imported intended for recycling) x 100

13. Waste (excluding major mineral waste) going to landfill final disposal (D1, D5, D12)

Data source: Eurostat
Date of data extraction: 5/10/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/env_wasoper/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/env_wasoper_esms.htm
Serie: 2010-2020
Unit: Tonnes
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Waste (excluding major mineral waste) going to landfill final disposal is an indicator that aims at showing how much of a country's own waste (in the following referred to as national waste) excluding major mineral waste is actually landfilled. This means that the indicator should reflect the treatment of national waste, no matter where it takes place, and it should exclude the waste imported.

Waste (excluding major mineral waste) includes "hazardous (hz) and non-hazardous (nh) waste from all economic sectors and from households, including waste from waste treatment (secondary waste) but excluding major mineral wastes and waste going into pre-treatment activities (like sorting, drying). It covers only waste from final treatment.

The indicator covers all wastes except the following waste categories:

- Mineral waste from construction and demolition (EWC-Stat 12.1)
- Other mineral wastes (12.2, 12.3, 12.5)
- Soils (12.6)
- Dredging spoils (12.7)" (Eurostat, 2023b).

"**Waste** is any substance or object which the holder discards or intends or is required to discard" (Eurostat 2023b).

Disposal – landfill (D1, D5, D12) is a category of waste management according to the Directive 2008/98/EC on waste.

14. Waste (excluding major mineral waste) going to incineration without energy recovery (D10)

Data source: Eurostat
Date of data extraction: 5/10/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/env_wasoper/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/env_wasoper_esms.htm
Serie: 2010-2020
Unit: Tonnes
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Waste (excluding major mineral waste) going to incineration without energy recovery is an indicator that aims at showing how much of a country's own waste (in the following referred to as **national waste**) excluding major mineral waste is actually incinerated without energy recovery. This means that the indicator should reflect the treatment of national waste, no matter where it takes place, and it should exclude the waste imported.

Waste (excluding major mineral waste) includes "hazardous (hz) and non-hazardous (nh) waste from all economic sectors and from households, including waste from waste treatment (secondary waste) but excluding major mineral wastes and waste going into pre-treatment activities (like sorting, drying). It covers only waste from final treatment.

The indicator covers all wastes except the following waste categories:

- Mineral waste from construction and demolition (EWC-Stat 12.1)
- Other mineral wastes (12.2,12.3, 12.5)
- Soils (12.6)
- Dredging spoils (12.7)" (Eurostat, 2023b).

"**Waste** is any substance or object which the holder discards or intends or is required to discard" (Eurostat 2023b).

Disposal - incineration (D10) without energy recovery is a category of waste management according to the Directive 2008/98/EC on waste.

15. Water stress: Intensity of use of renewable freshwater resources (abstraction over available renewable stocks)

Data source: UNSD – SDG 6.4.2
Date of data extraction 13/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-06-04-02.pdf
Serie: 2000-2020
Unit: Percentage (%)
Data providers: Data originate from governmental sources. The institutions responsible for data collection at national level vary according to countries. However, in general data for this indicator are provided by the Ministry of Agriculture, Ministry of Water, Ministry of Environment, and other line Ministries. In many cases, data collection at country level is coordinated by the National Statistics Office (NSO).
Data compilers: National institutions

Definitions, concepts and calculation *(according to United Nations methodology):*

"**The level of water stress or freshwater withdrawal as a proportion of available freshwater resources** is the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental flow requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services. This indicator is also known as water withdrawal intensity.

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users" (UNSD 2023d).

"**Total renewable freshwater resources (TRWR)** are expressed as the sum of internal and external renewable water resources. The terms "water resources" and "water withdrawal" are understood as freshwater resources and freshwater withdrawal" (UNSD 2023d).

"**Internal renewable water resources** are defined as the long-term average annual flow of rivers and recharge of groundwater for a given country generated from endogenous precipitation" (UNSD 2023d).

"**External renewable water resources** refer to the flows of water entering the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through agreements or treaties" (UNSD 2023d).

"**Total freshwater withdrawal (TFWW)** is the volume of freshwater extracted from its source (rivers, lakes, aquifers) for agriculture, industries and services. It is estimated at the country level for the following three main sectors: agriculture, services (including domestic water withdrawal) and industries (including cooling of thermoelectric plants). Freshwater withdrawal includes fossil groundwater. It does not include non-conventional water, i.e. direct use of treated wastewater, direct use of agricultural drainage water and desalinated water" (UNSD 2023d).

