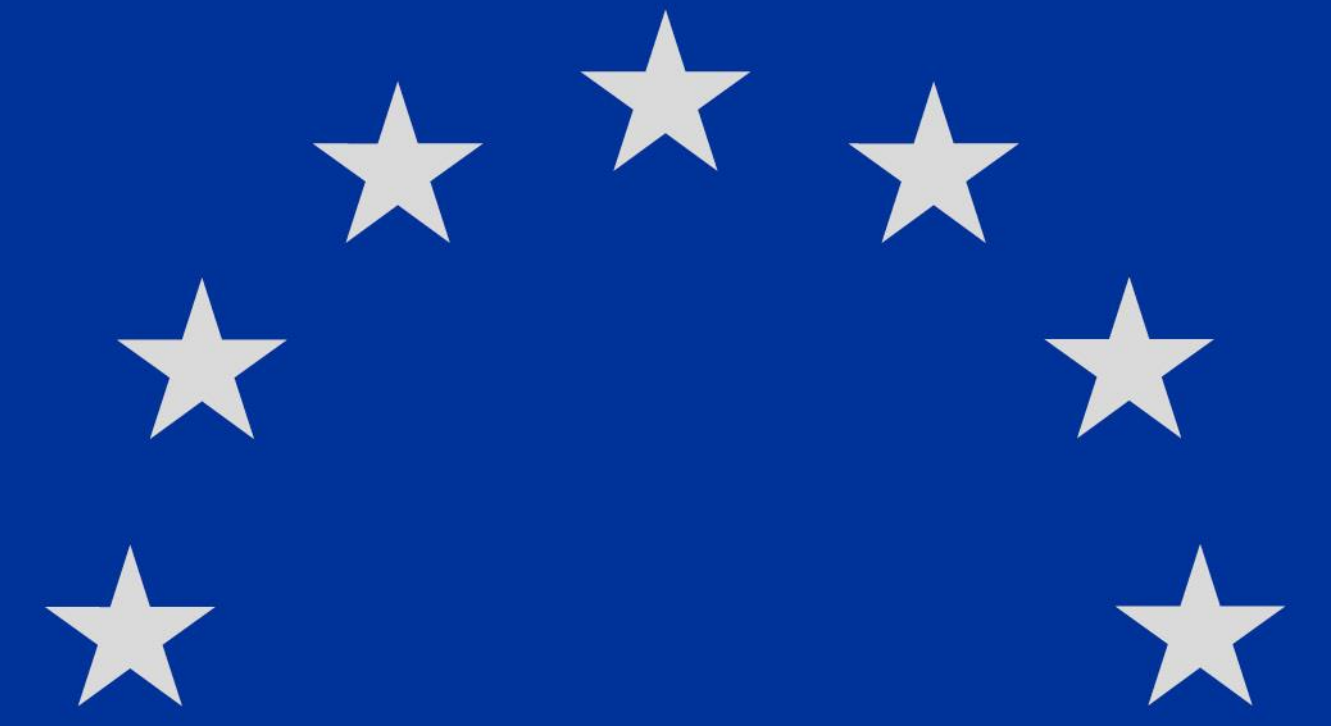
European Commission

Research and Innovation

New indicators measuring transition to circularity

Final report

Independent Expert Report



New indicators measuring transition to circularity - Final Report

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New indicators measuring transition to circularity

Final report

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Directorate-General for Research and Innovation
Healthy Planet

2025

EN

Contents

Abbreviations

AD	Anaerobic digestion
CCRI	Circular Cities and Regions and Initiative
CE	Circular Economy
CEAP	Circular Economy Action Plan
CEMF	Circular Economy Monitoring Framework
DG-RTD	Directorate-General for Research and Innovation
EC	European Commission
EEA	European Environment Agency
EOL	End-of-Life
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
GPP	Green Public Procurement
ICT	Information and Communications Technology
JRC	Joint Research Council
MCA	Multi Criteria Assessment
MFA	Material Flow Analysis
OEM	Original Equipment Manufacturer
PSS	Product Service Systems
RACI	Responsible, Accountable, Consulted, Informed
QA	Quality Assurance
RACER	Relevance, Acceptability, Credibility, Ease and Robustness
SLCA	Social Life Cycle Assessment

Abstract

English

This 24-month research project starts by providing a comprehensive baseline of current policy and funding frameworks in the EU which have the potential to facilitate or incentivise Circular Economy activities across 11 priority policy themes. It then provides a multi-faceted taxonomy of over 700 indicators either currently in use or proposed in recent studies. The list is developed into a multi criteria assessment tool, made available for bespoke use by any policy makers or interested parties, allowing for shortlisting of indicators based a range of priority options.

The themes covered are:

- Bioeconomy
- Households
- Cities and Regions
- Product Service Systems
- Priority materials:
  - Construction and buildings
  - Textiles
  - Batteries and vehicles
  - Electronics and ICT
  - Plastics
  - Packaging
  - Food, water and nutrients.

For the project's later stages, 60 indicators are selected across these themes for investigation, development and testing. The selection focusses on indicators where there was an opportunity for innovation in approach or level of implementation, and recommendations are made on whether each should be considered for further development. Of the indicators investigated, 34 are recommended for further developments with significant work required to progress, 21 with only minor work required, and 5 are not recommended for further development. The 21 indicators with minor work recommended are then developed into a roadmap for consideration, with specific recommendations forming a regulatory and policy plan, a technical action plan and a target setting discussion.

Final analysis leads to conclusions on an idealised suite of indicators for each policy theme, incorporating those covered in this study and other existing options. The work is rounded off with a summary of cross-cutting learnings and final considerations.

Français

Dans un premier temps, ce projet de recherche de 24 mois présente une référence complète des cadres de politiques et de financement européens actuels ayant le potentiel de faciliter ou d'encourager les activités d'économie circulaire et ce, sur 11 thématiques prioritaires. Dans un second temps, Il fournit une taxonomie à multiples facettes de plus de 700 indicateurs actuellement utilisés ou proposés dans des études récentes. Cette liste a été développée dans un outil d'évaluation multicritère permettant une présélection d'indicateurs sur la base d'une gamme d'options prioritaires. Elle est à disposition des décideurs politiques ou des parties intéressées pour une utilisation à la demande.

Les thèmes abordés sont :

- Bioéconomie
- Ménages
- Villes et régions
- Systèmes produit-service
- Matériaux prioritaires
  - Construction et bâtiments
  - Textile
  - Batteries et véhicules
  - Electronique et TIC
  - Plastiques
  - Emballage
  - Nourriture, eau et nutriments.

Pour les étapes ultérieures de ce projet, 60 de ces indicateurs ont été sélectionnés à des fins d'étude, de développement et de test. La sélection s'est concentrée sur les indicateurs pour lesquels il y avait une opportunité d'innovation dans l'approche ou dans le niveau de mise en œuvre. Des recommandations ont ensuite été faites sur les opportunités de leur développement ultérieur. Parmi les indicateurs étudiés, 34 sont recommandés pour de futurs développements et nécessitent encore un travail important, 21 avec seulement des travaux mineurs requis et 5 ne sont pas recommandés pour de futurs développements. Les 21 indicateurs avec des travaux mineurs recommandés sont ensuite développés dans une feuille de route à examiner, avec des recommandations spécifiques formant un plan réglementaire et politique, un plan d'action technique et une discussion sur la définition des objectifs.

L'analyse finale conduit à des conclusions sur une série d'indicateurs idéalisés pour chaque thème politique, intégrant ceux couverts dans cette étude et d'autres options existantes. Le travail est complété par un résumé des enseignements transversaux et des considérations finales.

Executive Summary

The context

As the European Union's Political Guidelines for 2024- 2029[1] reiterate the importance of continuing to strive towards the ambitious carbon emissions reduction target of 90% by 2040, the Circular Economy has a significant role to play. An acceleration of the transition to circularity will unlock decarbonisation benefits from the more sustainable use of materials and resources.

Alongside these clear environmental benefits, circularity also carries the potential to support various complementary political, economic and social aims. Reduced material demand will boost strategic autonomy and increase resilience to geopolitical volatility, particularly relating to strategic and critical raw materials. More efficient use of resources, reduction of waste management expenses, and the adoption and proliferation of innovative circular business models will improve competitiveness for individual organisations, Member States and the Union as a whole. These new models will also offer green jobs and skills, and facilitate the principle of a just transition away from the fossil-fuel based global economic system. Circular activities such as vehicle sharing, tool sharing libraries, reuse 'swap-shop' meetings and repair skills sessions, can also bring local, green, jobs and can all encourage greater societal cohesion, building community resilience against division of all natures.

The transition to circularity for the EU, though, will not happen without support and facilitation from policy makers and influential stakeholders at all levels. The European Commission, Member State governments and regulatory bodies, city and regional administrations and individual sector trade bodies and community-of-interest groups all have a role to play. To be successful, the policies, regulations and initiatives which fall within the remit of all these need to be designed, monitored and iteratively developed based on knowledge gained from a sound, robust and relevant set of indicators and metrics. Existing monitoring efforts cover some of the relevant aspects well, notably systems such as the Circular Economy Monitoring Framework[2], the Bioeconomy Monitoring System[3] and the Circular Cities and Regions Initiative[4]. There is a need, however, to develop complementary indicators which both expand the focus of traditional efforts to give greater attention to higher-value circularity activities, and allow for the specificity of relevant policy focus areas, economic sectors and material streams. What constitutes good progress towards circularity for, say, the construction industry is very different to what does for households and citizens in general, and the monitoring efforts therefore need to be similarly bespoke.

The project

This two-year research project aims at a thorough understanding of existing and potential circularity indicators and metrics, and tests, develops and proposes a suite of options for monitoring across 11 priority policy focus areas and material streams:

- Batteries and vehicles
- Bioeconomy
- Cities and regions
- Construction and buildings
- Electronics and Information and Communications Technology (ICT)
- Food, water and nutrients
- Households
- Packaging
- Plastics
- Product-Service Systems
- Textiles

[1] https://commission.europa.eu/about/commission-2024-2029_en
[2] https://ec.europa.eu/eurostat/web/circular-economy/monitoring-framework
[3] https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring_en
[4] https://circular-cities-and-regions.ec.europa.eu/

The project has sought to cover indicators at the macro, meso and micro levels of implementation, i.e., from international to household or company level, and select those with the potential to provide intelligence on current levels of circularity, progress of those levels over time, and the environmental, social and economic impacts of circular policies and initiatives. The project's objective was to identify and investigate indicators with a high degree of innovation, which either were not currently monitored at all, or were monitored but not at study-specific level of implementation. In purposely choosing to test and develop innovative indicators, it aimed to identify and investigate the inherent challenges posed in their deployment, and suggest options, both regulatory and technical, to tackle those challenges.

The project has progressed from the initial development of a **comprehensive policy and funding framework report**[5], through the cataloguing and taxonomisation of over 730 existing and potential circularity indicators, to the selection and in-depth testing of 60 indicators across the 11 focus areas. The selection process was informed by a series of substantial, sector-specific stakeholder engagement exercises, and was delivered via an **adaptable multi-criteria-analysis tool**[6] which forms part of the project output toolkit for policy makers.

The testing process led to the development of **19 stand-alone case studies**[7], grouping the 60 indicators by focus area and targeted sub-theme, and a **roadmap of recommended actions and targets** for those classed as most straight-forward to develop further. Parallel to the case studies and roadmap, a separate **sector targeted policy brief** was developed. This summarises the policy context and the learnings from the indicators tested for each sector, and proposes an 'ideal' suite of indicators to consider developing further, selected from those tested and existing or other potential monitoring efforts.

The lessons

The stakeholder engagement, indicator testing, and the reflection on the results, all corroborated the need for **tailored regulatory and monitoring approaches** for the varying focus areas, in order to work towards maximum sector-specific circularity. The suites of indicators suggested for each theme draw from several existing and potential frameworks to allow for a holistic understanding to be built. It is not necessarily advised, however, for specific formal frameworks to be developed for each. This could be useful for areas, such as product-service systems, where there is little to no formal monitoring in place, but other areas could benefit more from some high-level coordination and facilitation of collaboration between existing mechanisms and initiatives.

