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> Joint United Nations Economic Commission for Europe/Organisation for Economic Cooperation and Development Guidelines for measuring circular economy Part A: Conceptual Framework, statistical framework and indicators

Prepared by the Task Force on Measuring Circular Economy

Summary

This document was drafted by the Task Force on Measuring Circular Economy (chaired by Finland). The Conference of European Statisticians (CES) Bureau established the Task Force in February 2021 to draft practical guidelines for measuring circular economy, including clarification of key terms and definitions, identifying the data sources and key statistics and indicators needed from the policy point of view, and describing the required institutional collaboration.

Since the beginning the Task Force has been collaborating closely with the OECD Expert Group on a new generation of information for a Resource Efficient and Circular Economy (RECE-XG), and it was decided to join forces and to draft "Joint UNECE/OECD Guidelines for Measuring Circular Economy".

This document presents the draft conceptual framework, a statistical framework and a proposed indicator set for monitoring progress towards a circular economy (Part A). Guidance on data sources and on using indicators, the required institutional collaboration, and more case examples (Part B) will be prepared once Part A has been endorsed by the CES.

The current document is an excerpt of the full document prepared for translation purposes.

Subject to a positive outcome of an electronic consultation of the document with all CES members in April-May 2023, the Conference is invited to endorse the document.



I. Introduction

1. This document presents the draft conceptual framework, a statistical framework and a proposed indicator set for monitoring progress towards a circular economy (CE). It was developed in close cooperation between the informal OECD Expert Group on a new generation of information for a resource efficient and circular economy (RECE-XG) and the UNECE Task Force on measuring circular economy (UNECE-TF). The document also includes examples of measurement frameworks used by countries and other regional and national case examples on measuring the circular economy.

2. The main audience of this document are experts from National Statistical Offices and other government agencies being tasked with the measurement of circular economy. These are usually experts working in the areas of measuring sustainable use of natural resources, the implementation of the System of Environmental-Economic Accounting (SEEA) or environment statistics.

3. Another audience of this document are policy advisers and policy makers (e.g. national line ministries) involved in supporting the transition towards a circular economy and in using CE indicators.

4. The target audience benefits in particular from:

(a) The clarification of the conceptual understanding of a circular economy from the policy and monitoring points of view;

(b) A statistical framework which builds upon existing international standards and classifications, highlighting how existing statistics can be used and what needs to be further developed;

(c) A set of proposed indicators, which are internationally harmonised and support the monitoring of a transition towards a circular economy; and

- (d) National and regional case examples.
- 5. The three main chapters of this document cover:
 - I. The circular economy concept and a headline definition of a circular economy;
 - II. The statistical framework; and
 - III. A proposed list of indicators for measuring circular economy.

II. The circular economy concept and the headline definition of a circular economy

6. The CE concept relates to other concepts and principles, including but not limited to, resource productivity or resource efficiency, sustainable materials management and the so-called R-framework that now distinguishes 10 R strategies from the most circular to the least circular, including the 3Rs (reduce, reuse, recycle), and that can be applied to any stage of the production and consumption processes. But it goes beyond these concepts, as it pays greater attention to the circularity of the material flows and the socio-economic and environmental benefits that arise from it.

7. There is no common definition nor terminology for a circular economy (CE). Its meaning varies across countries and literature. It depends on the objectives pursued, and on the policies put in place. Most definitions in use have in common the principle of circularity and the goal of moving away from the traditional linear business models to more circular ones. A core view of a circular economy is that it can be defined relative to a traditional linear economic system, i.e. one that focuses on "closing" resource loops of current linear resource value chains. A second, slightly broader, view of a circular economy with some degree of material circularity, or within an economy that is more linear through product life extension. The third, and broadest, view of a circular economy is one that involves a more efficient use of natural

resources, materials and products within an existing linear system, also including reduction of their use (for example by buying services instead of products).

A. The R-framework

8. As time has gone on, the number of 'R's has multiplied. The Japanese Government's '3R Initiative' (reduce, reuse, recycle) dates from 2004. The European Union's waste hierarchy in its 2008 Waste Framework Directive has four Rs (reduce, reuse, recycle, recover). By 2017 nine separate Rs contributing to circularity had been identified. Today the reference is the more detailed R framework with 10 R strategies listed from the most circular to the least circular (Potting et al., 2017, p. 5).

9. Following Figure 1 presents the 10 broad strategies (9R-Framework), here in the form of a "Circularity Ladder". A description of these strategies can be found below.

Figure 1 A Circularity Ladder (source: Potting et al., 2018)



- (a) Smarter product use and manufacture (R0-R2):
- R0 Refuse: Make product redundant by abandoning its function or by offering the same function with a radically different product
- R1 Rethink: Make product use more intensive (e.g., through sharing products, or by putting multi-functional products on the market)
- R2 Reduce: Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.
 - (b) Expand lifespan of product and its parts (R3-R7):
- R3 Reuse: Reuse by another consumer of discarded product which is still in good condition and fulfils its original function.
- R4 Repair: Repair and maintenance of defective product so it can be used with its original function.
- R5 Refurbish: Restore an old product and bring it up to date.
- R6 Remanufacture: Use parts of discarded product in a new product with the same function.
- R7 Repurpose: Use discarded product or parts of it in a new product with a different function.
 - (c) Useful application of materials (R08-R09):

- R8 Recycle: Process materials to the same (high-grade) or lower (low grade) quality
- R9 Recover: Incineration of materials with energy recovery.

B. Mechanisms for a circular economy

10. CE mechanisms take place at different levels, including different government levels, different firm/sector levels (different institutional sectors and different industries) and different geographical areas with overlapping boundaries. They may cover different time horizons depending on countries' policy objectives.

11. The OECD distinguishes the following mechanisms that contribute at varying degrees to a circular economy (Figure 2). These mechanisms can be related to the 9R framework and to the circular economy model and circularity strategies used in the Bellagio principles (EEA & ISPRA, 2020):

- Closing resource loops seeks to prevent waste from being generated by substituting virgin materials and new products by secondary raw materials (i.e. from recycled industrial or household waste) and second-hand, repaired or remanufactured products.
- Slowing resource loops seeks to slow down consumption and demand for primary raw (virgin) materials by extending the life of existing goods with the help of a more durable product design. This can be achieved by building long-lasting products that are easy to repair and the ownership of which can change during the course of their lifecycle.
- Narrowing resource flows seeks to increase resource efficiency, either by decreasing the total amount of resources used per unit of output or by making better economic use of existing capacity, and achieve a more efficient use of natural resources, materials, and products, either through the development and diffusion of new production technologies, the increased utilisation of existing assets, or shifts in consumption behaviour away from material intensive goods and services. Narrowing a resource flow does not necessarily imply circularity in the form of loops. It can also be implemented within a linear business model by producing products with less materials and thus achieving a higher or equal output with less material input.

12. A "transition to a circular economy" could therefore be seen as involving any process that might lead to lower rates of natural resource extraction and use, and to lower negative environmental impacts. A circular economy transition, to the extent that it results in lower resource extraction without an associated reduction of economic output, can result in improved resource efficiency and decoupling.