"**Environmental flow requirements (EFR)** are defined as the quantity and timing of freshwater flows and levels necessary to sustain aquatic ecosystems, which, in turn, support human cultures, economies, sustainable livelihoods, and wellbeing. Water quality and also the resulting ecosystem services are excluded from this formulation which is confined to water volumes. This does not imply that quality and the support to societies which are dependent on environmental flows are not important and should not be taken care of. Methods of computation of EFR are extremely variable and range from global estimates to comprehensive assessments for river reaches. For the purpose of the SDG indicator, water volumes can be expressed in the same units as the TFWW, and then as percentages of the available water resources" (UNSD 2023d).

The indicator is computed as follows:

Stress (%) = TFWW/(TRWR – EFR) X 100

Where:

TFWW: total freshwater withdrawn
TRWR: total renewable freshwater resources
EFR: environmental flow requirements

To interpret the values of this indicator, four categories are used to identify the levels of stress severity:

NO STRESS <25%
LOW 25% - 50%
MEDIUM 50% - 75%
HIGH 75-100%
CRITICAL >100%

16. Water stress by sectors

Data source: UNSD SDG 6.4.2
Date of data extraction 16/10/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-06-04-02.pdf
Serie: 2000-2020
Unit: Percentage (%)
Data providers: Data come from governmental sources. The institutions responsible for data collection at national level vary according to countries. However, in general data for this indicator are provided by the Ministry of Agriculture, Ministry of Water, Ministry of Environment, and other line Ministries. In many cases, data collection at country level is coordinated by the National Statistics Office (NSO).
Data compilers: National institutions.

Definitions, concepts and calculation *(according to United Nations methodology):*

"**The level of water stress or freshwater withdrawal as a proportion of available freshwater resources** is the ratio between total freshwater withdrawn by all major sectors and total renewable freshwater resources, after taking into account environmental flow requirements. Main sectors, as defined by ISIC standards, include agriculture; forestry and fishing; manufacturing; electricity industry; and services. This indicator is also known as water withdrawal intensity.

This indicator provides an estimate of pressure by all sectors on the country's renewable freshwater resources. A low level of water stress indicates a situation where the combined withdrawal by all sectors is marginal in relation to the resources and has therefore little potential impact on the sustainability of the resources or on the potential competition between users. A high level of water stress indicates a situation where the combined withdrawal by all sectors represents a substantial share of the total renewable freshwater resources, with potentially larger impacts on the sustainability of the resources and potential situations of conflicts and competition between users" (UNSD 2023d).

"**Total renewable freshwater resources (TRWR)** are expressed as the sum of internal and external renewable water resources. The terms "water resources" and "water withdrawal" are understood as freshwater resources and freshwater withdrawal" (UNSD 2023d).

"**Internal renewable water resources** are defined as the long-term average annual flow of rivers and recharge of groundwater for a given country generated from endogenous precipitation" (UNSD 2023d).

"**External renewable water resources** refer to the flows of water entering the country, taking into consideration the quantity of flows reserved to upstream and downstream countries through agreements or treaties" (UNSD 2023d).

"**Total freshwater withdrawal (TFWW)** is the volume of freshwater extracted from its source (rivers, lakes, aquifers) for agriculture, industries and services. It is estimated at the country level for the following three main sectors: agriculture, services (including domestic water withdrawal) and industries (including cooling of thermoelectric plants). Freshwater withdrawal includes fossil groundwater. It does not include non-conventional water, i.e. direct use of treated wastewater, direct use of agricultural drainage water and desalinated water" (UNSD 2023d).

"**Environmental flow requirements (EFR)** are defined as the quantity and timing of freshwater flows and levels necessary to sustain aquatic ecosystems, which, in turn, support human cultures, economies, sustainable livelihoods, and wellbeing. Water quality and also the resulting ecosystem services are excluded from this formulation which is confined to water volumes. This does not imply that quality and the support to societies which are dependent on environmental flows are not important and should not be taken care of. Methods of computation of EFR are extremely variable and range from global estimates to comprehensive assessments for river reaches. For the purpose of the SDG indicator, water volumes can be expressed in the same units as the TFWW, and then as percentages of the available water resources" (UNSD 2023d).