Alongside the **tailored approach recommended for individual policy areas**, several cross-cutting learnings have emerged from the project process. With one of the express intentions of this work being to **identify and test innovative indicators** which were **not currently well-explored**, it was inevitable that challenges and barriers to their full development would be encountered. By far the most prevalent and most significant of these challenges was the gaining of access to, and indeed in some cases the very lack of existence of, relevant data. Reasons behind data issues include the inability of key data-holding stakeholders to supply the relevant info, either due to commercial sensitivities or simply a lack of time or staff resource. Other issues include methodological inconsistencies in data recording practices, making it difficult to draw accurate comparisons, and a lack of sufficient granularity in existing datasets to allow any significant analysis. While proxy datasets and extrapolation techniques could be deployed as Plan B or C for this project, the recommendations made in the project outputs give steps towards addressing the root causes. These include suggestions for new reporting requirements and regulations, and ways to support collection and reporting through enhanced harmonisation and simplification, and development of digital tools and portals. Whilst any potential increase in administrative burden is obviously a clear concern, if the desire is to develop a thorough understanding of circularity, its

[5] https://www.ricardo.com/ce-indicators

[6] https://research-and-innovation.ec.europa.eu/research-area/environment/circular-economy_en

[7] https://www.ricardo.com/ce-indicators

progress and its impact in the focus areas, then more and better data is going to be needed. It is the role of policy-makers and sector wide supporting bodies to minimise that burden as much as possible by ensuring open collaboration, well designed processes and requirements, and comprehensive support and guidance.

The provision of general guidance and information was another key theme to emerge from the work completed. This ranged from recommendations for public-facing information to raise awareness and encourage more circular personal choices, to more technical guidance suggestions such as circular design guidance for ease of repair and recoverability of priority materials or products. Again, collaboration is key here, between regulatory institutions, research bodies, industrial trade associations and innovation platforms. Effective and open stakeholder engagement and communication, across national and sectoral borders where appropriate, is needed to help develop a mutual understanding of the challenges, good practice in overcoming them, and the best shared approach to progress.

Final considerations arising from the project include the importance of understanding that increased circularity alone does not necessarily guarantee a positive environmental output. For example, the material demand reduction facilitated by the reuse of a certain piece of machinery could in theory be overshadowed by a higher lifetime operational energy demand than a newer version. True environmental impact understanding of any product or service can only be achieved through a holistic impact calculation, such as delivered through Life-Cycle Assessment. This should be considered for development into the planning and deployment of any regulatory or monitoring initiatives, to avoid a net unintended environmental harm.

Similarly, circularity indicators should not always be appraised in isolation. Instead, consideration should be given to potential interactions between indicators. Indicator sets taken together, such as, for example, public awareness and perception, actual use, and the quantitative impact of a specific product-service system can give a holistic overview of its successes and challenges. This in turn allows policy makers to more fully understand what works, what doesn't, and why, to iteratively develop and deploy more impactful circular economy policies and support mechanisms.

This project has prompted significant development in the understanding required to aid that process. It has delivered a comprehensive overview of the status-quo, delved into the possibilities for innovation and expansion of the understanding of true, sector-specific circularity, and has resulted in a set of lessons and usable tools for any interested policy-makers or influencers. Its learnings and outputs lay the initial groundwork for the future development and enhancement of circularity monitoring across a wide range of economic sectors and societal levels, further unlocking the potential for the circular economy to be a driving force, not only in tackling the climate crisis, but also in transitioning to a more sustainable, just, and equitable society.

This document represents the full final report of the project, and is accompanied by a number of stand-alone appendices, and a separate targeted policy brief, which is an extraction of Section 6.

1. Introduction

The transition to a circular economy (CE) needs to occur on multiple levels, from households and individual consumers to national and cross-border ecosystems. Measuring and monitoring the development of this transition is an ambitious task and is ideally supported by indicators relevant to all steps in that process. To make the systemic transition towards a CE and society measurable, and to help the European Commission (EC) improve the quality of its policy work and its research and innovation programming, a robust monitoring system needs to exist to measure circularity in all its facets.

This research project has the following key objectives:

1) Developing and presenting a comprehensive understanding of:
   a) Current policy framework for CE and its monitoring, across the European Union (EU).
   b) Existing circular indicators in use at macro, meso and micro levels.
2) Identifying, assessing, developing and testing new potential indicators to facilitate a greater understanding of the following facets of CE:
   a) Current levels of circularity - for horizontal comparison of circularity, such as for two products providing the same functionality or for two comparative cities or regions.
   b) Transition progress – analysis to allow baselining and progress over time.
   c) Impact – analysis of the triple-bottom-line impacts of sectoral innovations and policy or regulatory interventions.

These objectives have been delivered across the five key policy areas, and sub-areas, which form the basis of EU CE policy focus and ambition, most predominantly the Circular Economy Action Plan (CEAP) :

- Cities and regions.
- Households.
- Bioeconomy (defined for the context of this project as focussing on bio-based material streams).
- Priority products/materials.
  - Electronics and Information and Communications Technology (ICT).
  - Batteries and vehicles.
  - Packaging.
  - Plastics.
  - Textiles.
  - Construction and buildings.
  - Food, water and nutrients.
- Product service systems.

The project was delivered by a consortium of CE expert consultants, including:

- Ricardo.
- Ecorys.
- Norion.
- Institute for European Environmental Policy (IEEP).

2. Methodological summary

The overall methodological plan for the project is shown in Figure 1. The following sub-headings provide further detail on the specific methodology adopted across each key task, with the outcomes of each task discussed in the subsequent sections.

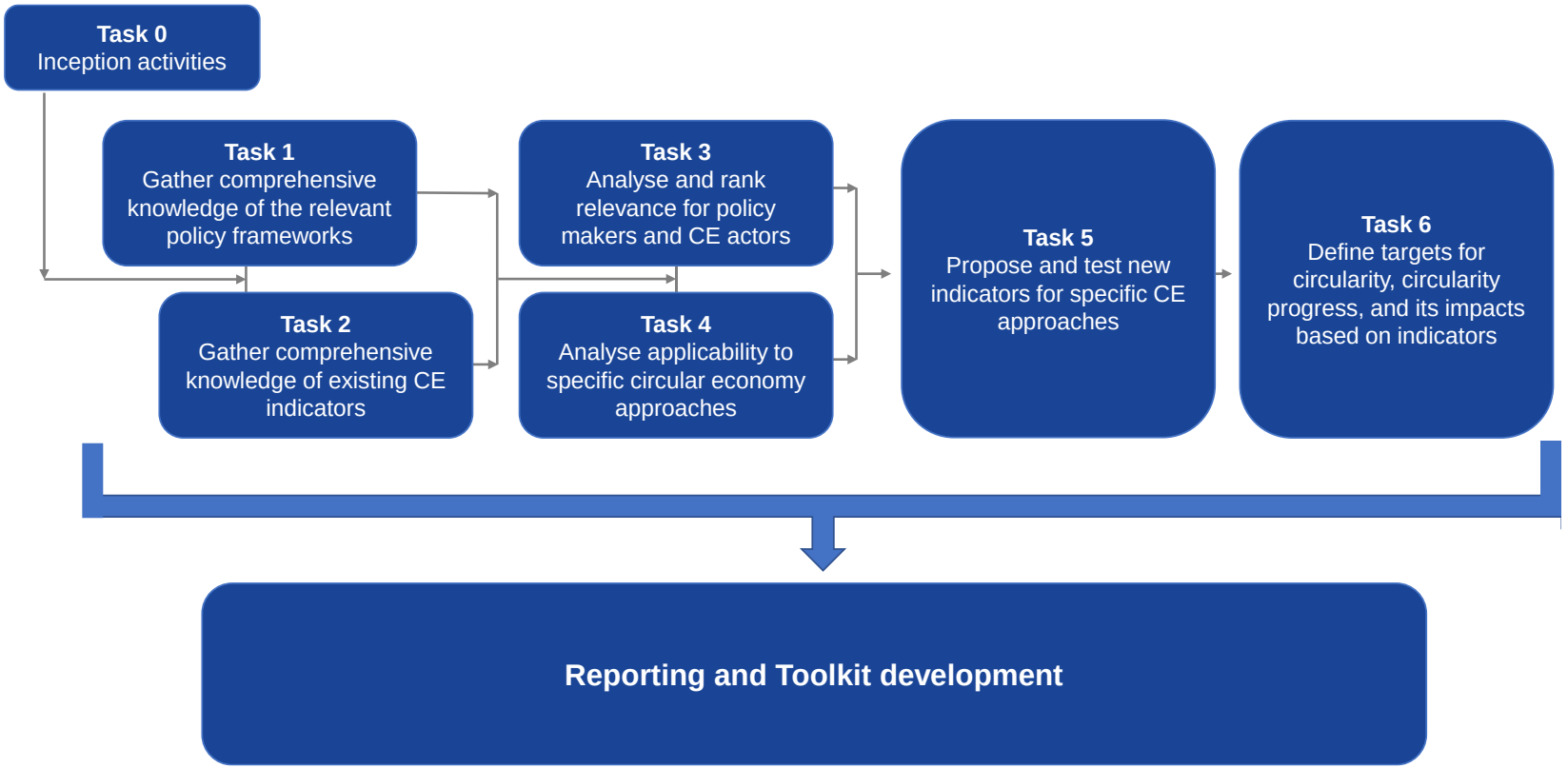


Figure 1: Overall methodological approach

2.1. Task 1 – Policy framework review

Task 1 adopted a three-stage approach, which was conducted as follows:

1) Development of Microsoft Excel templates to map, collate and assess relevant findings on existing policy and funding frameworks.
2) Desk-based research, covering:
   a) Mapping and review of EU legislation (conducted in January 2023): For each policy area, the EU Strategies, Action Plans and legislation (i.e. Directives and Regulations) influencing circularity were identified. Proposed but not yet implemented items were also considered in this analysis due to their potentially significant impact on the future legislative landscape.
   A detailed literature review of those items was then conducted with specific objectives and targets for circular transition identified and recorded. In total, the research team analysed:
      - 19 Strategy documents.
      - 11 Action Plans.
      - 30 Directives.
      - 23 Regulations.
   b) Mapping and review relevant EU funding framework: The mapping of relevant EU funds builds on the previous work conducted under the Urban Agenda Partnership for Circular Economy and the Circular Cities and Regions and Initiative (CCRI) , which have centralised information on EU CE funding. Building on the Circular City Funding Guide and the CCRI funding webpage, researchers compiled and mapped the existing relevant funding schemes.
3) Interviews with EU-level policy representatives, and the European Investment Bank, to complement the desk research. They were used as a tool to fill in gaps in understanding from the literature mapping and review, ask for the validation of the preliminary findings of the desk research, and to collect additional information on the advanced national legislation and/or funding schemes. Potential interviewees were selected based on their positions and expected expertise in each of the policy sub-areas. Priority was given to those flagged by DG RTD (who were presented with a long list proposed by the consortium) as relevant for the study. A template questionnaire was developed and tailored for the specific questions of each sub-policy area. In total, 12 interviews on objectives and targets in EU legislation were completed.

Further detail on the process followed, and the outputs of task 1, are available online[8].

2.2. Task 2 – Existing CE indicators mapping

A comprehensive mapping of existing and proposed CE indicators was carried out, resulting in the initial iteration of the CE Indicators Tool, a Microsoft Excel spreadsheet which is provided online[9].

A taxonomy for indicators was developed to allow systematic data collection. The taxonomy included the following parameters, which were populated in the longlist according to the indicators' current use or status:

- Name of indicator.
- Basic information:
  - Unit.
  - Status

[8] https://www.ricardo.com/ce-indicators

[9] https://research-and-innovation.ec.europa.eu/research-area/environment/circular-economy_en

  - Availability of data.
  - Type.
  - Quantitative or qualitative.
- Coverage:
  - Temporal.
  - Geographic.
  - Recent year.
- Level of implementation:
  - EU, National, Regional/Cities, Companies, Household.
- Description of indicator.
- Facets of CE covered:
  - Current level of circularity.
  - Transition/progress over time.
  - Impact (Economic, Environmental, Social).
- CE Themes / Sub-Themes:
  - CEAP Priority Products:
    - Electronics & ICT, Batteries & Vehicles, Packaging, Plastics, Textiles, Construction &. Buildings, Food, Water & Nutrients.
  - Cities & Regions (Municipal Initiatives & Waste Recycling).
  - Households (Private Consumption).
  - Product Service Systems (Product-oriented, Use-oriented, Result-oriented).
  - Bioeconomy.
  - Other.
- CE strategy:
  - Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle/Downcycle, Recover, None/Other).
- Life cycle phase:
  - Raw material.
  - Production.
  - Use phase.
  - Waste treatment.
- Theory of change:
  - Process.
  - Output.
  - Outcome.
  - Impact.
- Validation of usefulness:
  - RACER assessment.
- References:
  - Link to reference.
  - Link to data.