Figure 2

Mechanisms that contribute to a circular economy

Closing resource loops	 Increased product reuse, repair, re- manufacture Increased recycling and use of secondary raw materials (material substitution) 	 ✓ Reduced demand for new products & virgin materials 				
Slowing resource loops Narrowing resource loops	 Improved product design Increase use of long-lived products (product substitution) Increased product reuse and repair Increased material productivity/efficiency Improved use of natural resources Improved consumer behaviour: functionality & service vs ownership 	 New technologies, investment in R&D Expanded activity sectors: reuse, repair, re-manufacture, etc. Expanded sharing and service economies 				
Activities that drive a CE transition can also drive re-industrialisation, job creation,						

Source: Adapted from: McCarthy, A., R. Dellink and R. Bibas (2018), "The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches", OECD Environment Working Papers, No. 130, OECD Publishing, Paris, <u>https://doi.org/10.1787/af983f9a-en</u>.

C. A headline working definition for use in international work

1. A hierarchy of definitions

13. For the purpose of international work on monitoring progress towards a resource efficient and circular economy (OECD, UNECE), it was agreed to define the CE in a harmonised way that, while pointing at the key features of a CE, would be general enough to serve both policy needs and measurement needs; and that could evolve into a hierarchy of definitions, starting with a simple high-level or headline definition.

14. A definition for use in international work serves as a reference for work in countries. It is not designed to become the definition that countries should use, but countries that do not yet have a definition, could adapt it to their context.

15. Such a hierarchy of definitions helps converge around common key features, and give sufficient flexibility to further adapt to different measurement needs and approaches, and to different levels of application (e.g. global, regional, national, sub-national, sectors, industries or firms, products).

16. It comprises a headline definition, which is accompanied by simple explanatory notes and references to the mechanisms and strategies underlying a CE, as well as details to guide statistical measurement.

17. To develop the headline definition and its explanatory notes, existing CE definitions and descriptions were considered, together with advice from participants in the OECD RECE-XG and the UNECE Task Force. Particular attention was given to the working definition used by the OECD, the definitions used by European Commission and the European Environment Agency (EEA), and the suggested definition for measurement purposes by the UNECE Task Force/WP2.

Table 1

Main working definitions of a circular economy

OECD working definitions	European Union and EEA	UNECE-TF WP2 - Jan.2022
A circular economy is an economy that seeks to: - Maximise the value of the materials in the economy. - Minimise material consumption, in particular virgin materials, hazardous substances. - Prevent waste from being generated and reduce hazardous components in waste and products. Sustainable Materials Management (SMM) is defined as "an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity.	EU Action Plan for a Circular Economy A circular economy, maintains the value of products, materials and resources in the economy for as long as possible, and the generation of waste minimized. Bellagio declaration, Circular economy monitoring principles: A circular economy is an economy where the value of products, materials and resources is maintained in the economy for as long as possible. All outputs from one process is input for another. Thus, a move towards a circular economy entails reducing the intake of virgin materials and reducing the generation of waste.	A circular economy aims to minimize globally the input of natural resources and the generation of residuals by maintaining the value of goods and materials for as long as possible and by returning materials into the product cycle at the end of their use.

2. Headline definition

18. The headline definition reads as follows:

A circular economy is 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.

19. The definition highlights three interrelated features of a CE, starting with a distinctive feature that refers to maintaining the value of materials in the economy for as long as possible, thus linking to the circularity principle, whilst ensuring a positive outcome to society. The two other features dwell upon particular aspects that link to the ultimate objective of a CE

and whose monitoring is essential for the preservation of natural capital (natural resources, environmental quality).

D. The conceptual monitoring framework

20. The main purpose of the conceptual framework is to organise thinking about indicators, to identify relevant metrics and to ensure that nothing important gets overlooked. A framework reflects the integrated and cross-cutting nature of a CE while organising the indicators in a way useful to decision-makers and the public. A statistical framework, consistent with the System of Environmental-Economic Accounting (SEEA) where possible, will help to structure and combine underlying statistics, link CE terms and definitions to the terms and definitions used in official statistics, and ensure coherence among data sets.

21. Furthermore, analysis around the conceptual monitoring framework helps identifying the needs for capacity building in developing countries and emerging economies, in particular to consolidate and strengthen their information base on waste and material flows, R-strategies and related environmental impacts.

1. Scope

22. The conceptual framework covers all dimensions of a CE and the whole lifecycle of materials, products and services. The monitoring scope is limited to "materials" in line with material flow analysis and accounting, i.e. minerals (metallic and non-metallic industrial minerals), biomass, and energy carriers (e.g. coal, oil, gas). Water resources and energy (beyond energy carriers) are only covered to the extent that they are part of an integrated approach to the entire resource cycle and the associated environmental impacts. This is in line with the definition of the *OECD Council Recommendation on Resource Productivity* (OECD, 2008). The monitoring scope encompasses monitoring in physical and in monetary terms.

23. The principles applied in drawing up the proposal for a conceptual monitoring framework were:

- A balanced coverage of the main dimensions of a circular economy and of their main features, aligned with the working definition.
- The identification of key aspects for which indicators are needed, i.e. those that are of common relevance to resource efficiency and circular economy policies in CES member countries and beyond.
- A structure and indicators that could be applied at different levels and geographical areas (multilevel monitoring).

2. Structure

24. The framework combines the main features of a CE with the basic principles of accounting and the pressure-state-response (PSR) model used in environmental reporting and assessment. It has four components centred on the material life-cycle and the economy's production and consumption functions, and describes the interactions with the environment (the natural asset base and environmental quality), policy actions and the derived socio-economic opportunities. It thus implements the full range of elements captured in the Bellagio principles.

25. Given the breadth of the topics that need to be covered within the four components, a further structuring has been applied by defining indicator themes and topics (Table 2).

A. Material life-cycle and value chain

26. This component describes the various stages of the material life-cycle and value chain, from raw material inputs to solid waste generation, materials use in production and final consumption and the R strategies in place to keep the value of materials in the commercial cycle for as long as possible.

27. Related indicators show how materials enter, flow within and (eventually) leave the economy. They are related to reference values (benchmarks, thresholds, baselines, objectives, targets) and to environmental issues, including climate change, toxic contamination, biodiversity, natural resource management. They are to be complemented with information and indicators on the factors that drive demand for materials (population growth and structure, household size, economic growth and structure, income levels, final consumption expenditure) and on which policy levers can act.

28. This building block is further structured around three themes:

- · The material basis and productivity of the economy
- The management efficiency of materials and waste, and the circularity of material flows with reference to R strategies and CE mechanisms when possible
- Interactions with trade and globalisation (international dimension of a CE).
- 29. Data availability permitting the selected indicators should be able to:
 - distinguish between primary and secondary raw materials, and between technical and biological materials.
 - capture developments in materials that raise specific concerns as to:
 - their environmental significance.
 - their economic importance.

30. Relevant indicators can be derived from material flow accounts and waste statistics, complemented with new and improved indicators that capture the circularity of material flows in the economy and in production and consumption processes.

B. Interactions with the environment

31. This component describes the environmental and natural resource implications of material flows and the CE, considering the full life-cycle of materials. It is structured into two themes reflecting:

- The physical evolution of natural assets recognising that a declining asset base constitutes a risk to growth and well-being.;
- The environmental and human health impacts due to materials extraction, processing, use and end of life management, including impacts on climate, on air, water and soil quality, on biodiversity, and the underlying pressures.