"**Disaggregation by sectors:** Sectorial disaggregated data are provided to show the respective contribution of the different sectors to the water stress level, and therefore the relative importance of actions needed to contain water demand in the different sectors (agriculture, services and industry). The contribution of the different sectors to the water stress level is calculated as the proportion of sectoral withdrawals over total freshwater withdrawals, after taking into account the EFR.

Sectors are defined following the United Nations International Standard Industrial Classification of All Economic Activities ISIC 4 coding:

Agriculture, forestry and fishing (ISIC4. A01 A0210 A0322)
Industries
Services (G to T)" (UNSD 2023d).

The indicator is computed as follows:

Stress (%) = TFWW/(TRWR – EFR) X 100

Where:

TFWW: total freshwater withdrawn
TRWR: total renewable freshwater resources
EFR: environmental flow requirements

To interpret the values of this indicator, four categories are used to identify the levels of stress severity:

NO STRESS <25%
LOW 25% - 50%
MEDIUM 50% - 75%
HIGH 75-100%
CRITICAL >100%

17. Total GHG emissions

Data source: The World Bank
Date of data extraction 20/09/2023
Link to data and metadata: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE
Serie: 2000-2020
Unit: Kilo-tonnes CO_2 equivalent

Definitions, concepts and calculation *(according to The World Bank methodology):*

"**Total greenhouse gas emissions** in kt of CO_2 equivalent are composed of CO_2 totals excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH_4 sources, N_2O sources and F-gases (HFCs, PFCs and SF6)" (WB 2023).

"Conversion factors: The GHG totals are expressed in CO_2 equivalent using the GWP100 metric of the Second Assessment Report of IPCC and include CO_2 (GWP100=1), CH_4 (GWP100=21), N_2O (GWP100=310) and F-gases (c-C_4F_8 GWP=8700, C_2F_6 GWP=9200, C_3F_8 GWP=7000, C_4F_{80} GWP=7000, C_5F_{12} GWP=7500, C_6F_{14} GWP=7400, C_7F_{16} GWP=7820, CF_4 GWP=6500, HFC-125 GWP=2800, HFC-134a GWP=1300, HFC-143a GWP=3800, HFC-152a GWP=140, HFC-227ea GWP=2900, HFC-23 GWP=11700, HFC-236fa GWP=6300, HFC-245fa GWP=858, HFC-32 GWP=650, HFC-365mfc GWP=804, HFH-43-10-mee GWP=1300, SF6 GWP=23900)" (WB 2023).

18. Industrial discharges to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: Million m^3/year
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology)*:

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

19. Agricultural discharges to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 19/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: Million m^3/year
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology)*:

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

20. Industrial BOD discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)

Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2005 - 2021
Unit: 1000 Kg O_2/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology)*:

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**BOD** measures the amount of oxygen required or consumed for the microbiological decomposition (oxidation) of organic material in water. BOD is an index of the degree of organic pollution in water. It should be measured as the oxygen consumed in 5 days at a constant temperature of 20°C in the dark, which is commonly referred to as BOD5" (Eurostat 2014).

21. Industrial COD discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2005 - 2020
Unit: 1000 Kg O_2/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Chemical Oxygen Demand (COD):** The mass concentration of oxygen consumed under specific conditions by the chemical oxidation with bichromate of organic and/or inorganic matter in water" (Eurostat 2021).

22. Industrial N discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2010 - 2020
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Nutrients** are the substances that organisms (i.e., plants and animals) need to grow and survive. However, too many nutrients can have serious impacts on human health and may lead to rapid plant growth and the depletion of oxygen and life in water (e.g., algal blooms, red tides). Key nutrients include nitrogen, phosphorus and potassium" (UNDESA 2012).

"**Nitrogen** occurs in several compounds, e.g., ammonia, ammonium, nitrite or nitrate, depending on such factors as acidity, temperature and oxygen concentration" (UNDESA 2012).

23. Industrial P discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2010 - 2020
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Nutrients** are the substances that organisms (i.e., plants and animals) need to grow and survive. However, too many nutrients can have serious impacts on human health and may lead to rapid plant growth and the depletion of oxygen and life in water (e.g., algal blooms, red tides). Key nutrients include nitrogen, phosphorus and potassium" (UNDESA 2012).