2.2.1. Literature review and collation of existing indicator sets.

The literature review aimed to gather an extensive collection of existing and proposed indicators to ensure that both well-established indicators, as well as new and innovative indicators, were included in the longlist.

Existing indicator sets and monitoring frameworks.

Important resources for the identification of indicators were existing monitoring frameworks at EU level and sets of indicators developed by leading international organisations and public-private collaboration platforms. To ensure adequate coverage of national CE monitoring efforts across the EU, a systematic scanning for indicators in the national strategies for CE and resource efficiency of the five largest economies in the EU (Germany, France, Italy, Spain and Poland) was conducted. This was complemented by the monitoring framework of EU frontrunners in the CE, including the Dutch, French and Finnish indicators. Key documents covering the cities and region level included material from the CCRI and the OECD, covering monitoring frameworks of eight regions and nine cities. Table 1 summarises the key existing indicator sources used for the collation of the longlist.

Body	Title	Link
EU level		
Eurostat	Circular Economy Monitoring Framework	https://ec.europa.eu/eurostat/web/circular-economy/monitoring-framework
EEA	EEA Circularity Metrics Lab	Site no longer available.
JRC	Building a monitoring system for the EU bioeconomy	https://publications.jrc.ec.europa.eu/repository/handle/JRC119056
National level		
PACE	Circular Indicators for Governments	https://pacecircular.org/sites/default/files/2021-04/CircularIndicatorsForGovernments_FINAL.pdf
OECD	The OECD Inventory of Circular Economy Indicators	https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf
Germany	Deutsches Ressourceneffizienzprogramm III - 2020-2023	https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/ressourceneffizienz_programm_2020_2023.pdf
France	Roadmap for the Circular Economy	https://www.ecologie.gouv.fr/sites/default/files/FREC%20anglais.pdf
Italy	Strategia Nazionale per l'Economia Circolare	https://www.mase.gov.it/sites/default/files/archivio/allegati/PNRR/SEC_21.06.22.pdf
Spain	España Circular 2030	https://circulareconomy.europa.eu/platform/sites/default/files/espana_circular_2030_executive_summary_en_0.pdf
Poland	Broszura informacyjna wyniki projektu indeksy GOZ	https://www.gov.pl/web/rozwoj-technologia/projekt-oto-goz
Netherlands	Netherlands Integral Circular Economy Report 2021	https://www.pbl.nl/sites/default/files/downloads/2021-pbl-icer2021_english_summary-4228.pdf

Body	Title	Link
Finland	Indicators for the CE	https://www.stat.fi/tup/kiertotalous/kiertotalousliiketoiminnan-indikaattorit_en.html
Cities and Regions		
CCRI	Methodology for the implementation of a CE at the local and regional scale	https://circular-cities-and-regions.ec.europa.eu/support-materials/ccri-documents/methodology-implementation-circular-economy-local-and-regional
OECD	The OECD Inventory of Circular Economy Indicators	https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf

Table 1: Key sources of existing indicators

Indicators suggested by academic research.

Academic research papers covering all the priority policy areas and sub-areas of this project were reviewed. The search was conducted via the Royal Danish Library, which provides access to a wide range of leading scientific data banks such as Web of Science, JSTOR, Science Direct and Scopus. The time-range was defined to publications between 2021-2023, to focus on projects with innovative and complementary indicators that are not yet covered by the existing CE monitoring frameworks.

To ensure that findings were included even if they only covered one of the keywords (e.g. only batteries, and not batteries and vehicles), an advanced keyword search using the “AND” “OR” functions was applied, using the queries outlined in Figure 2.

Circular economy OR circularity (TITLE)

AND

Indicator OR metric OR measure (TITLE)

AND

Electronics OR batteries OR vehicles OR packaging OR plastics OR textiles OR construction OR buildings OR food OR water OR nutrients (ANY FIELD)

Circular economy OR circularity (TITLE)

AND

Indicator OR metric OR measure (TITLE)

AND

Households OR product-service-systems OR cities and regions OR bioeconomy (ANY FIELD)

Figure 2: Search queries for literature review.

A total of 65 academic articles were downloaded and screened for CE indicators. All search results were exported into Excel and screened according to their CE relevance with a simple traffic light (red-amber-green) scoring system:

- Literature deemed relevant were marked green. These were then downloaded.
- Literature deemed maybe relevant were initially marked as amber. These were passed for a second review to subsequently decide if the literature was relevant (green) or not relevant (red).
- Literature deemed irrelevant were marked as red and excluded.

2.2.2. Stakeholder engagement for additional fact finding.

Stakeholder consultation was conducted to further inform which metrics and categories to integrate into the assessment framework. Consultations with DG ENV focused on ensuring the best complementarity to existing EU monitoring frameworks. Other stakeholder engagement gathered additional indicators for the longlist, particularly in sectors where new CE monitoring systems were under development, such as the bioeconomy sector.

The activities included semi-structured qualitative interviews with industry experts, the organisation of a stakeholder workshop, and the participation of the Consortium in relevant external events to exchange knowledge and information on CE monitoring frameworks and ongoing developments on the EU level.

Review of longlist

The longlist was peer-reviewed by Consortium partners for completion and relevance at several stages throughout task 2. Members of the Consortium provided valuable inputs on methodology, scanning material, and how to ensure a consistent approach across the different project tasks.

Furthermore, the longlist was presented to external stakeholders to provide further inputs and feedback, including representatives from the European Environment Agency (EEA), Eurostat, DG ENV, DG RTD and the Joint Research Council (JRC). Valuable inputs were provided during two stakeholder workshops, as described below, and in writing by those who could not attend. Inputs and feedback provided were discussed internally and integrated into the final version of the longlist.

Interviews

Relevant contacts were identified across the Consortium, but a low response rate to the interview invitations meant that only four interviews were conducted, despite consistent further attempts to engage with targeted stakeholders through e-mail and phone calls, and to widen the target range. The interviews conducted are shown in Table 2.

Organisation	Sector
WEEE Forum[10]	ICT & Electronics
EUROPEN[11]	Packaging
SUSTRACK[12]	Bioeconomy
CCRI	Cities & Regions

Table 2: List of interviewees for task 2

In consultation with DG-RTD, it was decided not to pursue further individual interviews but to prioritise consultation via workshops to draw conclusions from peer discussions. Further engagement with industry bodies was carried out later in the project, during task 4, to ensure sector specific professional input to the project.

Stakeholder workshop in collaboration with DG RTD

A three-hour interactive online stakeholder workshop was organised in collaboration with DG RTD to present the longlist and assessment framework and gather feedback from relevant actors within the EU institutions. The workshop was hosted on Microsoft Teams on 17th April 2023, and had 18 attendees.

[10] https://weee-forum.org/

[11] https://www.europen-packaging.eu/

[12] https://sustrack.eu/

The visual collaboration platform Miro created an engaging and interactive format so all participants could contribute with their input. Before the workshop, the in-progress version of the longlist had been shared with all attendees, allowing them to understand the assessment tool beforehand and ensuring an informed discussion of the progress made.

Time	Programme
13:00 – 13:15	Welcome & Introduction to Project
13:15 – 13:25	Tour de Table
13:25 – 13:35	Diving into the world of CE indicators - Warm up exercise (Miro)
13:35 – 14:00	Presentation of the Indicator Framework & Long-list
14:00 – 14:15	Break
14:15 – 14:25	Challenges in measuring progress on CE: Short introduction of key concepts
14:25 – 14:55	Challenges in measuring progress on CE: Discussion in small groups (Miro)
14:55 – 15:10	Presentation of group discussions (Miro)
15:10 – 15:25	From long list to short list: What criteria are most relevant ? - Voting exercise (Miro)
15:25 – 15:55	From long list to short list: Discussion of findings (Miro)
15:55 – 16:00	Final remarks & Good-bye

Figure 3: Programme of stakeholder workshop 17th April 2023

The key questions discussed at the workshop were:

- Monitoring progress on the inner circles of the R10-strategies (refuse, rethink, reduce, reuse) remains difficult – How can we overcome this challenge?
- Social aspects are less visible in existing CE monitoring models – Is it time to change this, and how could it be done?
- Should we mainly look at indicators linked to EU CE targets and objectives or move beyond?
- Should we only include indicators based on official statistics for which data is available and easily accessible?
- Are indicators at the impact level relevant, or should we primarily focus on the footprint level?
- How can we monitor progress on the implementation and impact of Product Service Systems?

These questions were discussed in two break-out rooms facilitated by Consortium team members. The discussion results were collected on the Miro board, an example of which is shown in Figure 4.

A ranking exercise provided further inputs on the most critical metrics for the assessment framework. The relatively mixed results, shown in Figure 5, show that, the CE themes and strategy are generally considered more important than the life cycle phase.

In the second part of the workshop, participants presented the results from the group discussions, and the results were grouped according to keywords.

Figure 4: Screenshot of Miro Board: Group discussion.

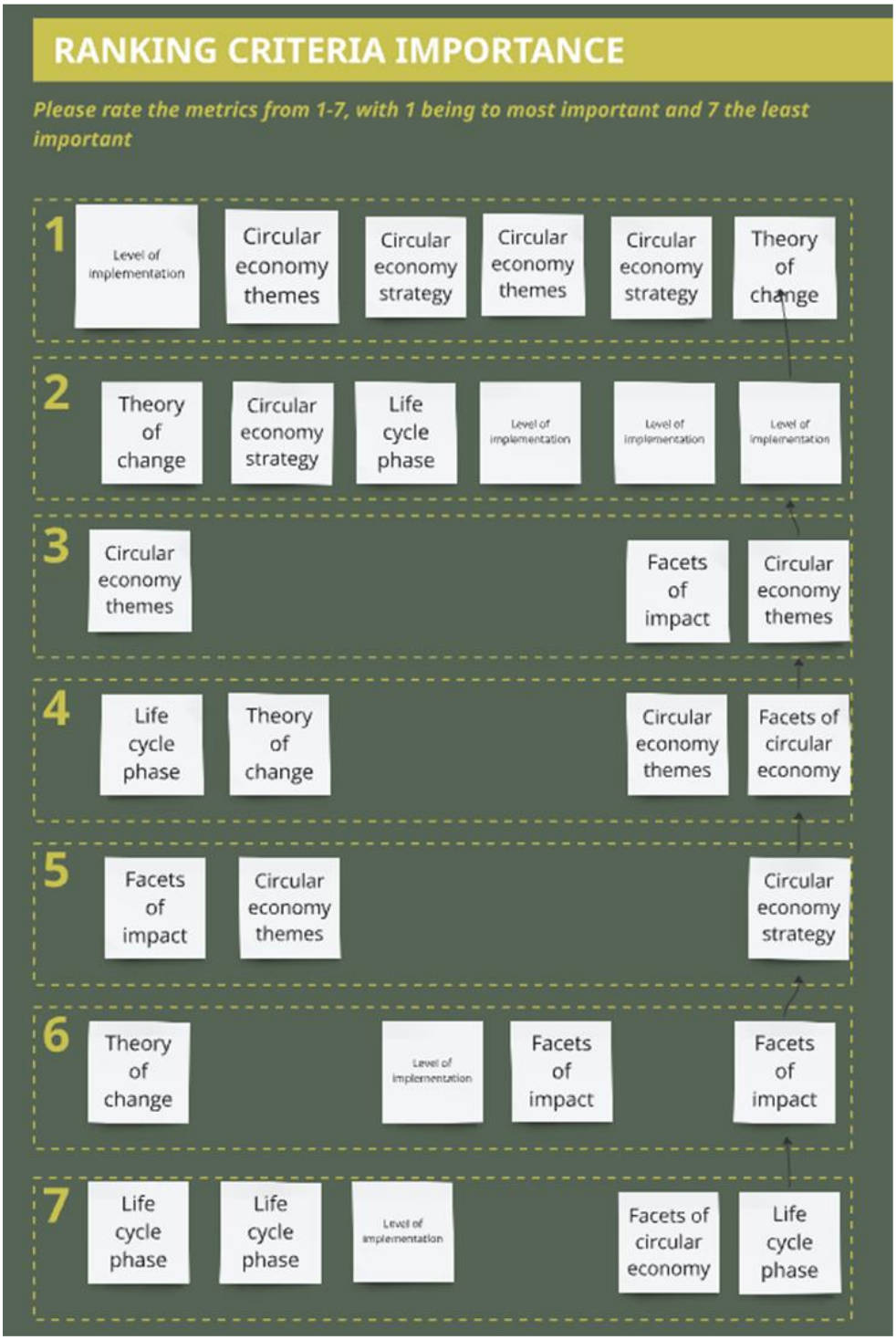


Figure 5: Screenshot of Miro Board: Voting exercise.