32. Relevant indicators can be derived from sets of environmental and green growth indicators, with some adjustments to be fit for CE purposes.

C. Responses and actions

33. This component describes policy responses (environmental, economic, sectoral, social) and other societal responses and actions to establish a resource-efficient and circular economy, including measures to change awareness and behaviour and to create new socio-economic opportunities (e.g. new markets, education and training, innovation) that help ensure a just transition.

34. Related indicators are to cover the variety of policy tools that can support a CE by setting the right framework conditions, provide incentives towards substituting away from scarce environmental resources and foster innovation, productivity and human capital. This includes economic, regulatory and information instruments and partnerships.

- 35. The measures to be considered are structured as follows:
 - Measures to support or incentivise circular use of materials, promote recycling markets and optimise design. Examples include:
 - Taxes, subsidies and regulations supporting circular business models

- Downstream policy instruments that create incentives for recycling and enhance sorting at source
- Upstream policy instruments that help restrain demand for primary materials, make recycled materials more price competitive and incentivise design for circularity, extended lifespans, recycling & dismantling.
- Measures to improve the efficiency of waste management and close leakage pathways such as investments in waste management infrastructure, waste collection and sorting; anti-littering instruments, including bans or taxes on frequently littered items (e.g. plastics); and instruments that enhance sorting at source, including bans or taxes on landfilling and incineration
- Measures to boost innovation and orient technological change for more (efficient and) circular material lifecycles, enhanced recycling, and reduced leakage of residuals to the environment. Examples include: R&D budgets of governments and businesses; development and international diffusion of CE technologies (e.g. patented inventions related to recycling and secondary raw materials)
- Target setting and planning, including resource productivity and recycling targets, targets on recycled content, waste reduction& prevention, landfilling; and the availability of CE plans and strategies
- Measures to strengthen domestic and international financial flows for a circular economy and reduced leakage of residuals to the environment. Examples include: Business investments in CE activities, government budgets allocated to CE objectives; Official development assistance (ODA) and Foreign Direct Investment (FDI) dedicated to CE activities
- Measures to inform, educate and train, including product- and packaging-oriented information instruments and measures such as eco-labelling, certification schemes; integration of CE issues in school curricula and professional training.

36. It is recognised that these measures do not all lend themselves to being measured by indicators. Related indicators could also be grouped according to the type of instruments (economic, regulatory, etc.), the targeted objective as described above or in line with the CE mechanisms (closing resource loops, slowing resource loops, narrowing resource flows).

D. Socio-economic opportunities

37. This component describes the social and economic outcomes of a circular economy, taking into account aspects of economic efficiency and social equity that are central to a just transition.

38. Related indicators capture the development of new markets, trade and employment opportunities, supply security or autonomy, levels of education, skills development (closely linked to the capacity to innovate), and behavioural changes (households, consumers, firms). They also capture new developments, which are not visible through broader recycling and material flow indicators, such as the uptake of new circular business models and industrial ecology/symbiosis initiatives with links to entrepreneurship, and sharing economy initiatives, as well as distributional aspects of CE policies and actions, such as environmental justice.

- 39. The indicators are structured around four themes:
 - Market developments and new business models
 - · Trade developments
 - · Skills, awareness and behaviour
 - Distributional aspects of CE policies.

Table 2**Overview of framework themes and indicator topics**

Framework	Themes	Indicator topics - Aspects to be considered				
Material life- cycle and value chain	The material basis of the economy (level & characteristics of materials supply and their use in the economy)	 Material inputs and consumption: share of renewable materials, recyclable materials Material accumulation in the economy 				
	The circularity of material flows and the management efficiency of materials & waste (with reference to R strategies and CE mechanisms)	 Waste generation Contribution of secondary raw materials to material inputs or consumption Contribution of renewable materials to production processes Products diverted from the waste stream through repair, remanufacture, reuse Materials diverted from final disposal through recycling and recovery Materials leaving the economic cycle 				
	Interactions with trade	- Material exports, imports, trade balance				
Interactions with the environment	Natural resource implications (physical evolution of natural assets)	 Material extraction (used) Natural resource residuals (unused extraction) Changes in natural resource stocks; extraction rates, depletion ratios Water abstracted for material extraction and processing Intensity of use of forest resources 				
	Environmental quality implications (effects of materials extraction, processing, use and end of life management on environmental conditions)	 Impacts on climate and air quality: GHG emissions, carbon footprint of priority materials, air emissions Impacts on water and soil quality: pollutant discharges to water from material extraction & processing; soil contamination due to material extraction & processing and end-of-life management Impacts on biodiversity: land and habitats 				
	Impacts on human health	 Air pollution and water-related health impacts Exposure to risks from waste management and production sites 				
Responses and actions	Support circular use of materials, promote recycling markets and optimise design	 Taxes, tax reliefs, transfers, regulations supporting circular business models and the use of repaired, refurbished, remanufactured goods Reform of subsidies encouraging unsustainable use or extraction of materials Circular Public Procurement; Green Public Procurement; Extended producer responsibility, Deposit-refund, Pay-as-You-Throw schemes Design for extended lifespans, for recycling & dismantling Taxes on materials/products raising particular concerns Bans/guidelines on substances that restrict recycling 				
	Improve the efficiency of waste management and close leakage pathways	 Investments in waste management Waste prevention and anti-littering instruments Bans, taxes on frequently littered items (e.g. plastics) Bans, taxes on landfilling, on incineration w/o energy recovery 				
	Boost innovation & orient technological change for more circular material lifecycles	 CE R&D budgets of governments and businesses Development and international diffusion of CE technologies 				
	Target setting and planning	 Targets on: resource productivity, recycling, recycled content, waste reduction& prevention, landfilling CE plans and strategies 				
	Strengthen financial flows for a circular economy and reduced leakage	 Domestic flows: Government & business expenditure on CE activities; government budgets allocated to CE objectives (link to green budgeting) International flows: CE related Official Development Assistance (ODA); Foreign Direct Investment (FDI). 				
	Inform, educate, train	 Product & packaging instruments: eco-labelling, certification schemes, Integration of CE issues in school curricula & prof. training Other information and communication instruments 				
Socio- economic opportunitie	Market developments and new business models	 CE entrepreneurship, goods and services; business models, start-ups, industrial ecology/symbiosis initiatives Employment markets and jobs; Recycling markets 				
s for a just transition	Trade developments	 Trade in CE related goods and services Supply security/autonomy/resilience 				
efficiency and social equity)	Skills, awareness and behaviour	 CE literacy and skills Public opinion on CE issues Behavioural changes (households, consumers, firms) 				
	Inclusiveness of the transition (distributional aspects of CE policies)	to be defined; to reflect how different territories and population groups are affected or benefit from CE policies and actions (young people, women, vulnerable communities, etc.).				

III. The statistical framework

40. This chapter discusses the scope of a circular economy from the statistical measurement point of view. It translates the headline definition and conceptual monitoring framework into concepts, terms and definitions which are used in statistics, so that existing statistics from various domains can be used or further developed for measuring circular economy from different perspectives. It advocates a statistical framework that is as much as possible aligned with the principles of Economy-wide Material Flow Accounting (EW-MFA) and the System of Environmental-Economic Accounting (SEEA) with regard to definitions, system boundaries and classifications.