"**Phosphorus** can be found in different compounds, e.g., orthophosphates, condensed phosphates and organically bound phosphorus" (UNDESA 2012).

24. Industrial SS discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2010 - 2020
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered to be process wastewater for purposes of this questionnaire. Sanitary wastewater and surface runoff from industries are also excluded here" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Suspended solids** are small particles of solid pollutants in water that contribute to turbidity and resist separation by water treatment. Suspended solids are usually measured in terms of total suspended solids, which are also referred to as total suspended non-filterable solids (i.e., they cannot be filtered out of water using a filter)" (UNDESA 2012).

25. Agricultural BOD discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: 1000 Kg O_2/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**BOD** measures the amount of oxygen required or consumed for the microbiological decomposition (oxidation) of organic material in water. BOD is an index of the degree of organic pollution in water. It should be measured as the oxygen consumed in 5

days at a constant temperature of 20°C in the dark, which is commonly referred to as BOD5" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting, and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

26 Agricultural COD discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: 1000 Kg O_2/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Chemical Oxygen Demand (COD):** The mass concentration of oxygen consumed under specific conditions by the chemical oxidation with bichromate of organic and/or inorganic matter in water" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting, and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

27. Agricultural N discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting, and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

"**Nutrients** are the substances that organisms (i.e., plants and animals) need to grow and survive. However, too many nutrients can have serious impacts on human health and may lead to rapid plant growth and the depletion of oxygen and life in water (e.g., algal blooms, red tides). Key nutrients include nitrogen, phosphorus, and potassium" (UNDESA 2012).

"**Nitrogen** occurs in several compounds, e.g., ammonia, ammonium, nitrite or nitrate, depending on such factors as acidity, temperature and oxygen concentration" (UNDESA 2012).

28. Agricultural P discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting, and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

"**Nutrients** are the substances that organisms (i.e., plants and animals) need to grow and survive. However, too many nutrients can have serious impacts on human health and may lead to rapid plant growth and the depletion of oxygen and life in water (e.g., algal blooms, red tides). Key nutrients include nitrogen, phosphorus, and potassium" (UNDESA 2012).

"**Phosphorus** can be found in different compounds, e.g., orthophosphates, condensed phosphates and organically bound phosphorus" (UNDESA 2012).

29. Agricultural SS discharged to water bodies

Data source: OECD – "Water: wastewater generation and discharge". OECD Environment Statistics (database)
Date of data extraction 5/10/2023
Link to data and metadata: https://doi.org/10.1787/1771e2b8-en
Serie: 2000 - 2021
Unit: 1000 Kg/day
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to OECD methodology):*

"**Wastewater:** water which is of no further immediate value to the purpose for which it was used or in the pursuit of which it was produced because of its quality, quantity or time of occurrence. However, wastewater from one user can be a potential supply to a user elsewhere. Cooling water is not considered to be wastewater for purposes of this questionnaire" (Eurostat 2021).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a (fresh or non-fresh) water body from a point or a non-point source" (Eurostat 2021).

"**Agricultural sector** (ISIC 01-03) covers crop and animal production, hunting, and related service activities; forestry and logging; and fishing and aquaculture. Wastewater generated from these activities for the most part enters the environment as non-point pollution" (UNSD 2023d).

"**Suspended solids** are small particles of solid pollutants in water that contribute to turbidity and resist separation by water treatment. Suspended solids are usually measured in terms of total suspended solids, which are also referred to as total suspended non-filterable solids (i.e., they cannot be filtered out of water using a filter)" (UNDESA 2012).

30. Proportion of total discharges to water bodies safely treated

Data source: UNSD SDG 6.3.1
Date of data extraction 13/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-06-03-01.pdf
Serie: 2015
Unit: Percentage (%)
Data providers: National Statistical Offices (NSOs) are the primary responsible authorities for providing data to be used for global statistics. NSOs may draw on data collected or compiled by relevant national or other authorities, such as ministries, municipalities, or regulatory authorities.
Data compilers: UN-Habitat, WHO, and UNSD.