2.2.3. Categorisation of existing CE indicators and developing longlist.

For all identified indicators, information was collected on a multitude of parameters as described in the taxonomy and added to an Excel database with three sheets:

1. The introductory sheet describing the categories and parameters for assessment.
2. The longlist of all indicators (with information on the different parameters).
3. The dashboard that allows selection of indicators according to a combination of the taxonomy criteria.

A total of 732 indicators were plotted in the longlist. Indicators were plotted based on the information provided by the reference (e.g. level of implementation), as well as the assessment of the information that was not provided by the original reference (e.g. which R-Strategy an indicator covers). To avoid duplicates before adding an indicator from a new source, it was checked whether this indicator had already been found in another source and plotted into the longlist. However, the final longlist still contains a range of indicators that were very similar in title but differ in terms of methodology or level of implementation. This is because the indicators were plotted based on the information provided in the original source, and not based on where an indicator potentially *could be* used. When the original reference did not provide any information, it was plotted based on the research team's own assessment. For example, an indicator used for measuring "jobs created by the sharing economy" on a city/regional level was plotted for the impact level "cities and regions", even if it potentially could be applied on the national level as well. A full overview of all categories, parameters, and a detailed description of each is provided in

LIFE CYCLE PHASE		**Raw material**	The classification framework stage it monitors changes wi
		Production	
		Use phase	
		End of life	
THEORY OF CHANGE		**Process**	Processes are activities, e.g.
		Output	Outputs are the results of pr to outcomes.
		Outcome	An outcome may represent a as increased reuse or recycli not to be confused with the o
		Impact	Impacts are the long term eff emissions, higher biodiversi
VALIDATION OF USEFULNESS	**RACER criteria (1-5; 5 at best)**	**Relevant**	Relevant for reaching objecti
		Acceptable	Acceptable for stakeholders,
		Credible	Credible for non-experts, una simple and robust as possib
		Easy to monitor	Easy to monitor (e.g. data co
		Robust	Robust against manipulation administrative burdens to bu shifted from businesses to p
		RACER AVERAGE SCORE	The average score from all R
REFERENCES		**Reference**	Name of organisation, title o
		Link to reference	Link to the online reference f
		Link to data	Link to the data set for the in

Figure 6.

METRICS / INDICATORS / DATA STREAMS		INDICATOR:	Column A is the indicator name. Each name should be self explainatory
DATA	Basic info	UNIT:	The unit of measurement.
		Status of indicator (existing, proposed)	States whether the indicator is existing and mapped or a new propsed indicator.
		Availability of data	Is data available for the indicator and if so, to what degree; signal, indicator or potential? **Signal** refers to data being available, but only for a a limited timeframe or geographic. **Indicator** refers to data being available and regularly updated. **Potential** refers to the potential of a meaningful indicator but there is no data available.
		Indicator type: ratio/index/composite/metric	The indicator type differentiates between **ratio** (number relative to a reference value), **index** (single number resulting from the aggregation of two or more indicators), **metric** (measured against an existing standard) or a composite (including two or more different dimensions of measurement).
		Qualitative indicator	This class refers to indicators which do not involve inumeration, but instead are measured against pre-determined criteria.
		Quantitative indicator	This class refers to indicators which do involve inumeration.
	Coverage	Temporal	The timespan the indicator or signal has been active.
		Geographic	The geography the indicator, signal or potential is relevant for.
		Recent year	The most recent year for data collection.
LEVEL OF IMPLEMENTATION		EU	Indicators relevant for the EU level.
		National	Indicators relevant for the national level.
		Cities/regions	Indicators relevant for city/regional level (in particular municipal waste streams).
		Companies	Indicators relevant for company and industry level.
		Household	Indicators relevant for household level, particularly private consumption and initiatives at a citizens' level.
DESCRIPTION		Description of the indicator/signal/potential	Thorough description of the indicator/signal/potential. It is important that the description enables a common understanding.
METHOD		Methodical considerations	Relevant metholodical flaws/limitations/weaknesess/blind spots as well as exeptional advantages related to the metric.
		Required methodology	The specific methodology required for this indicator, e.g. product LCA, PEF, material flow analysis, survey, etc.
FACETS OF CE		Current level of circularity	**Indicators that allow for horizontal comparison of circularity, e.g. for two products with the same functionality.**
		Transition/Progress over time	**Indicators that allow baselining and measure progress over time.**
	Impact	Economic	**Indicators that monitor progress related to ecological responsibility.**
		Environmental	**Indicators that monitor progress related to economic performance.**
		Social	**Indicators that monitor progress related to social aspects.**

CE THEMES / SUB-THEMES	CEAP	Electronics & ICTs	As defined in CEAP 2020.
		Batteries & Vehicles	As defined in CEAP 2020.
		Packaging	As defined in CEAP 2020.
		Plastics	As defined in CEAP 2020.
		Textiles	As defined in CEAP 2020.
		Construction & Buildings	As defined in CEAP 2020.
		Food, Water & Nutrients	As defined in CEAP 2020.
	Cities & Regions	Cities/regions	Municipal initiatives & waste streams.
	Households	Private consumption	Private consumption & initiatives on citizen's level.
	PSS	Product-oriented	Product-related service, e.g. product maintenance and servicing contracts.
		Use-oriented	Product lease, renting and sharing, e.g. car sharing.
		Result-oriented	Activity management, e.g. chemical management.
	Bioeconomy	Bio-based economy	Bio-based economy, i.e. the production of products and materials from bio-based feedstock. For example, bio-based fertilisers, proteins and plastics.
CE STRATEGY		Refuse	Turning a product redundant by cancelling its function, or by substituting it with a radically different product.
		Rethink	Intensifying product use, e.g. via product sharing or multifunctional products.
		Reduce	More efficient use and/or manufacture of products through the use of fewer natural resources and materials.
		Reuse	Reuse of discarded yet still usable product, for the same purpose, by a different user.
		Repair	Repair and maintenance of broken or malfunctioning product, to enable continuation of its original function.
		Refurbish	Refurbishing and/or modernising of an older product, so that the improved version can be used in the product's original function.
		Remanufacture	Using parts of a discarded product in a new product of the same function.
		Repurpose	Using discarded products or their parts in new products with a different function.
		Recycle, downcycle	Processing of materials to achieve the original high-quality or reduce to low-quality.
		Recover	Incineration of materials, recovering their energy (most often not included as a circular strategy).
		Other / None	Other CE Strategy or lack of CE Strategy, e.g. amount of waste generated.

LIFE CYCLE PHASE		**Raw material**	The classification framework categorises each indicator according to which life cycle stage it monitors changes within.
		Production	
		Use phase	
		End of life	
THEORY OF CHANGE		**Process**	Processes are activities, e.g. policy responses, workshops, collaborations.
		Output	Outputs are the results of proceses, e.g. number of workshops. They may or may not lead to outcomes.
		Outcome	An outcome may represent a change in a group of people, organizations, or place (such as increased reuse or recycling). While the outcomes may be the policy target - they are not to be confused with the overall goal which is the impact.
		Impact	Impacts are the long term effects on environment, society and the economy (e.g. reduced emissions, higher biodiversity, or better welfare).
VALIDATION OF USEFULNESS	**RACER criteria (1-5; 5 at best)**	**Relevant**	Relevant for reaching objectives and targets on CE.
		Acceptable	Acceptable for stakeholders, e.g. policy-makers and industry representatives.
		Credible	Credible for non-experts, unambiguous and easy to interpret. Indicators should be as simple and robust as possible.
		Easy to monitor	Easy to monitor (e.g. data collection should be possible at low cost).
		Robust	Robust against manipulation (e.g. administrative burden: If the target is to reduce administrative burdens to businesses, the burdens might not be reduced, but instead shifted from businesses to public administration).
		RACER AVERAGE SCORE	The average score from all RACER criteria.
REFERENCES		**Reference**	Name of organisation, title of journal article, or project from which indicator stems.
		Link to reference	Link to the online reference for this indicator, if available.
		Link to data	Link to the data set for the indicator, if available.

Figure 6: Screenshot of key for indicator framework.

2.3. Tasks 3 & 4 – Analysis and ranking of longlist indicators

Tasks 3 and 4 of the project were delivered concurrently, being in essence only subtly different aspects of an overall Multi Criteria Assessment (MCA) exercise. Task 3 called for assessment of relevance and potential value of the indicators to EU and Member State policy makers, and task 4 for specific relevance to the 11 policy themes and sub themes which were the focus of the study.

2.3.1. Stakeholder engagement

Stakeholder engagement was a key element of these tasks to ensure that the analysis delivered was practical and relevant to the specific aims of the project. A series of interviews explored the stakeholders' opinions of what an 'ideal' view of maximum circularity would look like for their organisation and sector, how to get there, and how to monitor its progresses and impacts. The interviews also provided a detailed understanding of the important factors/aspects to consider when choosing indicators and metrics to measure circularity across their sector or focus area. This was used to develop the criteria and weighting applied to select the most suitable circularity indicators for each sub-policy area. The interviews lasted between 45 minutes and 1 hour in length, and comprised four key questions:

1. What does the ideal view of circularity look like in your sector?
2. What is currently happening in relation to achieving circularity in your sector, and what still needs to happen?
3. Referring back to your answer in Question 1, how can this ideal view of circularity be measured?
4. When choosing indicators or metrics to measure circularity across your sector, what are the most important factors to consider?

A questionnaire was also developed and shared with stakeholders in case they were unable to participate via an interview, which covered the same questions as above.

In total, over a 2-month period, 36 interviews and questionnaires responses were completed, which was just short of the aim (to complete 4 interviews across each sub-policy area (i.e. 44 in total)). Although the aim was not quite achieved, this was still considered successful by the team and DG-RTD considering that the stakeholder engagement stage took place over the summer period of 2023. Table 3 provides a breakdown of the interviews across each sub-policy area of interest.

Sub-policy area	Number of interviews/questionnaires
Bioeconomy	1
Cities and regions	6
Households	3
Batteries and vehicles	5
Construction and buildings	3
Electronics and ICT	2
Food, water and nutrients	2
Packaging	4
Plastics	4
Textiles	4
Product Service Systems	1
General responses	1
Total	**36**

Table 3: Breakdown of interview and questionnaire responses received.

Please view Appendix 2 in the previously submitted 'Interim report' for a complete list of the stakeholders who participated in this engagement phase.

2.3.2. Develop assessment criteria functionality.

Before the assessment was conducted to generate a shortlist from the longlist, additional functionality was developed into the longlist Excel sheet from task 2, turning it into a usable MCA tool. With this functionality, the tool, provided as Appendix 0 to this report, can be used further in future by any interested stakeholders to further investigate and assess indicators, based on their own priorities and aims.

An MCA is often used to quantify the best performing or most appropriate item, based on pre-defined criteria. These items are then scored, weighed and summed to produce an overall score. By ranking the final score, it was possible to identify the best performing indicators to take forward onto the 11 separate shortlists. The following updates were made to the indicator longlist to develop it into the functional tool:

- 11 separate longlists were created (one for each sub-policy area).
- 'Shortlist' tabs were added, which were automatically populated with the 30 highest scoring indicators.
- A 'weightings' tab was added, where each assessor could change the associated weighting of each RACER criteria and additional criteria (if relevant).

2.3.3. Define criteria and weighting.

The RACER criteria (Relevance, Acceptability, Credibility, Easy and Robust) developed by the EC formed the basis of the indicator assessment. Within the context of this project, RACER was defined as follows:

- *Relevance* refers to whether the indicator is closely linked to the objectives to be reached.
- *Acceptability* refers to whether the indicator is perceived and used by key stakeholders (such as policymakers, civil society and industry).
- *Credibility* refers to whether the indicator is transparent, trustworthy and easy to interpret.
- *Ease* refers to the easiness of measuring and monitoring the indicator.
- *Robustness* refers to whether the data is biased and comprehensively assess circularity.

Alongside RACER, based on the outputs of the stakeholder engagement activities, additional criteria can be developed within the MCA, allowing future users to tailor it to their specific needs or preferences.

The additional functionality added into the MCA allows each assessor to assign a relevant weighting to the RACER assessment. For this exercise, the same and equal weightings across the RACER criteria were applied to all the sub-policy areas, but the functionality to adjust this is present for future users. To ensure consistency and fairness across all 11 assessments, the application of RACER scores was guided by the matrix shown in **Error! Reference source not found.** below.