A. Key terms and definitions

41. The headline definition described earlier in this document is policy-oriented and leaves some room for interpretation of what should be included from the statistical perspective. For example, it is unclear whether flows of water or energy are within the measurement scope of what is called 'materials' and to what extent these flows should be covered.

42. The nomenclature used in statistics is much older than the concept of the circular economy. It is therefore important to interpret it with this new concept in mind, to agree on common principles and build consensus on a common language. Doing so will reduce terminological ambiguities (due to different expert communities using different definitions for similar terms) and help produce information that is more comparable.

1. Key-terms used in the headline definition of a circular economy

A. 'Materials`

43. The CE headline definition uses the term 'materials' in a broad sense. It understands 'materials' to include natural resources, and the materials and products derived therefrom, i.e. materials at all points throughout their life-cycles. This definition includes three different (partially overlapping, non-mutually exclusive) categories:

- · Natural resources
- Materials within a life-cycle, including waste
- Products within a product-cycle, including end-of-life products.

44. In the context of EW-MFA, the functioning of a national economy, which is based and dependent on external exchanges of materials and energy, is compared with the metabolism of an organism. EW-MFA describe the material throughput of an economy, both at the input side as well as at the output side. They are physical flow accounts and record the movement of materials measured in physical mass (e.g., tonnes). The *Eurostat-Handbook of EW-MFA* (Eurostat, 2018) specifies that "materials are physical bodies that have mass and volume".

45. For the purpose of measuring the circular economy, it is recommended to use the EW-MFA definition of materials with the understanding that it includes materials at all relevant stages of the material life cycle.

46. Materials are usually analysed by type and often grouped by category (e.g. biomass, metal ores, non-metallic minerals, fossil energy carriers). They can be analysed by specific groups or sub-groups of materials (e.g. flows of solid waste, carbon emissions) or for individual materials or substances (e.g. certain metals or hazardous substances).

47. Materials can be qualified with respect to the status of their natural stocks, the stage of their life-cycle or their processing, or their importance for the economy or the environment. The following terms have been defined in various other frameworks (such as Ellen MacArthur, CES Waste Statistics Framework, SEEA-CF, international conventions, etc.):

- **Renewable materials**: Materials whose stocks are continually replenished at a rate equal to or greater than the rate of depletion. Examples include: cotton, hemp, maize, wood, wool, leather, agricultural by-products, nitrogen, carbon dioxide, and sea salt. To fit in a circular economy such materials (where relevant) must be produced using regenerative production practices. (Ellen MacArthur Foundation, 2021)
- Non-renewable or finite materials: Materials whose stocks are non-renewable on timescales relevant to the economy, i.e. not geological timescales. Examples include: Metals and minerals; fossil forms of carbon such as oil, coal, and natural gas; and sand, rocks, and stones. (Ellen MacArthur Foundation, 2021)
- **Non-virgin materials**: Materials that have been previously used. This includes: Materials in products that have been reused, refurbished or repaired; components that have been remanufactured; materials that have been recycled. Also referred to as secondary materials. (Ellen MacArthur Foundation, 2021)
- Virgin materials: Materials that have not yet been used in the economy. These include both finite materials (e.g. iron ore mined from the ground) and renewable materials (e.g. newly produced cotton). (Ellen MacArthur Foundation, 2021). A synonym for virgin materials is "primary raw materials" (in contrast so "secondary raw materials", see below)
- Waste (materials): Any material which the holder discards or intends or is required to discard. (UNECE, 2021)
- Secondary raw materials:
 - Based on the legislation on the extractive industry (published in the *Extractive Waste Directive (2006/21/EC)* and the legal definitions of waste and waste management hierarchy regulated by the *Waste Framework Directive (2008/98/EC)*, secondary raw materials can be defined as materials and products which can be used as raw materials by simple re-use, or via recycling and recovery. (European Commission 2022)
 - Recycled materials/substances that meet end-of-waste criteria as defined in the *Directive 2008/98/E on Waste* (European Commission, 2020)

• Secondary materials:

- A secondary material has already been used and recycled (= recycled material). It refers to the amount of the outflow which can be recovered to be re-used or refined to re-enter the production stream. One aim of dematerialization is to increase the amount of secondary material used in production and consumption to create a more circular economy. (IRP, 2022)
- Secondary material also referred to as recycled material, refers to any material that has been used at least once before, is not the primary product of a manufacturing or commercial process, and can include post-consumer material, post-industrial material, and scrap. (IRP, 2018)
- **Critical raw materials**: Those raw materials that are most important economically and have a high supply risk are called critical raw materials. (European Commission 2020a).

2. Value of materials`

48. The headline definition of a CE states that "*the value of materials in the economy is maximised and maintained for as long as possible*", with the 'value of materials' being understood to encompass the value for society as a whole, taking into account economic efficiency, environmental effectiveness and social equity.

49. The phrase "*maintaining the value for as long as possible*" links to the circularity concept and to the higher-level R-strategies that help close or slow material loops in the economy, such as reuse, repair or remanufacturing.

50. Even if it is mainly the economic value which is usually measured, 'value' in the context of a circular economy has a broader meaning, thus leading to an indicator set and underlying statistics that cover all pillars of sustainability.

51. Examples of different types of values covered are revenues, savings, productivity, sustainability, satisfaction, empowerment, engagement, experience and trust.

B. 'Minimising the input of materials and their consumption'

52. The phrase "*minimising the input of materials and their consumption*" of the CE headline definition is understood to contain both:

(a) a quantitative dimension, e.g. reducing the quantity of materials extracted from natural resources (virgin materials/primary raw materials, unused extraction) and the quantity of materials used whether from domestic origin or from imports;

(b) a qualitative dimension, e.g. reducing the use of materials that are potentially damaging to the environment or whose production and consumption processes have negative environmental impacts, and improving the productivity of materials use at all stages of their life-cycle.

53. In statistics the term 'extraction of virgin materials' does not exist. The 'input of materials' is understood as 'extraction of materials from natural resources' from the statistical point of view.

C. The generation of waste is prevented and negative environmental impacts reduced throughout the life-cycle of materials`

54. The annotations of the headline definition specify that "*by referring to the life-cycle of materials:*

(a) Waste prevention at all stages of the life-cycle is reflected and the importance of higher level Rs is highlighted;

(b) All associated environmental impacts are reflected, including impacts on climate, on air, water and soil quality, on biodiversity, on natural assets, as well as underlying pressures in terms of emissions or discharges of pollutants, greenhouse gases, wastewater, and other residuals from production and consumption processes, including natural resource residuals (e.g. unused extraction)."

55. Many definitions of a circular economy refer to the "*minimization of generation of waste*" (or like the headline definition "*generation of waste is prevented*") as one of the main objectives of a circular economy. However, since the CE aims to "*maximise the value of materials in the economy*" this already implies the minimization of waste generation. What needs to be measured in addition is the loss of materials in the economy and the potential impact on the environment by generation of waste for final disposal as well as releases of other residuals to the environment.

56. From the statistical point of view therefore the phrase "generation of waste is prevented and negative environmental impacts reduced" can be understood to include all types of residuals.