Definitions, concepts and calculation *(according to United Nations methodology):*

"**Proportion of total discharges to water bodies safely treated:** This indicator measures the volumes of wastewater which are generated through different activities, and the volumes of wastewater which are safely treated before discharge into the environment. The ratio of the volume treated to the volume generated is taken as the 'proportion of wastewater flow safely treated' " (UNSD 2023d).

"**Total wastewater generated** is the total volume of wastewater generated by economic activities (agriculture, forestry and fishing; mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; and other economic activities) and households. Cooling water is excluded" (UNSD 2023d).

"**Wastewater:** Wastewater is water which is of no further value to the purpose for which it was used because of its quality, quantity or time of occurrence. Cooling water is not considered here" (UNSD 2023d).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a water body (fresh or non-fresh) from a point source" (Eurostat 2021).

"**Wastewater treatment:** Process to render wastewater fit to meet applicable environmental standards or other quality norms for recycling or reuse" (UNSD 2023d).

"The amount of wastewater generated is calculated by summing all of the wastewater generated by different economic activities and households. The amount of wastewater safely treated is calculated by summing all of the wastewater flows which receive treatment considered equivalent to secondary treatment or better. The proportion of wastewater flows which are safely treated is calculated as a ratio of the amount of wastewater safely treated to the amount of wastewater generated" (UNSD 2023d).

Proportion of wastewater safely treated = Amount of wastewater generated / amount of wastewater safely treated

31. Proportion of industrial discharges to water bodies safely treated

Data source: UNSD SDG 6.3.1
Date of data extraction 13/09/2023
Link: https://unstats.un.org/sdgs/dataportal/database
Link to metadata: https://unstats.un.org/sdgs/metadata/files/Metadata-06-03-01.pdf
Serie: 2015
Unit: Percentage (%)
Data providers: National Statistical Offices (NSOs) are the primary responsible authorities for providing data to be used for global statistics. NSOs may draw on data collected or compiled by relevant national or other authorities, such as ministries, municipalities, or regulatory authorities.
Data compilers: UN-Habitat, WHO, and UNSD.

Definitions, concepts and calculation *(according to United Nations methodology):*

Proportion of industrial discharges to water bodies safely treated: This indicator measures the volumes of industrial wastewater which are generated, and the volumes of industrial wastewater which are safely treated before discharge into the environment. The ratio of the volume treated to the volume generated is taken as the 'proportion of industrial wastewater flow safely treated'.

Wastewater flows can be classified into industrial, services, and domestic flows, with reference to the International Standard Industrial Classification of All Economic Activities Revision 4 (ISIC).

- Industrial (ISIC divisions 05-35)
- Services (ISIC divisions 45-96)
- Domestic (private households)

"**Domestic wastewater:** Wastewater from residential settlements which originates predominantly from the human metabolism and from household activities" (UNSD 2023d).

"**Industrial (process) wastewater:** Water discharged after being used in, or produced by, industrial production processes and which is of no further immediate value to these processes. Where process water recycling systems have been installed, process wastewater is the final discharge from these circuits. To meet quality standards for eventual discharge into public sewers, this process wastewater is understood to be subjected to ex-process in-plant treatment. Cooling water is not considered here. Sanitary wastewater and surface runoff from industries are also excluded here" (UNSD 2023d).

"**Total wastewater generated** is the total volume of wastewater generated by economic activities (agriculture, forestry and fishing; mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply; and other economic activities) and households. Cooling water is excluded" (UNSD 2023d).

"**Wastewater:** Wastewater is water which is of no further value to the purpose for which it was used because of its quality, quantity or time of occurrence. Cooling water is not considered here" (UNSD 2023d).

"**Wastewater discharge:** The amount of water (in m^3) or substance (in kg BOD/d or comparable) added/leached to a water body (fresh or non-fresh) from a point source" (Eurostat 2021).

"**Wastewater treatment:** Process to render wastewater fit to meet applicable environmental standards or other quality norms for recycling or reuse" (UNSD 2023d).

The proportion of industrial wastewater flows which are safely treated is calculated as a ratio of the amount of industrial wastewater safely treated to the amount of industrial wastewater generated.

32. Investments in waste management by general governments

Data source: Eurostat
Date of data extraction: 28/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/env_ac_epigg1/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/env_ac_epea_esms.htm
Serie: 2014-2021
Unit: Millions constant 2015 United States dollars
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to Eurostat's methodology):*

"**Gross investment in tangible goods** is defined by Eurostat as investment during the reference year in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded" (Eurostat 2023b).