Criterion	Description	1 (Poor)	2 (Neutral)	3 (Good)
Relevance	Refers to whether the indicator is closely linked to the objectives to be reached.	Does not support a better understanding of true circularity.	Supports a better understanding of true circularity.	Highly supportive towards gaining a better understanding of true circularity.
		Supports no value-added circular opportunities.	Supports lower value-added opportunities (i.e. metrics related to waste generation, recycling, waste management, etc.).	Supports higher value-added opportunities (i.e. all R-strategies above remanufacturing) and wider systemic change (e.g. indicators that encourage PSS or circular design).
		Not linked to the project objectives and/or European policy objectives (existing or upcoming).	Linked to the project objectives, but not to European policy objectives (existing and/or upcoming).	Fully aligned with project objectives and European policy objectives (existing and/or upcoming).
Acceptability	Refers to whether the indicator is perceived and used by key stakeholders (such as policymakers, civil society, and industry).	Poorly accepted by key stakeholders, e.g. due to the use of confidential data.	Relatively accepted by key stakeholders as the benefits of measuring are clear.	Key stakeholders are motived to report this indicator, due to mandatory legislative requirements (current or upcoming), potential commercial benefit or being in the public interest.
Credibility	Refers to whether the indicator is transparent, trustworthy and easy to interpret.	No defined methodology associated with this indicator and/or interpretation of the indicator is ambiguous.	Methodologies have been proposed or currently existing, but not for this particular indicator (e.g. in a research article).	There is an EU defined methodology.
		Difficult to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are not familiar with).	Moderately easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are aware of but are not confident in practical use).	Easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders already use and are confident in applying).
Ease	Refers to the easiness of measuring and monitoring the indicator.	No defined methodology associated with this indicator and/or interpretation of the indicator is ambiguous.	Methodologies have been proposed or currently existing, but not for this particular indicator (e.g. in a research article).	There is an EU defined methodology.
		Difficult to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are not familiar with).	Moderately easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders are aware of but are not confident in practical use).	Easy to understand and communicate to stakeholders (e.g. units or measurement of something that stakeholders already use and are confident in applying).
Robustness	Refers to whether data is biased and comprehensively assesses circularity.	No consistent methodology and dataset are available.	A consistent methodology and dataset available.	A consistent methodology and dataset available.
			A composite/aggregated indicator (based on multiples dimensions).	A one-dimensional indicator.
			A proxy indicator.	

Table 4: RACER assessment matrix

2.3.4. Assess longlist to agreed criteria.

A series of internal briefing documents, one for each sub-policy area, were produced to support the shortlisting process. The briefing documents summarised the current and upcoming policy landscape (building on insights in the task 1 report such as key strategies, targets and interventions), and current or ongoing indicator development activity. The briefing documents are included in Appendix 3 of the previously submitted Interim Report.

Once the criteria and weightings were agreed by the assessor and signed off by the project management team, the MCA exercise began. Figure 7 gives an overview of the indicator collation and shortlisting process.

During the assessment, each assessor conducted the following steps:

Step 1: Answer the pre-RACER Yes/No pass questions.

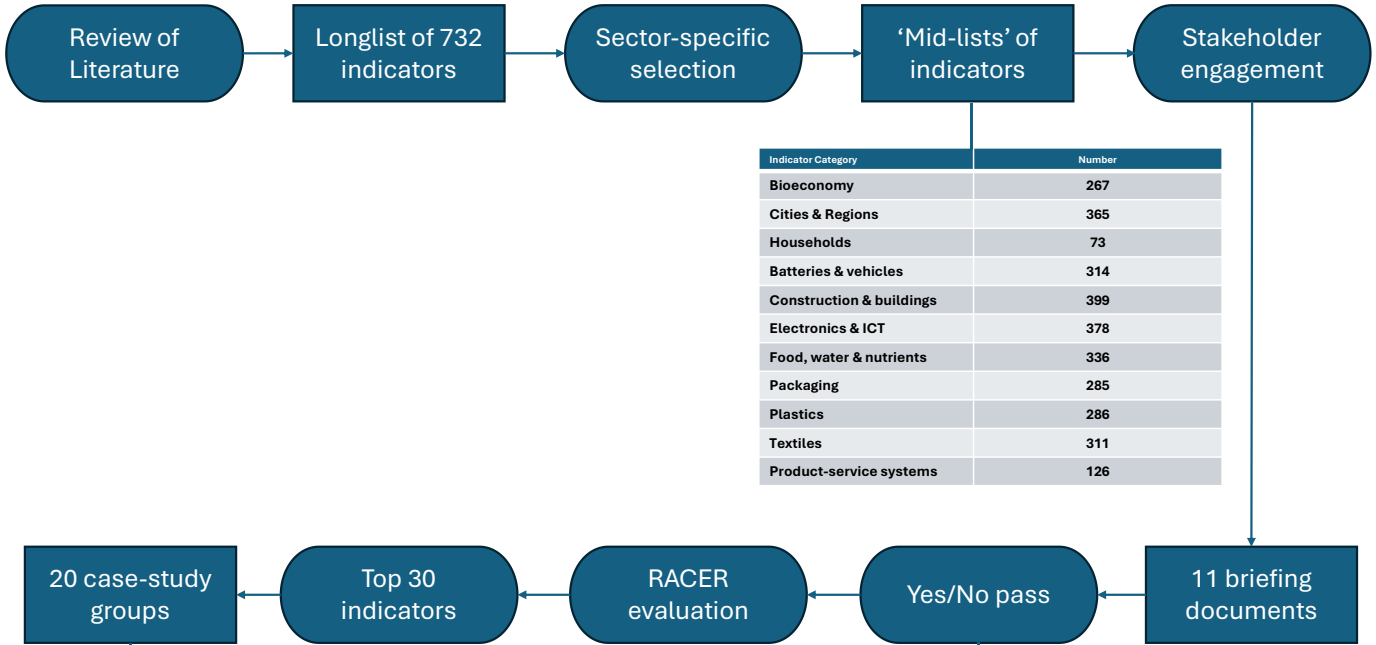
To facilitate the simplification of the process, and to ensure that full RACER assessment was only carried out on indicators of specific interest and potential future value to each policy area, the team firstly carried out a yes/no pass by asking two basic questions, with reference to the developed briefing documents:

- *Does this indicator, for this sub-policy area, have the potential to measure true circularity?* This is where specific R-strategy understanding was built into the assessment. 'True' circularity might be different for each of the policy themes and sub-themes, not all industry sectors covered, for example, are at the stage of maturity in CE thinking, nor do they have the same capacity for eventual change. To gain an understanding of what 'true circularity' looks like for each area, the assessment referred to the questionnaire and interview responses from stakeholder engagement.
- *Can we do something new with it?* This was the opportunity to think innovatively, particularly since the longlist criterion "level of implementation" is plotted based on where an indicator currently ***is*** used, not where it ***could be used.*** An indicator was viewed as potentially 'new' if:
  - It is already in use, **but** a different level of implementation could be tested (e.g. EU, Member State, regional, business/household etc.).
  - It is already in use, **but** we can tailor certain aspects could be tailored (e.g. adopt a different methodological approach, suggest greater levels of granularity, etc.).
  - It is a completely new indicator of interest at any level (i.e. proposed), with potential value to include for further consideration.

During this decision-making process, the assessment referred back to the policy-area briefing document. High-level justifications were provided for the assessment of each indicator.

Step 2: Remove any irrelevant indicators.

Any indicator that did not receive a positive response to both pre-RACER assessment questions was ruled out from further analysis through applying the filtering function.



Indicator Category	Number
Bioeconomy	267
Cities & Regions	365
Households	73
Batteries & vehicles	314
Construction & buildings	399
Electronics & ICT	378
Food, water & nutrients	336
Packaging	285
Plastics	286
Textiles	311
Product-service systems	126

Indicator Category	Updated Number
Bioeconomy	45
Cities & Regions	29
Households	37
Batteries & vehicles	55
Construction & buildings	80
Electronics & ICT	87
Food, water & nutrients	78
Packaging	71
Plastics	62
Textiles	120
Product-service systems	55

Indicator Category	Updated Number
Bioeconomy	8
Cities & Regions	9
Households	10
Batteries & vehicles	4
Construction & buildings	3
Electronics & ICT	4
Food, water & nutrients	3
Packaging	4
Plastics	3
Textiles	3
Product-service systems	11

Figure 7: Indicator collation and shortlisting process.

Step 3: Determine whether any additional criteria are needed.

As mentioned in Section 2.3.3, additional criteria were considered (alongside RACER) which may be valuable for particular sub-policy areas. For example, this could have included:

- Does the metric adopt a whole life cycle approach?
- Does the metric measure a specific life cycle stage which is a hotspot area?

However, based on the stakeholder responses, no additional criteria were identified as a priority for any of the sub-policy areas.

Step 4: Conduct the RACER evaluation.

RACER was used as the main form of assessment for the indicators. A score of 1 (poor) to 3 (good) was given to each indicator for each RACER criteria. All metrics received a score of at least 2 for 'Relevance' due to having already carried out the pre-RACER assessment. The total of the scores was used to rank the metrics. To ensure consistency in applying the approach, the assessment matrix shown in **Error! Reference source not found.** was applied to support the decision-making process.

Each indicator was assessed based on the 'new' aspect(s) identified in Step 1. This was to ensure that innovative and advanced indicators which had not previously been implemented were selected.

Step 5: Select the required number of indicators to take forward to task 5.

For each sub-policy area, a sufficiently large number of indicators was needed to ensure enough case study groups would be developed in task 5 with the requisite facet coverage. Pivot tables were added into the MCA shortlist tabs for each sub-policy area to analyse coverage of relevant criteria. As per the project Terms of Reference and the initial methodology plan, indicators were selected from the top 30 scoring ones in each policy area, and grouped to fulfil the desired coverage across the following facets of CE:

- Current level of circularity.
- Transition/progress over time.
- Impact:
  - Economic.
  - Environmental.
  - Social.

The mapping of the above criteria to the indicator longlist had already been conducted in task 2. After ensuring a balanced coverage of the five facets within each policy area and sub-area, the indicators were organised into case-study groups based on similarities across the proposed testing methodologies, to ensure efficiency in approach and consistency of reporting in task 5. The remaining indicators within the top 30 lists were then individually reviewed to ensure that any particularly interesting, relevant or ambitious indicators had not been missed. The wording of the indicator name and identified methodology was then tailored to ensure all descriptions were clear heading into the testing phase.

Resulting from this process, 60 indicators were shortlisted, organised into 19 specific case-study groups to take forward into the testing stage.

During the testing process in task 5, the wording and context of some of the indicators were refined to develop them to provide best potential value and insight to policy makers. The final list of shortlisted indicators involved in the testing process is show in Table 5.

Policy area	Case Study Group	URN	Indicator name
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector
	B2	B2	Share of local forestry by-products going to energy generation
	B2	B3	Share of organic fertiliser used in agricultural practices
	B1	B4	Number of products with the EU Ecolabel that are bio-based
	B1	B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activity undertaken
	B1	B6	Cost savings through industrial symbioses using bio-based material
	B3	B7	Effects on local communities of a circular bioeconomy
	B2	B8	Share of biological waste treated with anaerobic digestion
Batteries & vehicles	BV1	BV1	Car-sharing frequency rates
		BV2	Virgin vs. recycled plastic raw material used in the production of vehicles
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry
		BV4	Ease of Disassembly Metric (eDIM)
Cities & regions	CR1	CR1	Share of publicly purchased products following EU GPP criteria
	CR1	CR4	Share of public procurement notices that stipulate specific CE aspects
	CR2	CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems
	CR3	CR7	Number of city resources implementing transition agendas
	CR1	CR8	Budget of public procurement notices that stipulate specific CE aspects
	CR3	CR9	Collaborative spaces equipped with material and equipment to encourage repair
	CR2	CR10	Number of regional development agencies providing circular economy programmes
Electronics & ICT	EICT1	EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products
		EICT2	Real recycling rate of electronic and ICT equipment
		EICT3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models
		EICT5	Share of consumer electronics put on market fulfilling ecodesign criteria
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost
	H1	H3	Share of household income spent on service models rather than related ownership of goods
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials
	H1	H5	Items of clothing repaired by households per year
	H3	H6	Reuse of consumer goods via reuse centres
	H1	H7	Household spending on maintenance and repair
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households
	H2	H9	Water footprint of private consumption
	H1	H10	Unused household goods
Packaging	Pa1	Pa1	A sustainable brand index for packaging products and manufacturers
		Pa2	No. of legislative incentives created to encourage circularity
		Pa3	Percentage by weight of packaging POM which has been designed according to circular principles
		Pa4	Changes in expenditure through applying circular principles throughout the packaging value chain
		Pa5	Share of take-away meals and drinks provided in reusable packaging