57. According to SEEA-CF, residuals are flows of solid, liquid and gaseous materials, and energy that are discarded, discharged or emitted by establishments and households through processes of production, consumption or accumulation. Groups of residuals are solid waste, wastewater, emissions (to air, water, to soil), dissipative uses of products, dissipative losses and natural resource residuals.

58. Generation of residuals occurs in both production and consumption activities. Residuals may be returned to the economy, e.g. as secondary raw materials, re-used wastewater, etc. Residuals may also be for final disposal (e.g. waste on a managed landfill or CO2 disposed in carbon capture and storage systems) or may be released to the environment which usually results in negative effects on environmental quality and health.

59. According to the CES Waste Statistics Framework (UNECE, 2021), "waste is any material which the holder discards or intends to or is required to discard". However, this

actually refers to materials from the holder's point of view. Therefore, material that is considered to be waste for the holder could be at the same time be a good (with a market value) for the receiver of that material.

60. In some CE definitions the term 'residual waste` is used. For the purpose of measuring CE this is understood as a synonym for the term 'waste for final disposal`.

D. The scope of the statistical measurement

61. The scope of statistics for measuring the CE depends on the purpose for which the data are to be used, their level of application, the scope of the CE policies in place, the stage of transition a country is in, and the perspective taken. Hence alternative measurement boundaries are relevant for different uses and users (policy makers, businesses, citizens, statisticians, researchers, academia). It is to be noted that determining what counts in a CE determines who and what actions are viewed as contributing to a CE.

1. Measurement dimensions and levels of application

62. The statistical measurement needs to take into account the economic, environmental and social dimensions of a CE and its levels of application, including the macro, meso and micro levels (Figure 3), as well as the way materials flow through the economy, and between the economy and the environment (Figure 5). It is furthermore important that the statistics produced for different dimensions and levels complement each other and are coherent with each other. Figure 3 illustrates how the different analytical levels are interrelated.

A. The macro, meso and micro levels

63. The circular economy operates at different inter-related levels:

(a) The micro level, for example products, companies, consumers;

(b) The meso level, for example economic activity sectors, industries, cities, subnational governments. This level also includes eco-industrial parks, networks and clusters;

(c) The macro level, i.e. national or supranational economies.

The statistical framework needs to lend itself to being applied to all these levels.

Figure 3

Different perspectives of a circular economy (source: UNECE Task Force)



B. The social, economic and environmental dimensions

64. The three pillars of sustainable development (social, economic and environmental) are explicitly covered by the main building blocks of the conceptual framework and should be reflected in the statistical framework:

- (a) Material life-cycle and value chain (production and consumption)
- (b) Interactions with the environment (environmental effectiveness)
- (c) Responses and actions (policies, measures, framework conditions)
- (d) Socio-economic opportunities (economic efficiency and social equity).

2. Foundation and scope of the statistical framework

65. The statistical framework is grounded in the Central Framework of the System of Environmental-Economic Accounting (SEEA-CF), which sees the economy as being inside the environment and measures flows as presented in Figure 4:

- (a) Flows from the environment to the economy;
- (b) Flows within the economy or between economies; and
- (c) Flows from the economy to the environment.

Figure 4

The conceptual foundation of the statistical framework: the SEEA-CF (source: SEEA-CF, Figure 2.1)



66. In addition to the SEEA-CF the presented statistical framework builds on the headline definition of a circular economy and the conceptual framework. It further embeds the three main levels of application (micro, meso and macro), so as to ensure a coherent measurement across all CE dimensions and levels.

67. Its scope is thus broader and more detailed than the one of the SEEA-CF:

(a) The SEEA-CF is designed for analysis at the macro- and meso-levels; the measurement of the CE also considers the micro level.

(b) The SEEA-CF is designed to measure the interactions between the environment and the economy and to produce statistics that can easily be combined and interrelated. However, it does not fully cover aspects related to socio-economic opportunities and other aspects that are important for the transition to a CE, such as innovation and technology development, education, training and skills development, consumer behaviour.

A. Overview of the statistical framework

68. Figure 5 gives a simple overview of the measurement scope and shows how flows of materials interact with the domestic economy and environment and with the rest of the world. It builds on the principle of mass balancing and links the concepts of system analysis and of integrated environmental-economic accounting as described in the SEEA.

69. Figure 6 shows the links with the building blocks of the conceptual framework framework and its indicators. It shows how the framework fits into the broader picture of material flows, and how it could be used to develop a coherent narrative of a circular economy across all levels.

70. The overview diagram shows flows from the environment to the economy (input flows), flows within the economy, and flows from the economy to the environment (output flows) as well as flows between the domestic economy and the rest of the world (RoW, imports and exports). Flows within the economy refer to production and consumption activities, and to the 'R strategies' that aim at keeping the value of materials at their highest level for as long as possible. The diagram also refers to anthropogenic stocks of materials in the economy (i.e. fixed assets in SNA terms). Some materials accumulate in the economy where they are stored in the form of buildings, transport infrastructure or durable and semidurable goods, such as cars, industrial machinery or household appliances. The materials stored in such goods are sooner or later removed from the stocks in the form of end-of life products and waste (e.g. construction and demolition waste) and may be released back to the environment. Anthropogenic stocks also represent important mines for future use (the so-called 'urban mines').

71. The overview diagram was designed to apply to the macro-level, but it can equally be used to characterise CE data at the meso-level. The arrows in the diagram represent the direction of physical material flows, but can equally be applied to monetary flows. Data on both monetary and physical flows can be obtained from SEEA-CF use and supply tables.



Figure 5 Overview of the statistical framework of the circular economy

72. Description of the main components of the overview diagram (Figure 5):

(a) **Rest of the World (RoW) economy and environment**: These are actually two layers, which for simplification reasons are presented as one.

 Following the SNA and the SEEA-CF, the RoW economy refers to all non-resident institutional units that enter into transactions with resident units, or have other economic links with resident units. Flows between the RoW economy and the domestic economy are imports and exports.

• The RoW 'Environment' refers to the non-domestic environment. It is an important layer to be considered for example when calculating footprints or embedded emissions. It refers to the extraction of materials from natural resources in the RoW for imports to the domestic economy, as well as to related residuals released to the environment in the RoW, for example during production and transport activities.

(b) **Domestic environment:** This refers to the environment in which the domestic economy takes place. Following the SNA and the SEEA-CF, this also includes the environment outside the national territory when extraction of natural resources or releases of residuals to the environment are caused by an activity residing in the given country (the residence principle). Flows between the domestic environment and the domestic economy are:

- Extraction of materials from natural resources (flows from the environment to the economy)
- Releases of residuals to the environment (flows from the economy to the environment).

(c) **Domestic economy:** Following the SNA and the SEEA-CF, the domestic economy is defined as the sum of all the institutional units that are resident in the economic territory of a country (the SNA uses the term 'total economy'). For measurement purposes, the following elements are relevant:

- Inputs to the domestic economy:
 - Flows from the domestic environment to the economy (material extraction)
 - Flows from the RoW the to the domestic economy (imports)
- Outputs of the domestic economy:
 - Flows from the domestic economy to the domestic environment (releases of residuals)
 - Flows from the domestic economy to the RoW (exports)
- Flows within the domestic economy (production and final consumption flows; lifecycle of materials; R-strategies)
- Stocks within the domestic economy (anthropogenic stocks or fixed assets) and net additions to these stocks.