"**General government sector** is the grouping of institutional units which are non-market producers whose output is intended for individual and collective consumption and are financed by compulsory payments made by units belonging to other sectors, and institutional units principally engaged in the redistribution of national income and wealth. The institutional units classified in the general government sector are non-market producers, but they may have some secondary market output." (Eurostat 2013).

"**Waste management** refers to activities and measures aimed at the prevention of the generation of waste and the reduction of its harmful effect on the environment. It includes the collection and treatment of waste, including monitoring and regulation activities. It also includes recycling and composting, the collection and treatment of low-level radioactive waste, street cleaning and the collection of public litter" (Eurostat 2023c).

"**Waste** are materials that are not prime products (that is, products made for the market) for which the generator has no further use for own purposes of production, transformation, or consumption, and which he wants to dispose of. Wastes may be generated during the extraction of raw materials, during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity. Residuals recycled or reused at the place of generation are excluded. Also excluded are waste materials that are directly discharged into ambient water or air" (Eurostat 2023c).

Exchange rates: Original data from Eurostat are expressed in Euros. The period average exchange rates (United States dollar to Euros) used were taken from the IMF, Database on International Financial Statistics (IMF 2023).

33. Investments in waste management by corporations as specialists and secondary producers

Data source: Eurostat
Date of data extraction: 28/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/env_ac_epissp1/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/env_ac_epea_esms.htm
Serie: 2014-2021
Unit: Millions constant 2015 United States dollars
Data providers: National institutions
Data compilers: National institutions

Definitions, concepts and calculation *(according to Eurostat's methodology)*:

"**Gross investment in tangible goods** is defined by Eurostat as investment during the reference year in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded" (Eurostat 2023b).

"Corporations. This sector includes in particular specialist and secondary market producers of environmental protection services (i.e. the units of the corporations sector whose principal activity is the production of environmental protection services and units for which production of environmental protection services is a secondary activity)" (Eurostat 2023c).

"**Waste management** refers to activities and measures aimed at the prevention of the generation of waste and the reduction of its harmful effect on the environment. It includes the collection and treatment of waste, including monitoring and regulation activities. It also includes recycling and composting, the collection and treatment of low-level radioactive waste, street cleaning and the collection of public litter" (Eurostat 2023c).

"**Waste** are materials that are not prime products (that is, products made for the market) for which the generator has no further use for own purposes of production, transformation, or consumption, and which he wants to dispose of. Wastes may be generated during the extraction of raw materials, during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity. Residuals recycled or reused at the place of generation are excluded. Also excluded are waste materials that are directly discharged into ambient water or air" (Eurostat 2023c).

Exchange rates. Original data from Eurostat are expressed in Euros. The period average exchange rates (United States dollar to Euros) used were taken from the IMF, Database on International Financial Statistics (IMF 2023).

34. Business investment in circular economy activities (percentage of GDP)

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie012/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Percentage (%) of Gross Domestic Product (GDP).
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Sectors of circular economy included: According to Eurostat's methodology, this indicator includes Gross investment in tangible goods in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector.

"**Gross investment in tangible goods** is defined by Eurostat as investment during the reference year in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded" (Eurostat 2023b).

This indicator is calculated by Eurostat in three steps as follows:

- "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.
- 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.
- Produce the estimates based on official statistics, in particular structural business statistics, PRODCOM, national accounts, the Labour Force Survey and others" (Eurostat 2023b).

35. Business investment in circular economy activities (Millions constant 2015 United States dollars)

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie012/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Millions constant 2015 United States dollars
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Sectors of circular economy included: According to Eurostat's methodology, this indicator includes Gross investment in tangible goods in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector.

"**Gross investment in tangible goods** is defined by Eurostat as investment during the reference year in all tangible goods. Included are new and existing tangible capital goods, whether bought from third parties or produced for own use (i.e. capitalised production of tangible capital goods), having a useful life of more than one year including non-produced tangible goods such as land. Investments in intangible and financial assets are excluded" (Eurostat 2023b).