Policy area	Case Study Group	URN	Indicator name
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry
		PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU
PSS	PSS1	PSS1	Consumer perception of the attractiveness of PSS models
	PSS1	PSS2	Percentage of citizens who have used PSS models
	PSS2	PSS3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased
	PSS3	PSS4	EU project funding allocated to research and development projects on PSS
	PSS2	PSS5	No. of companies offering PSS-solutions within the electronics and ICT sector
	PSS2	PSS6	The percentage of public procurement contracts for electronics and ICT that incorporate PSS models
	PSS3	PSS7	No. of public financial incentives directed at PSS providers/models
	PSS3	PSS8	No. of countries that have included PSS in their national CE strategies
Textiles	T1	T1	Number of jobs in the textile repair sector
		T2	Number of jobs in the textile recycling sector
		T3	Total amount of separately collected textiles
		T4	Total volume of secondary raw material output from textile recycling
		T5	Share of recycled content in textile products put on market by EU brands and retailers
Food, water & nutrients	FWN1	FWN1	Presence of guidance (labelling) on climate impact of food product categories
		FWN2	Presence of requirements for organic products in public-procurement of food
		FWN3	Sustainable Calorie intake per capita gap of animal-based food consumption
Construction & buildings	CB1	CB1	Number of building products with EPDs
		CB2	Share of building projects that are certified
		CB3	Utilisation rate of existing building stock

Table 5: Shortlisted indicators for testing

2.4. Task 5 – Testing and development

This task incorporated the shortlisted indicators from tasks 3 and 4 into a detailed development and testing programme. The case studies presented the process by which the indicators were developed, analysed and assessed. As well as the actual analysis of the indicator data testing and analysis results (where data was available), each is objectively analysed for its suitability for further development across the EU. Learnings from the identification, planning, delivery and analysis of the relevant methodology for each indicator form the basis of a new assessment of their:

- Robustness.
- Reliability.
- Relevance.
- Objectiveness.
- Directness.
- Availability.
- Replicability.

The methodology followed for each indicator is discussed in detail in the respective case studies. The vast majority of case studies included some level of:

- Desktop literature review
- Identifying and summarising current cutting-edge knowledge on the relevant subject matter. Informing on-going stakeholder engagement foci, data collection and analysis direction, and indicator conclusion and insights.
- Stakeholder engagement
- Identifying, mapping and extensive reach-out to stakeholders deemed key to providing insight, context and data for the investigation of the indicator. Engagement took the form of e-mail correspondence, telephone and video interviews, and the provision of standardised data collection templates where appropriate.
- Data collection and analysis
- Detailed data collection plans were drawn up for all indicators, identifying existing public data sets to draw upon, target data holders to engage with as described above, and strategies for filling any already known gaps, such as the deployment of surveys or web-scraping techniques.
- The plans also covered the expected analysis or calculations to be carried out, as detailed in the individual Case Study reports.

The methodologies employed are summarised in Table 6, with some more detailed discussion of examples of specific interest below. Full detail of all processes followed is available in the individual case study reports[13].

[13] https://www.ricardo.com/ce-indicators

Policy area	Case Study Group	URN	Indicator name	Key methodologies							
				Survey	Desk-based research	Literature review	Data analysis	Stakeholder engagement/interviews	Material Flow Analysis	Web-scraping tool	Narrative approaches
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector		X			X	X		
	B2	B2	Share of local forestry by-products going to energy generation		X			X	X		
	B2	B3	Share of organic fertiliser used in agricultural practices		X				X		
	B1	B4	Number of products with the EU Ecolabel that are bio-based		X						
	B1	B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activity undertaken		X			X			
	B1	B6	Cost savings through industrial symbioses using bio-based material		X			X			
	B3	B7	Effects on local communities of a circular bioeconomy								X
	B2	B8	Share of biological waste treated with anaerobic digestion		X			X	X		
Batteries & vehicles	BV1	BV1	Car-sharing frequency rates	X							
		BV2	Virgin vs. recycled plastic raw material used in the production of vehicles				X	X	X		
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry				X	X			
		BV4	Ease of Disassembly Metric (eDIM)				X				X
Cities & regions	CR1	CR1	Share of publicly purchased products following EU GPP criteria	X	X	X		X		X	
	CR1	CR4	Share of public procurement notices that stipulate specific CE aspects	X	X	X		X		X	
	CR2	CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems	X	X	X		X			
	CR3	CR7	Number of city resources implementing transition agendas		X	X		X			
	CR1	CR8	Budget of public procurement notices that stipulate specific CE aspects	X	X	X		X		X	
	CR3	CR9	Collaborative spaces equipped with material and equipment to encourage repair		X			X			
	CR2	CR10	Number of regional development agencies providing circular economy programmes		X	X		X			
Electronics & ICT	EICT1	EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products	X							
		EICT2	Real recycling rate of electronic and ICT equipment		X			X			
		EICT3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing		X						
		EICT5	Share of consumer electronics put on market fulfilling ecodesign criteria		X						

Policy area	Case Study Group	URN	Indicator name	Key methodologies							
				Survey	Desk-based research	Literature review	Data analysis	Stakeholder engagement/interviews	Material Flow Analysis	Web-scraping tool	Narrative approaches
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person	X							
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost		X						
	H1	H3	Share of household income spent on service models rather than related ownership of goods	X							
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials	X							
	H1	H5	Items of clothing repaired by households per year	X							
	H3	H6	Reuse of consumer goods via reuse centres					X			
	H1	H7	Household spending on maintenance and repair	X							
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households	X							
	H2	H9	Water footprint of private consumption		X						
	H1	H10	Unused household goods	X							
Packaging	Pa1	Pa1	A sustainable brand index for packaging products and manufacturers	X	X						
		Pa2	No. of legislative incentives created to encourage circularity		X			X			
		Pa3	Percentage by weight of packaging POM which has been designed according to circular principles		X			X			
		Pa4	Changes in expenditure through applying circular principles throughout the packaging value chain		X			X			X
		Pa5	Share of take-away meals and drinks provided in reusable packaging	X	X						
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics		X						
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry		X						
		PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU	X	X						
PSS	PSS1	PSS1	Consumer perception of the attractiveness of PSS models	X							
	PSS1	PSS2	Percentage of citizens who have used PSS models	X							
	PSS2	PSS3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased		X						
	PSS3	PSS4	EU project funding allocated to research and development projects on PSS		X						
	PSS2	PSS5	No. of companies offering PSS-solutions within the electronics and ICT sector		X			X			
	PSS2	PSS6	The percentage of public procurement contracts for electronics and ICT that incorporate PSS models		X			X			
	PSS3	PSS7	No. of public financial incentives directed at PSS providers/models		X						
	PSS3	PSS8	No. of countries that have included PSS in their national CE strategies		X						

Policy area	Case Study Group	URN	Indicator name	Key methodologies							
				Survey	Desk-based research	Literature review	Data analysis	Stakeholder engagement/interviews	Material Flow Analysis	Web-scraping tool	Narrative approaches
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person	X							
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost		X						
Textiles	T1	T1	Number of jobs in the textile repair sector		X			X			
		T2	Number of jobs in the textile recycling sector		X			X			
		T3	Total amount of separately collected textiles		X			X			
		T4	Total volume of secondary raw material output from textile recycling		X			X			
		T5	Share of recycled content in textile products put on market by EU brands and retailers		X			X			
Food, water & nutrients	FWN1	FWN1	Presence of guidance (labelling) on climate impact of food product categories		X			X			
		FWN2	Presence of requirements for organic products in public-procurement of food		X			X		X	
		FWN3	Sustainable Calorie intake per capita gap of animal-based food consumption				X				
Construction & buildings	CB1	CB1	Share of building products with EPDs with circular properties		X			X			
		CB2	Number of building projects certified by schemes with circularity requirements		X			X			
		CB3	Utilisation rate of existing building stock		X						

Table 6: Summary of testing methodologies

2.4.1. Citizen surveys

Citizen surveys provided a valuable tool to quantify the sentiment, perception and behavioural factors of selected indicators. They allowed for snapshot analysis of current values for the indicator in question to be made and, when developed into a systematic and consistent programme, transition progress over time. They also provided a useful complement to hard statistical analysis and allowed for the development of a much deeper understanding of many of the social and behavioural aspects which current CE monitoring frameworks simply do not capture.

In order to maximise efficiencies, the indicators were grouped into four separate surveys based on their commonalities. France was chosen as geographical region for the 'Household goods, clothing & furniture' survey as the French Government have implemented a number of policy initiatives that encourage repair (such as offering citizens a 'repair bonus' to mend their clothes and a repair index on electronic devices). The Netherlands was selected for the 'Sustainable brands and reusable food packaging' survey, due to its high citizen participation on climate and sustainability related topics. Germany was selected for both the 'Vehicles and Electronics & ICT' and 'Product Service Systems' survey, due to the high number of cities which could be captured within the sample. The survey groupings are detailed in Table 7.

Name of survey		Geography	Sample size	Relevant indicators	
1	**Household goods, clothing & furniture**	France	1,000	H5	Items of clothing repaired by households per year
				H7	Household spending on maintenance and repair, across priority product and material streams
				H10	Unused household goods, across priority products and material streams
				H8	Comparison of life of household furniture as estimated by manufacturers and the actual use time by households
2	**Sustainable brands and reusable food packaging**	Netherlands	2,000	Pa1	A sustainable brand index for consumer packaged goods
				Pa5	Share of take-away meals and drinks provided in reusable packaging
3	**Vehicles and Electronics & ICT**	Germany	2,000	BV1	Car-sharing frequency rates
				H1	Use of private vehicles, as a percentage of kilometres travelled per person
				EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products
4	**Product Service Systems**	Germany	2,000	PSS2	Percentage of citizens who have used PSS models
				PSS1	Consumer perception of the attractiveness of PSS models

Name of survey		Geography	Sample size	Relevant indicators	
				H3	Share of household income spent on service models rather than related ownership of goods
				H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials

Table 7: Overview of citizen survey indicators

The data informing this analysis, and the conclusions drawn from it, were gathered in a nationally representative survey of citizens in France, the Netherlands and Germany, conducted by YouGov Plc for the sole purpose of this project. Once the surveys were developed and disseminated, the results were returned in 5 – 7 days.

2.4.2. Material Flow Analysis

Five indicators underwent some level of Material Flow Analysis (MFA), as the most appropriate approach to develop an understanding of the aspects they look to measure. These are listed in Table 8.

Indicator	
B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector
B2	Share of local forestry by-products going to energy generation
B3	Share of organic fertiliser used in agricultural practices
B8	Share of biological waste treated with anaerobic digestion (AD)
BV2	Virgin vs. recycled plastic raw material used in the production of vehicles

Table 8: Overview of MFA indicators

For B1, an MFA-style analysis was conducted on national economic and employment datasets as a proxy for the initially desired direct data at a regional granularity level. Data for indicators B2, B3 and B8 was collected through a combination of desk-based research and stakeholder engagement with relevant national or local government agencies and statistical offices, industry bodies and individual companies. Where data was not readily available at regional level, proxy data was again used by determining national averages and applying them to the relevant calculations.

Indicator BV2 encountered direct data challenges, with individual automotive manufacturers reluctant to share required data due to confidentiality concerns, and any publicly available data being limited and inconsistent in its detail and formatting. Therefore, anonymised existing data available to the research team was used, from a recent recycled content research and mapping exercise carried out independently for a European automotive manufacturer. This was then augmented with additional insight from two external interviews.

2.4.3. Web-scraping

Web-scraping is a digital method to extract data from online platforms/databases. The process involves “fetching the data” where a webpage is downloaded, before data is “extracted”, thereby allowing the webpage’s contents to be searched, reformatted, and analysed in a relatively efficient manner. It can be an efficient, method for data collection, applying an element of automation to the

identification and selection process, freeing up time for the subsequent detailed analysis. Four indicators in this study, shown in Table 9, utilised a web-scraping approach to data collection, as it was deemed they had potential provide insight into its value and effectiveness as an indicator assessment method.

Indicator	
CR1	Share of publicly purchased products following EU Green Public Procurement (GPP) criteria
CR4	Share of public procurement notices that stipulate specific CE aspects
CR8	Budget of public procurement notices that stipulate specific CE aspects
FWN2	Presence of requirements for organic products in public procurement of food

Table 9: Overview of web-scraping indicators

In each case, web-scraping was used to extract and download procurement data from public procurement platforms/databases associated with each area of study and assess the presence of predetermined key terms.