73. Most of these flows and elements can be measured by applying the SEEA-CF, with some limitations though. To ensure coherence with the SNA and the SEEA-CF, the residence principle should be applied. It should be noted though that in EW-MFA the boundary between the 'environment' and the 'economy' slightly deviates from the SNA definition of the boundary of the economy in the case of extraction of cultivated biological resources (agricultural plants and forests).

74. Figure 6 links the statistical framework with the conceptual framework and its indicators.





75. The following gives a summary of the building blocks of the conceptual framework and how they relate to the statistical framework.

(a) Building block 'material life-cycle and value chain': As this building block is at the heart of measuring a circular economy it is presented in the centre of the diagram. Relevant for its measurement are the themes:

- Material basis and productivity of the economy: Indicators and statistics include for example, share of renewable or recyclable materials;
- Management efficiency of materials and waste, and the circularity of material flows, with reference to R-strategies and CE mechanisms when possible: Indicators and statistics include for example, waste generation or products diverted from the waste stream through repair, remanufacture, reuse;
- CE activities and sectors: Indicators and statistics include for example, share of products sold via second-hand shops or the share of waste recycled by specialised companies;
- Interactions with trade: Indicators and statistics include for example the physical and monetary trade balance.

(b) Building block 'interactions with the environment': This block concerns both layers – the domestic and the RoW environment. It covers:

- Natural resource implications: This refers to the physical evolution of natural assets through material extraction (input flows). Indicators and statistics are for example on natural resource residuals or changes in natural resource stocks;
- Environmental quality implications: These are the result of both the use of natural resources (input) and the release of residuals to the environment (output). Indicators and statistics measure for example the impacts on climate, air, water and soil quality. They also include carbon footprint measures of priority materials and other measures of embedded emissions.

(c) Building block 'responses and actions': This block describes the policy responses and other societal responses and actions to establish a circular economy. As they

provide the framework conditions for the entire system to work, they are presented outside of the environment-economy layers. Indicators and statistics for measurement include for example taxes on materials raising environmental concerns, investments in waste management, CE R&D budgets, CE-related ODA etc.

(d) Building block 'socio-economic opportunities': This block describes the social and economic outcomes of a circular economy. They are usually measured on the level of the domestic economy, and include indicators and statistics on market developments (e.g. jobs), skills, awareness and behaviour as well as the inclusiveness of the transition. Furthermore, it includes trade implications, for example development of flows between the domestic economy and RoW, but also addresses supply security of certain materials and goods.

IV. Indicators for measuring circular economy

76. The main objective of this chapter is to present a relatively small set of core indicators for measuring circular economy which are relevant in the entire region, internationally comparable, and which are recommended to be produced regularly by National Statistical Systems.

77. As information on a circular economy is not yet available for all dimensions and aspects to be considered, the proposed indicator set encompasses both operational and aspirational indicators.

- Operational indicators are indicators that are available or could be made available at a reasonable cost in the short to medium term, and that build on recognised definitions and methodologies.
- Aspirational indicators are new or improved indicators that while relevant and desirable to fill gaps require important statistical and methodological efforts. Such indicators could become part of an international measurement agenda.

A. A 3-tier structure of indicator types

78. As for other OECD environmental indicators, it is proposed to use a 3-tier structure of core, complementary and contextual indicators, based on their relevance, measurability and usefulness to track key features of the circular economy transition.

- **Core indicators** (or their proxy when the core indicator is currently not measurable) are indicators that capture key elements of a CE, respond to main CE policy questions and point at developments or changes that require further analysis and possible action. Core indicators are designed to provide the big picture of the transition to a CE. They represent a common minimum set of indicators for use in CES and OECD member states, and other international work and that countries would be encouraged to produce or adapt to their own circumstances. The number of core indicators should be limited so as to facilitate the monitoring and communication of major trends; it should not exceed 20-25.
- **Complementary indicators:** Indicators that accompany or complement the message conveyed by "core" indicators, by providing additional detail (sub-national detail, sectoral detail) or focus (particular materials or activities), or by covering additional aspects. For country application of the framework, other country-specific indicators can be added.
- **Contextual indicators:** indicators that provide background information on socioeconomic and environmental variables to facilitate interpretation in the appropriate country context and to inform about drivers of material use. They include general indicators on the characteristics of economic growth (GDP, income) and changes in countries' industrial structure.

B. Proposed indicator set

79. Table 3 gives an overview of the proposed core indicators, structured in line with the conceptual framework. The list is not final and will be refined based on further consultations with countries.

Table 3

Overview of framework th	hemes and proposed	core indicators
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Framework	Themes		Proposed core indicators ^(a)
Material life-	The material basis of the economy	•	Material consumption & productivity (DMC, RMC): trends and mix
value chain	The circularity of material flows and the management efficiency of materials & waste (with reference to <i>R</i> strategies and <i>CE</i> mechanisms)		Waste generation: total, municipal, specific waste streams Circular use rate National recycling rate Waste going to final disposal
	Interactions with trade	n	one
Interactions with the environment	Natural resource implications (physical evolution of natural assets)	► ►	Natural resource index/ depletion ratios: energy & mineral resources Intensity of use of renewable freshwater resources
	Environmental quality implications (effects of materials extraction, processing, use and end of life management on environmental conditions and human health)	•	GHG emissions from production activities Pollutant discharges from production activities to water bodies and share safely treated
	Impacts on human health	P	aceholder_
Responses and actions	Support circular use of materials, promote recycling markets and optimise design	•	Taxes and government support for circular business models
	Improve the efficiency of waste management and close leakage pathways	•	Investments in waste management infrastructure, waste collection and sorting (government, businesses) Tax rate/tonne landfilled or incinerated
	Boost innovation & orient technological change for more circular material lifecycles	•	R&D expenditure on CE technologies : budget allocations (government, businesses)
	Target setting and planning	P	aceholder: distance to targets
	Strengthen financial flows for a circular economy and reduced leakage	•	Business investments in CE activities
	Inform, educate, train	P	aceholder
Socio- economic	Market developments and new business models	•	Gross value added of CE sectors Share of jobs in CE sectors
opportunities	Trade developments	n	one
for a just	Skills, awareness and behaviour	P	aceholder
transition (economic efficiency and social equity)	Distributional aspects of CE policies	<u>P</u>	laceholder

Note: (a) The proposed core indicators include both operational core indicators that are measurable for most OECD countries, and aspirational core indicators that require further work and that countries are encouraged to produce. Placeholders refer to indicators that are yet to be identified and defined. Other indicators that could become core indicators in future can be found in Table 4.

80. Table 4 presents the framework themes with a detailed list of proposed indicators.

81. Notes concerning Table 4:

(a) All indicators are expected to reflect change over time.

(b) **Indicator types**: Acronyms used in the table: Core indicator (Core); Complementary indicator (Compl); Contextual indicator (Cont)

(c) **Relevance** indicates the level of relevance/usefulness of the proposed indicator for the given topic: High (H); Medium (M); Low (L).

(d) **Measurability** indicates the current availability of data and agreed methodologies.

• High (H) = measurable in the short term.