This indicator is calculated by Eurostat in three steps as follows:

- "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.
- 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.
- Produce the estimates based on official statistics, in particular structural business statistics, PRODCOM, national accounts, the Labour Force Survey and others" (Eurostat 2023b).

Exchange rates. Original data from Eurostat are expressed in Euros. The period average exchange rates (United States dollar to Euros) used were taken from the IMF, Database on International Financial Statistics (IMF 2023).

36. Gross value added to circular economy sector as percentage of the GDP

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie012/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Percentage (%)
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Sectors of circular economy included: According to Eurostat's methodology, this indicator includes Gross investment in tangible goods in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector.

"**Value added at factor costs** is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. It can be calculated as the sum of turnover, capitalized production, other operating income, increases minus decreases of stocks, and deducting the following items: purchases of goods and services, other taxes on products which are linked to turnover but not deductible, duties and taxes linked to production. Value adjustments (such as depreciation) are not subtracted" (Eurostat 2023b).

This indicator is calculated by Eurostat in three steps as follows:

- "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.

- 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.
- Produce the estimates based on official statistics, in particular structural business statistics, PRODCOM, national accounts, the Labour Force Survey and others" (Eurostat 2023b).

37. Gross value added to circular economy sector

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie012/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Millions constant 2015 United States dollars
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

Sectors of circular economy included: According to Eurostat's methodology, this indicator includes Gross investment in tangible goods in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector.

"**Value added at factor costs** is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. It can be calculated as the sum of turnover, capitalized production, other operating income, increases minus decreases of stocks, and deducting the following items: purchases of goods and services, other taxes on products which are linked to turnover but not deductible, duties and taxes linked to production. Value adjustments (such as depreciation) are not subtracted" (Eurostat 2023b).

This indicator is calculated by Eurostat in three steps as follows:

- "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.
- 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.
- Produce the estimates based on official statistics, in particular structural business statistics, PRODCOM, national accounts, the Labour Force Survey and others" (Eurostat 2023b).

Exchange rates. Original data from Eurostat are expressed in Euros. The period average exchange rates (United States dollar to Euros) used were taken from the IMF, Database on International Financial Statistics (IMF 2023).

38. Jobs in circular economy sectors

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie011/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Full-time equivalent (FTE)
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

"**Number of persons employed** is defined as the total number of persons who work in the observation unit, i.e. the firm (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it - e.g. sales representatives, delivery personnel, repair and maintenance teams. It excludes manpower supplied to the unit by other enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service" (Eurostat 2023b).

"**Circular economy sectors:** According to Eurostat's definitions, jobs in circular economy sectors measures the number of persons employed in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector" (Eurostat 2023b). Following the recommendations of the Guidelines for measuring circular economy (UNECE/OECD), these sectors should be expanded as data availability progresses to include other circular economy activities, including second-hand markets and sharing economy.

39. Proportion of jobs in circular economy sectors in total employment

Data source: Eurostat - Circular Economy Indicators Database
Date of data extraction: 25/09/2023
Link: https://ec.europa.eu/eurostat/databrowser/view/cei_cie011/default/table?lang=en
Link to metadata: https://ec.europa.eu/eurostat/cache/metadata/en/cei_cie011_esmsip2.htm
Serie: 2005-2021
Unit: Percentage (%) in the total employment
Data providers: European Statistical System (ESS)
Data compilers: Eurostat

Definitions, concepts and calculation *(according to Eurostat's methodology):*

"**Number of persons employed** is defined as the total number of persons who work in the observation unit, i.e. the firm (inclusive of working proprietors, partners working regularly in the unit and unpaid family workers), as well as persons who work outside the unit who belong to it and are paid by it - e.g. sales representatives, delivery personnel, repair and maintenance teams. It excludes manpower supplied to the unit by other enterprises, persons carrying out repair and maintenance work in the enquiry unit on behalf of other enterprises, as well as those on compulsory military service" (Eurostat 2023b).

"**Circular economy sectors:** According to Eurostat's definitions, jobs in circular economy sectors measures the number of persons employed in the following three sectors: the recycling sector, repair and reuse sector and rental and leasing sector" (Eurostat 2023b). Following the recommendations of the Guidelines for measuring circular economy (UNECE/OECD), these sectors should be expanded as data availability progresses to include other circular economy activities, including second-hand markets and sharing economy.