The process involves developing the tool with a series of programming scripts, and was conducted in five stages:

Step 1: Defining key **terms** related to circular procurement

Selecting the key words for the tool to search for in the target procurement platforms and databases, ranging from broad concepts such as ‘resource efficiency’ and the R-strategy terms, to more detailed specific requirements such as ‘design for disassembly’ or ‘product life extension’.

Step 2: Scraping procurement website

The web-scraping process itself. Initiated by opening the target procurement website and navigating through it to extract and download procurement notices based on the predefined codes and criteria. This step downloaded all relevant data associated with notices of interest for each indicator, including publication date and value.

Step 3: Downloading relevant PDF documents.

Following the initial scraping, all the PDF documents available associated with each non-excluded procurement notice were downloaded. This included downloading the listed technical specifications, justifications, contracts and evidence associated with each identified procurement notice.

Step 4: Performing an automated PDF analysis.

Another script analysed the downloaded PDF documents, searching for the key terms, extracting specific information to enable the quantification of results, such as the frequency of key term use, and their specific location in supporting documentation, which enabled further quality assurance processes.

Step 5: Fuzzy matching and quality assurance.

Fuzzy matching is a web-scraping technique to review strings of text for similarities, identifying similar, but not identical elements in data, applied where exact matches between data fields were not feasible due to variations in naming conventions or typos.

2.4.4. Narrative approaches (where data not available)

During the testing phase, it became evident that the data required to deliver a full testing programme for some indicators either did not exist or was not readily available. Where the data was not currently available, a 'narrative' approach was conducted which involved the team providing a thorough investigation of the relevant indicator, provided guidance on potential steps to gather data, and what methodology/approach needs to be adopted once it is received. Table 10 shows these indicators, with further detail beneath.

Indicator	
B7	Effects on local communities of a circular bioeconomy
BV4	Ease of Disassembly Metric (eDIM)
Pa4	Changes in expenditure through applying the circular principle of 'reuse' in manufacturing businesses

Table 10: Overview of narrative indicators

B7 - Effects on local communities of a circular bioeconomy

The 'narrative' approach conducted to test this indicator was a combination of literature review and desk-based search. This methodological approach was chosen as there is currently not one indicator or harmonised methodology that can assess whether a project is as sustainable as possible and that new social harms/impacts are not inadvertently created.

A preliminary literature review included reviewing academic papers and grey literature to assess which existing social impact assessment methodology would be best to test this indicator (Social Return On Investment, Social Impact Assessments, or Social Life Cycle Assessment (SLCA)).

From this initial work, the SLCA methodology was found to be most suited for the purpose of this project and further literature review was conducted to set the EU context in relation to the selected methodology, provide an overview of the SLCA methodology and assess the advantages and limitations of using the SLCA methodology as an indicator to evaluate the social impacts of bioeconomy projects on the local community.

Finally, desk-based search identified a case study which was used to illustrate how the SLCA methodology was applied in a similar context and how this related to this project.

BV4 - Ease of Disassembly Metric (eDIM)

The 'narrative' approach to test this indicator was a literature review of academic research journals to identify existing conceptual frameworks that could potentially be applied to test this indicator. This methodological approach was chosen as no evidence from initial desk-based search of the metric being applied to the automotive sector before could be found.

From this task, a novel calculation approach used in the electronics sector was selected as it had the potential to be reused in the automotive sector. Further research was then conducted to outline this theoretical case study's testing and measuring process, identifying potential challenges and drawing lessons learnt from the literature review and process designing.

Pa4 - Changes in expenditure through applying the circular principle of 'reuse' in manufacturing businesses.

The 'narrative' approach to test this indicator was the outlining of the methodology that was thought to be the most suited to test this indicator. This methodological approach was chosen as the suggested testing methodology would have required potential funding for participants to provide

the required data and an extended period of monitoring which was beyond the timeframe of this project's testing period.

The methodology suggested was developed based on the team's experience in collecting data, engaging with stakeholders and conducting MFA, which were the key tasks outlined to conduct the testing.

2.5. Task 6 – Target setting and data collection planning

The final stage of the project (task 6) was focused on reviewing the outputs from all previous tasks delivered and outlining recommendations to ensure the successful implementation of those indicators listed for further development.

Task 6 was broken down into three distinct sub-tasks, which were as follows:

- Review existing CE targets.
- Target Proposal.
- Data collection planning.

2.5.1. Review existing CE targets.

This sub-task included a thorough desktop review of existing CE targets identified through tasks 1 and 2, followed by a quantitative gap analysis.

Before starting the desk-based search, the sources used to conduct task 1 and 2 literature reviews were collated using Microsoft Excel in a tab called "CE targets source list". The following information was gathered:

- Title of and link to the source.
- Task related to the source (task 1 or 2).
- Name of the reviewer.
- Whether if the source has been reviewed or not.
- Any comments (e.g. reason why the source was not reviewed).

Task 4 outputs were not reviewed at this stage as it was thought that the knowledge accrued during that task was forming the basis of task 5 outputs, which would be reviewed at a later stage to correlate the targets identified to the indicators tested.

In the same document another tab was created titled "CE targets log" to log the CE targets found in the sources reviewed. The information recorded included the following:

- Targets identified during task 1 and 2 literature reviews.
- Updated targets (if relevant).
- Link to the source.
- Subtheme(s).
- R-themes and additional note related to the R-themes.
- Strengths and weaknesses of the targets, based on experts' opinion.
- Stakeholders concerned by the targets (e.g. businesses, regulators, consumers).
- Methodology to measure the targets (if available).

Following this, the desk-based search was conducted, reviewing each source and listing any CE targets identified. Task 1 already listed the targets for the sources reviewed, therefore, the desk-based search only consisted in identifying whether if the targets had changed between when tasks 1 and 6 were conducted. This was done by identifying the latest version of the source. If the source was not updated since task 1, then it was assumed that targets were not updated. If the source was updated, then the reviewer conducted a high-level review of the document to identify any changes to the targets mentioned. Sources pulled from task 2 were fully reviewed to identify CE targets as this was not part of the work originally conducted. Once a target was identified, the information required was then recorded.

This exercise was used for identifying CE themes to be prioritised for setting new targets for the indicators proposed, and to determine how useful some of the proposed indicators were to fill the detected gaps.

2.5.2. Target proposal

A review of existing appropriate methodologies for developing realistic but challenging targets was conducted. Identified good practice methods were then synthesised, along with key elements of the delivery method of this study, into a proposed combined methodology for the setting of targets for indicators emerging from the study as priority recommendations.

Targets suggested follow the methodology discussed in greater detail in Section 5.3.2, where possible. In summary, the suggested steps are:

- Step 1: Gather and assess existing data.
- Step 2: Identify initiatives and prioritise.
- Step 3: Test and validate with stakeholders.
- Step 4: Define effective SMART target.
- Step 5: Execute strategies and report on outcome.

However, due to the very nature of this project's ambition to investigate innovative indicators, it was not always possible to fully define targets where knowledge, data or definition gaps were revealed in the course of the investigations. The recommendations in the 19 case study documents lay out the action needed to progress the indicators further to the point of being able to set realistic and sensible targets.

2.5.3. Data Collection Plan

This was the development of a plan for how and where to collect the relevant data to measure progress towards proposed targets.

It drew from, and built upon, discussion in the individual case study documents and included, an assessment of the availability and quality of data, defining the frequency for the collection data and identifying the most suitable bodies to take responsibility for monitoring of each of the respective targets.

3. Policy Framework

The full results of task 1 are presented in the Policy Framework report, provided as separate file online[14], and are summarised at high-level below.

3.1. Policy Findings

Objectives at the EU level to enhance the CE transition have been identified across all policy areas investigated as part of this exercise. However, not all policy areas yet have specific targets developed to achieve these objectives and enable the CE transition.

Those policy areas that have developed specific targets mainly focus on the end of value chains and the lifecycle of products rather than the conception or production phase. Targets on the recovery and recycling of resources and materials are therefore the most common across all policy areas and sub-areas, while those related to increasing circular conception and design of products are limited to some specific value chains such as packaging and plastics, which include targets on minimum recycled materials rates in new products.

Policy areas can be classified by their target setting across two subsets:

- **Policy areas with multiple EU targets** which include packaging, plastics, electronics and ICT, batteries and vehicles, food, water and nutrients, cities and regions' waste. Targets for these areas usually stem from one specific Regulation or Directive for a particular policy area. Some areas (e.g. plastic and food, water, and nutrients areas) have targets distributed across multiple Strategies, Regulations and/or Directives. Construction and buildings, bioeconomy (biobased plastics) and households as consumers are also areas with multiple targets, but these are either limited to specific sub-areas (e.g. polymer properties for biobased plastics for the bioeconomy area, plastic and food consumption for households as consumers) or in the process to be established (e.g. on whole-life carbon for construction and buildings).
- **Policy areas with no established EU targets**, which include bioeconomy (biobased fertilisers and proteins), textiles and product service systems. For these areas, no specific and quantitative targets are identified and there is currently limited prospect of seeing targets included through EU legislation in the near future. This assessment is based on the finding that no existing legislation with specific targets relevant for the area has been identified and that no other existing relevant proposal for legislation has been put forward at this stage.

[14] https://www.ricardo.com/ce-indicators

Table 11 summarises these findings:

Policy Area or Sub-Area	EU CE targets position
Households	Targets set across multiple instruments.
Cities and Regions	Policy area specific targets set.
Bioeconomy (biobased fertilisers and proteins)	No established targets.
Bioeconomy (biobased plastics)	Targets set across multiple instruments.
Product Service Systems	No established targets.
Food, water and nutrients	Policy area specific targets set.
Batteries and vehicles	Policy area specific targets set.
Electronics and ICT	Policy area specific targets set.
Construction and buildings	Policy area specific targets set.
Plastics	Policy area specific targets set.
Packaging	Policy area specific targets set.
Textiles	No established targets.

Table 11: Policy area target summary

3.2. Findings on funding schemes

While there is no single funding scheme at the EU level which exclusively targets CE, some EU funding programmes target specific areas relevant for CE. For example, through dedicated calls for proposals, setting overarching objectives or indirectly facilitating circular transition by supporting green and sustainable initiatives. These finding schemes are summarised in Table 17 of the task 1 report.

***National* funding schemes relevant to the CE were found to be relatively uncommon, though national funds are largely backed by EU funding.** Several Member States provide research grants to support green and circular innovation. These grants may be targeted to businesses, universities, or broad consortia of the private and public sectors. The task 1 report includes (in its Section 3.4.1) further detail on the example of six Member States (Austria, France, Germany, Italy, Spain, and Poland) that have implemented the NextGenerationEU Recovery and Resilience Facility to support green and circular innovation.

4. Indicator case study summaries

4.1. Coverage

The case study reports resulting from the testing phase for each of the 60 shortlisted indicators are available as Appendix 7.3. provided alongside this report. Table 12 below shows how the indicators studied in task 5 map on to the categorisations of level of implementation, facets of CE and the various R-Strategies. Please note that one indicator can cover multiple level of implementation, facets of CE and R-Strategies.

The most common level of implementation is 'Regional/Cities' with a coverage of 34%, followed by 'National' (21%), 'Companies' and 'Household' (15% each) and EU (14%). In terms of facets of CE, the 'Current level of circularity' and 'Transition/progress over time' are similarly represented (respectively 45% and 55%). The 'Impact – Environmental' is the most represented impact with 45%, followed by 'Impact – Economic' with 31% and 'Impact – Social' with 23%.

The top three R-Strategies covered by the shortlisted indicators are 'Rethink' (16%), 'Reuse' (15%) and 'Reduce' (13%). The R-Strategies that are less represented are 'Other' (4%), 'Recover' (5%) and 'Refuse', 'Remanufacture' and 'Repurpose' (6% each). This high relative proportion of R-Strategies at the top-end of the list is reflective of the study's ambition to investigate innovative indicators of higher impact or value-retention circularity activities, in an effort to rebalance the traditional focus on understanding of progress in recovery and recycling rates.