- Medium (M) = measurable in the medium term.
- Low (L) = measurable in the longer term.

(e) **Related indicator sets:** international indicator set that includes the same or a similar indicator. OECD: set of material flow and resource productivity indicators (MFRP), core set of environmental indicators (CEI), green growth indicators (GGI); EU monitoring framework (EU-MF) (European Commission 2018); SDG global indicator set (SDG); UNECE Working Package 3 (WP3) list (Sept.2022).

Table 4Framework themes and proposed indicators: Detailed list

Framework themes and indicator topics	Possible indicators (a)	Type (b)	Rel. (c)	Meas. (d)	Related indicator sets (e)		
1.1 Material inputs	 Direct material inputs (trends; intensities; mix) a. Production-based domestic material inputs (DMI) b. Demand-based raw material inputs (RMI) 	Compl	Η	H/M	OECD MFRP; WP3 Core		
	 Share of materials from renewable natural stocks in DMI 	Compl	Н	Н	OECD MFRP		
1.2 Material	Material consumption and productivity (trends; mix)	Core	Н	Н	SDG 8.4.2/12.2.2		
Concernation	 a. Production-based domestic material consumption (DMC) b. Demand-based raw material consumption (RMC) (material footprint) c. Production-based material productivity (GDP/DMC) d. Demand-based raw material productivity (net disposable income/RMC) 		Η	H/M	SDG 8.4.1/12 2.1 OECD MFRP, GGI, CEI; WP3 Core: footprint		
	 Share of materials from renewable natural stocks in DMC 	Compl	н	н			
	 Share of recyclable materials in DMC 	Compl	M	1			
1.3 Material	 Net addition to stocks 	Compl	н	-			
accumulation	 Changes in man-made stocks of mineral resources 	Compl	М	L	OECD MFRP		
2.1 Waste generation	Total waste generation (trends; intensity per GDP, per capita)	Core	Н	M	OECD CEL ELLME SDG		
(materials ending up	 Municipal waste generation 		М	H/M	11 6 1 ⁻ WP3 Core		
as waste)	 Waste generation trends by source, and by waste or material type (% share in total; trends) e.g. Hazardous waste Construction & demolition waste; mining and quarrying waste Waste electrical and electronic equipment, packaging waste, plastics 	Compl	Η	Μ			
	 Total primary waste supply by sector (% share in total, intensities per value added) (from waste accounts) 	Compl	Н	M/L			
	 Waste generation compared to DMC (or DMI) (total, by type of material) 	Compl	М	М	OECD MFRP, EU MF		
	Food waste generated - Food loss index (production and supply levels) - Food waste index (retail and consumption levels)	Compl	Η	L	SDG 12.3.1, EU MF; WP3 Core		
	\circ Hazardous waste generated & % treated, by type of treatment	Compl	М	М	SDG 12.4.2		
2.2 Circularity of material flows	 Circular material use rate Share of recycled materials (secondary raw materials) in material consumption (all materials, material groups, selected materials) 	Core	Η	H/M	EU MF; OECD MFR;P WP3 Core		
	\odot Intermediate consumption of secondary raw materials in production processes	Compl	Н	L?	EU MF		
	Renewable content of material inputs into production processes (average %)	Compl	Η	L	ISO WD2 59020; WP3 Core		
2.3 Products diverted from the waste stream	 Ratio of products repaired or reused to new products sold, by product type 	Compl	Н	M/L	WP3 Core		
(repair, remanufacture,	 <u>Placeholder</u>: Remanufacturing by sector or by branch 	Compl	Н	L			
2.4 Materials diverted from final disposal through recycling or recovery	National recycling rate: share recycled in total waste generated (or collected)	Core	Η	Μ	SDG 12.5.1/OECD MFRP, CEI, GGI/ EU MF; WP3 Core		
	$\circ~\mbox{Recycling}$ or recovery rates for selected waste or material types	Compl	Н	М	OECD MFRP ; EU MF		
	 Incineration rates with energy recovery 	Compl	М	Н			
	 Capacity of waste recovery infrastructure, by type (recycling, incineration with energy recovery, other recovery) 	Compl	М	Μ			
2.5 Materials leaving the economic cycle	Waste going to final disposal (landfill or incineration w/o energy recovery): total; by type of materials	Core	Н	H/L	OECD MFRP; WP3 Core		
3. Interactions with trade (see also "opportunities" below)							
3.1 Trade in materials	 Material exports, material imports (incl. in RMe) Physical trade balance (incl. in RMe) 	Compl	М	Η	OECD MFRP		
	 Material intensity of trade flows (trade value indicator) 	Compl	М	Η	OECD MFRP		
3.2 Trade in CE related materials and products	 Trade in secondary raw materials: share in imports, in exports Trade in second-hand goods, EoL products Trade in waste and scrap 	Compl	Μ	Η	OECD MFRP		
Interactions with the environment							
	$_{\odot}$ Domestic extraction from natural stocks (renewable & non-	Compl	М	Н	OECD MFRP		

Framework themes	Possible indicators (a)	Туре	Rel.	Meas.	Related indicator sets
and indicator topics		(b)	(c)	(d)	(e)
natural resource stocks	Placeholder: Natural resource index (aggregate and by type of material; non-renewable assets) / Depletion ratios, extraction over existing reserves	Core	М	M/L	OECD MFRP, GGI
	 Changes in natural stocks (global) of mineral resources 	Cont	М	М	
	Intensity of use of renewable freshwater resources (abstraction over available renewable stocks) (water stress)	Core	Н	М	OECD CEI, GGI; SDG 6.4.2; WP3 Core
	$\circ~$ Intensity of use of forest resources (removals over growth)	Compl	Н	М	OECD CEI
1.2 Other natural	$_{\odot}$ Water abstracted for material extraction and processing	Compl	М	М	
resource impacts	\circ Water footprint of selected products or sectors	Compl	М	М	
	 Natural resource residuals: Unused extraction (by material group) 	Compl	Μ	L	
2.1 Impacts on climate	GHG emissions from production activities (trends, intensities) - Total GHG emissions (proxy)	Core	Н	M H	WP3 Core
	$\circ~$ Share of emissions from waste management or waste sector	Compl	Н	М	WP3
	 Carbon footprint (CO₂) 	Compl	Н	М	WP3 Core
	 Carbon footprint of priority materials or products, of selected sectors 	Compl	М	L	OECD MFRP
2.2 Impacts on air quality	 Air pollutant emissions from production activities (trends, intensities) 	Compl	М	М	
2.3 Impacts on water and soil quality	Pollutant discharges from material extraction and processing to water bodies & share safely treated – Total discharges to water bodies & % safely treated (proxy)	Core	М	М	OECD CEI; WP3 Core: safe treatm.
	 Share of waste improperly managed (proxy for waste leakage) Number of uncontrolled open landfills 	Compl	Н	М	
	Placeholder: Soil contamination	Compl	М	М	
2.4 Impacts on	Placeholder: Impacts from material extraction, processing, use	Compl	н	М	
2.5 Impacts on human health	Population exposure to air pollution; related premature deaths and welfare costs	Compl	М	М	
	Placeholder: Water-related health impacts	Compl	М	М	
	Placeholder: population groups living in the vicinity of waste management sites and production sites	Compl	М	L	
Responses and a	ctions				
1.1 Measures	Taxes and government support for CE business models	Core	Н	М	OECD, Eurostat, WP3
business models and	 VAT relief and tax credits for refurbished/repaired items 	Compl	Н	М	Core
encouraging reuse, repair,	 Tax benefits for businesses for the purchase/use of repaired, refurbished, remanufactured items 	Compl	Н	М	
remanufacturing (incl. industrial ecology/	 Trade tariffs: Import and export taxes for re-used and refurbished equipment compared to taxes on new equipment 	Compl	Н	М	
symbiosis & snaring models)	 Circular Public Procurement (CPP) or Green Public procurement (GPP): share of CPP (GPP) in total public procurement (total; by type of good) 	Compl	Н	L	EU MF, WP3 Core
1.2 Measures encouraging	Design for extending lifespans (i.e. durability, repairability, upgradeability)	Compl	Н	М	
optimised design or eco-design	 Requirements for minimum lifespan, warranties, software upgrades Requirements for accessibility to spare parts 				
	Design for recycling, dismantling & material circularity • Bans/Guidelines on hazardous substances • Taxes on difficult-to-recycle items • Availability of multiance documents on design for recycling	Compl	Н	Μ	
1.2 Measures encouraging efficient	 Reform of subsidies encouraging unsustainable use or extraction of materials, e.g., taxes on virgin materials 	Compl	Н	М	
use of materials and economically efficient waste recoverv	Extended Producer Responsibility (EPR) schemes Availability of EPR schemes in different product sectors: distance between reported performance and set target	Compl	М	М	
	Deposit-refund systems (DRS) & Pay-as-you-throw (PAYT) schemes • Availability of DRS in different product sectors (scope of beverage containers, for reuse & recycling) • Availability of PAYT schemes	Compl	Μ	H/M	
2.1 Measures to improve waste management	Investments in waste management infrastructure, waste collection and sorting (government, businesses)	Core	Η	М	EU MF; WP3 Core
	 Bans, taxes on frequently littered items or single-use items (e.g. plastics) 	Compl	Н	Н	

Framework themes	Possible indicators (a)	Туре	Rel.	Meas.	Related indicator sets
and indicator topics		(b)	(c)	(d)	(e)
2.2. Measures to	 Tax rate/tonne landfilled or incinerated 	Compl	Н	Н	
reduction	 ○ Landfill bans 	Compl	Η	Н	
3. Boost innovation	on and orient technological change				
3.1 Measures supporting R&D	Government and business R&D expenditure on CE technologies (recycling, secondary raw materials,): budget allocations	Core	Η	M/L	
3.2 Technology development and international diffusion	 Patented inventions related to (1) recycling and secondary raw materials; and (2) reuse and repair models as: % of total technologies, by inventor's residence 	Compl	М	M/L	OECD; EU MF; WP3 Core
	 % of foreign inventors, by patent office 	Compl	М	M/L	
4. Target setting	and nlanning				
4 1 Targets & distance	Placeholder: Distance to targets	Compl			
to targets		Compi			
Ŭ	- Resource productivity targets	Compl	Н	H	WP3 Core (Placeholder)
	 Recycled content targets, by type of product 	Compl	Н	M/L	
	 Recycling targets, by type of waste 	Compl	Н	Н	
	 Reuse targets, by type of product 	Compl	Н	L	
	 Waste reduction and prevention targets, by type of waste 	Compl	Н	Н	
	 Landfill targets, distance to targets by type of waste 	Compl	М	Н	
4.2 CE strategies &	tbd	Compl	М	?	
plans					
5. Strengthen fina	ancial flows				
5.1 Domestic financial	Business investment on CE activities	Core	Н	М	
flows	 Povenue from CE related taxes 	Compl		11/14	EU MF. WP3 Core
	Cevenue Irolli CE relateu laxes	Compl	н	H/IVI	
E 0 International		Compi	н	IVI	
5.2 International financial flows	• CE related Official Development Assistance (ODA)	Compl	M	L	
	• CE related Foreign Direct Investment (FDI)	Compl	М	L	
6. Inform, educat	e and train				
 Information instruments 	Placeholder • Eco-labelling; product labelling & certificates • Requirement to provide repair guidelines • Requirement to provide: - information on expected lifespan - dismantling guidelines & material content lists for recyclers	Compl	Μ	M/L	
 Education and training 	Placeholder o Integration of CE issues in school curricula and professional	Compl	Η	М	
- CE	Gross value added related to circular economy sectors:	Core	М	H/L	EU ME: WP3 Core
entrepreneurship,	share in GDP and change over time				
goods & services incl. uptake of new circular business models, industrial ecology/symbiosis initiatives	 CE start-ups and trademarks CE certification of companies 	Compl	М	L	
 Employment markets and jobs 	Jobs in CE sectors: share in total employment and change over time	Core	Н	H/L	EU MF, WP3 Core
	 Jobs in sharing economy, reuse and repair activities: number and change over time 	Compl	Н	L	
 Recycling markets 	 Markets for recycled materials 	Compl	Н	L	
2. Trade develop	oments				
- Trade in CE related	• Trade in recycled (secondary raw) materials (share in imports &	Compl	М	M/L	OECD MFRP
goods and services	 exports) Trade in recyclable materials (share in imports & exports) 	Compl	М	L	FUMF
 Supply security/ autonomy 	Domestic material autonomy (aggregate, by material group) a. share of domestic extraction in DMI or DMC b. share of domestic extraction in RMI or RMC	Compl	Н	Н	OECD MFRP, EU MF, WP3 Core
	 Supply security of "strategic" raw materials, by material or material group 	Compl	Н	М	OECD MFRP, EU MF
	 o Food security o Energy security 	Compl	Η	М	
3. Skills and awa	areness				
– Skills	 ○ CE literacy ○ CF skills : indicator thd 	Compl	М	L	
- Awareness	 Public opinion on CE issues and actions 	Compl	М	L	
- Behavioural	Placeholder: Households, consumer, firm behaviour	Compl	М	L	

Framework themes and indicator topics	Possible indicators (a)	Type (b)	Rel. (c)	Meas. (d)	Related indicator sets (e)	
changes		(~)		(~)		
4. Inclusiveness	of the transition					
	<u>Placeholder:</u> Distributional aspects & socio-economic inequality of CE policies	tbd	М	L		
1. Factors that d	rive demand for materials					
 Socio- demographic factors 	 Population growth and structure Household size 	Cont	Μ	Η		
 Economic factors 	\circ GDP growth and structure (trends, value added by sector)	Cont	М	Н		
	 Income levels: GDP per capita 	Cont	Μ	Н		
	 Income inequality (Gini index); wealth inequality 	Cont	Μ	H/M		
	 Human development index (HDI) 	Cont	Μ	Н		
	 Final consumption expenditure: government, household 	Cont	Μ	Н		
- Sectoral drivers	 Construction: tbd, e.g., floor space per capita, value added of construction sector 	Cont	Η	M/L		
-	 Other (tbd) 					
2. Factors that influence the environmental implications of material use						
 Environmental drivers 	 Energy supply and consumption: trends and intensities 	Cont				
	 Water use efficiency 	Cont				
	 Protected areas 	Cont				
	○ Other					