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector			x	x			x	x		x				x	x	x	x	x	x		
	B2	B2	Share of local forestry by-products going to energy generation			x	x		x			x											x	
	B2	B3	Share of organic fertiliser used in agricultural practices			x			x	x		x				x									
	B1	B4	Number of products with the EU Ecolabel that are bio-based	x	x				x	x	x	x	x												x
	B1	B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activity undertaken			x	x		x	x			x												x
	B1	B6	Cost savings through industrial symbioses using bio-based material			x	x		x	x	x	x			x							x	x	x	

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
	B3	B7	Effects on local communities of a circular bioeconomy			x	x	x	x		x	x	x											x
	B2	B8	Share of biological waste treated with AD			x	x			x	x	x											x	
Batteries & vehicles	BV1	BV1	Car-sharing frequency rates			x			x		x	x	x		x									
		BV2	Virgin vs. recycled plastic raw material used in the production of vehicles				x		x			x				x						x		
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry		x					x		x					x							
		BV4	Ease of Disassembly Metric (eDIM)				x		x		x	x			x		x	x	x	x	x			
Cities & regions	CR1	CR1	Share of publicly purchased products following EU GPP criteria			x				x	x	x			x	x	x	x	x					
	CR1	CR4	Share of public procurement notices that			x			x	x	x	x			x	x	x	x	x	x	x	x		

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
			stipulate specific CE aspects																					
	CR2	CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems			x	x		x	x	x				x		x					x	x	
	CR3	CR7	Number of city resources implementing circular transition agendas			x				x		x	x											x
	CR1	CR8	Budget of public procurement notices that stipulate specific CE aspects			x					x	x			x	x	x	x	x					
	CR3	CR9	Collaborative spaces equipped with material and equipment to encourage repair			x			x	x		x	x				x	x							
	CR2	CR10	Number of regional development agencies providing CE programmes			x			x			x			x										
Electronics & ICT	EIC T1	EIC T1	Percentage of citizens opting for sustainable alternatives instead of			x				x			x				x	x	x	x				

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
			new purchases for Electronic or ICT products																					
		EIC T2	Real recycling rate of electronic and ICT equipment		x				x			x										x		
		EIC T3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models			x			x		x	x			x	x	x	x	x	x				
		EIC T5	Share of consumer electronics fulfilling ecodesign criteria		x		x				x			x	x	x	x	x			x			
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person			x		x	x	x		x	x											x
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost					x	x			x		x	x	x	x	x	x	x	x	x	x	

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
	H1	H3	Share of household income spent on service models rather than related ownership of goods			x		x	x		x		x		x		x							
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials			x		x	x	x	x	x	x		x										
	H1	H5	Items of clothing repaired by households per year			x		x		x		x							x						
	H3	H6	Reuse of consumer goods via reuse centres		x			x	x			x	x				x								
	H1	H7	Household spending on maintenance and repair, across priority material streams			x		x		x	x	x							x	x					
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households	x				x		x	x	x		x		x									

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
	H2	H9	Water footprint of private consumption, at national level					x	x	x		x		x	x	x	x	x	x	x	x	x	x	
	H1	H10	Unused household goods, across priority products and material streams			x		x		x		x	x									x		
Packaging	Pa1	Pa1	A sustainable brand index for consumer packaged goods			x				x			x			x						x		
		Pa2	Number of legislative incentives created to encourage circularity in the European packaging industry	x	x					x		x		x										
		Pa3	Percentage by weight of packaging POM designed by circular principles		x		x		x			x			x	x	x	x	x	x	x	x		
		Pa4	Changes in expenditure through applying the circular principle of ‘reuse’ in manufacturing businesses		x		x		x	x	x			x	x	x	x	x	x	x	x	x	x	

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
		Pa5	Share of take-away meals and drinks provided in reusable packaging		x	x		x			x	x	x	x	x	x	x							
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics		x					x		x	x											x
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry			x				x		x												x
		PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU			x			x		x	x			x		x					x		
PSS	PSS 1	PSS 1	Consumer perception of the attractiveness of PSS models		x	x		x		x			x		x									
	PSS 1	PSS 2	Percentage of citizens who have used PSS models		x	x		x	x	x			x				x	x	x	x				

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
	PSS 2	PSS 3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased		x				x		x				x									
	PSS 3	PSS 4	EU project funding allocated to research and development projects on PSS	x						x	x				x	x	x							
	PSS 2	PSS 5	Number of companies offering PSS-solutions within the electronics and ICT sector		x		x		x	x	x	x			x	x	x							
	PSS 2	PSS 6	The number of public procurement contracts for electronics and ICT that incorporate PSS models			x			x	x	x	x			x	x	x							
	PSS 3	PSS 7	Number of public financial incentives directed at PSS providers/models		x				x	x	x				x	x	x							
	PSS 3	PSS 8	Number of countries that have included PSS in their national CE strategies		x				x	x		x			x	x	x							

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
Textiles	T1	T1	Number of jobs in the textile repair sector	x	x					x	x		x					x						
		T2	Number of jobs in the textile recycling sector	x						x	x		x									x		
		T3	Total amount of separately collected textiles	x	x					x		x										x		
		T4	Total volume of secondary raw material output from textile recycling	x						x		x										x		
		T5	Share of recycled content in textile products put on market by EU brands and retailers	x					x	x		x										x		
Food, water & nutrients	FW N1	FW N1	Presence of guidance (labelling) on climate impact of food product categories		x		x				x	x	x	x	x	x								
		FW N2	Presence of requirements for organic products in public-procurement of food			x			x	x		x	x			x								

Policy area	Case Study Group	URN	Indicator name	LEVEL OF IMPLEMENTATION					FACETS OF CE					R-STRATEGIES										
				EU	National	Regional/Cities	Companies	Household	Current level of circularity	Transition/progress over time	Impact - Economic	Impact - Environmental	Impact - Social	Refuse	Rethink	Reduce	Reuse	Repair	Refurbish	Remanufacture	Repurpose	Recycle, downcycle	Recover	Other
		FW N3	Sustainable Calorie intake per capita gap of animal-based food consumption	x						x	x	x		x	x									
Construction & buildings	CB1	CB1	Share of building products with EPDs with circular properties	x					x	x	x	x					x	x	x	x	x	x	x	
		CB2	Number of building projects certified by schemes with circularity requirements	x								x				x								
		CB3	Utilisation rate of existing building stock	x							x	x	x	x											
TOTAL				**13**	**19**	**31**	**14**	**14**	**33**	**40**	**31**	**45**	**23**	**10**	**27**	**22**	**26**	**18**	**14**	**11**	**10**	**18**	**8**	**7**

Table 12: Coverage mapping of shortlisted indicators.

4.2. Interaction with the CEMF

The transition towards a CE is a complex, multifaceted endeavour requiring effective monitoring and evaluation frameworks to track progress across diverse sectors. This section considers how the indicators developed in this project can complement and enhance the existing Circular Economy Monitoring Framework (CEMF)[15]. By doing so, the aim is to ensure comprehensive coverage of critical themes related to sustainability and circularity, including cities and regions, households, the bioeconomy, priority products and materials and PSS.

4.2.1. Understanding the CEMF

The CEMF serves as a comprehensive framework designed to facilitate the assessment of circular economy initiatives across the EU. By providing a structured approach to monitoring circularity, the CEMF aims to support EU Member States in reporting their progress towards circular economy objectives, enhancing transparency and accountability. The CEMF consists of a set of indicators that track various aspects of circularity, including resource efficiency, waste management and material recovery.

The framework encompasses several thematic areas, each contributing to a holistic understanding of circular economy performance. These areas include:

- **Resource productivity**: This focuses on the efficiency with which resources are used in the economy, highlighting the importance of maximising the value derived from materials while minimising waste.
- **Waste generation and management**: This aspect assesses the total waste generated per capita, recycling rates and end-of-life (EOL) treatment of waste materials, essential for evaluating progress in waste reduction and resource recovery.
- **Consumption footprint**: This indicator gauges the overall environmental impact of consumption patterns, emphasising the need for sustainable production and consumption practices.

While the CEMF provides a solid foundation for monitoring circularity at the EU level, the indicators developed in this project add significant value by offering more granular insights into specific practices and behaviours contributing to circularity.

4.2.2. Complementing the CEMF with additional indicators

The indicators identified in this project are designed to align closely with the objectives of the CEMF while also providing unique insights that are not fully captured by existing metrics. By integrating these indicators into the CEMF framework, the overall capacity to monitor and evaluate the transition to a circular economy effectively is enhanced.

Batteries and vehicles

The CEMF currently offers limited indicators relevant to the automotive and batteries sectors. While it monitors metrics like circular material use and end-of-life recycling input rates, there is a significant gap regarding sector-specific indicators for automotive batteries and vehicles. This project's developed indicators address these gaps by focusing on critical aspects of circularity not captured by the CEMF. For instance, the "Car sharing frequency" indicator measures the impact of shared mobility on reducing the need for new vehicle production. Other indicators assess the use of recycled plastics in vehicles, automotive battery reuse and the ease of disassembly for vehicles, which can enhance recycling efficiency. By integrating these indicators, the project aims to provide a more comprehensive understanding of how the automotive sector can contribute to

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

circular economy objectives, particularly the R-strategies of Refuse, Rethink and Reuse. This alignment will help policymakers track progress and implement effective strategies for reducing resource consumption and waste in the automotive industry.

Food, water and nutrients

The CEMF contains indicators that support circularity in food production, such as GHG emissions from production activities and food waste generation. These metrics can inform EU targets aimed at reducing food waste while also highlighting the environmental impacts of food consumption. However, existing CEMF indicators do not sufficiently capture the nuances of food production, particularly regarding sustainable procurement practices. The indicators in this project aim to enhance the existing framework by providing more granular insights into food sustainability. They could complement indicators on GHG emissions by focusing on climate labelling and can improve the understanding of public procurement by examining organic food requirements. Additionally, the food waste generation indicator is strengthened by metrics assessing sustainable calorie intake, allowing for a deeper understanding of consumption patterns. This comprehensive approach enables a clearer assessment of circularity in the food sector, supporting the R-strategies of Refuse and Reduce while also providing insights into the broader environmental impacts of food production and consumption. By aligning these tested indicators with CEMF, the project contributes to a more integrated understanding of sustainability within the food system.

Cities and Regions

The CEMF plays a critical role in tracking circular economy objectives but lacks the ability to collect sub-national data, which limits insights into local progress towards these targets. Existing metrics monitor material consumption, investments and job creation at a macro level, but they do not effectively assess the influence of local policies or specific R-strategies. This project seeks to bridge these gaps by developing indicators applicable at the city and regional level that directly support the CEMF's objectives. For instance, indicators quantifying the share and value of public procurement notices with circular economy criteria can help local administrations monitor the integration of circularity into procurement practices. Additionally, testing indicators related to industrial symbiosis and capacity-building programmes provides data that enhance the CEMF's insights into local circular economy activities. By focusing on the effectiveness of local policies in promoting circularity, these indicators enable cities and regions to illustrate their contributions to circular economy transitions.

Households

The CEMF captures household circularity through indicators that quantify food waste, recycling rates and municipal waste generation. However, limitations exist in distinguishing household waste from commercial sources, which can lead to overestimations in waste metrics. Moreover, the CEMF does not account for the utilisation rates of products, reuse behaviours or perceptions of circular products among households. This project addresses these gaps by considering indicators that will provide deeper insights into household behaviours and their contributions to circularity. For example, metrics tracking the number of items repaired, household spending on maintenance and the prevalence of unused goods can illuminate patterns of consumption and waste. These indicators indirectly support macro-level CEMF indicators such as material footprint and consumption footprint. Overall, these tested indicators will improve understanding of household contributions to circularity, facilitating more effective strategies for promoting sustainable practices within the home.

Packaging

The CEMF employs various indicators to measure packaging waste generation and recycling rates. However, these indicators face limitations, including the lack of differentiation between household and commercial waste streams, hindering targeted interventions. Additionally, while overall packaging waste is monitored, the CEMF does not capture the recyclability of specific materials, such as different types of plastics. This project's indicators aim to address these gaps by focusing on packaging designed for reuse and tracking the implementation of reuse systems. For example, measuring the volume of reusable packaging placed on the market can provide

insights into legislative efforts promoting circularity. By introducing indicators that capture the entire lifecycle of packaging, from production to reuse, the project supports the CEMF's goals of reducing waste and promoting sustainable packaging practices. This comprehensive approach aligns with R-strategies like rethinking packaging design and encouraging reuse, thus advancing the EU's circular economy objectives. Overall, these tested indicators enhance the understanding of packaging circularity and inform more effective policy measures.

Bioeconomy

The CEMF includes various indicators relevant to the bioeconomy, yet it requires refinement to capture the specific dynamics within this sector. Current indicators provide a general understanding of resource productivity and circular material use but lack granularity regarding bio-based materials. The project identifies the need for tailored metrics to monitor GHG emissions from bio-based production and the specific circular material use rate for bio-based products. By developing these indicators, the CEMF can better support targeted policy initiatives that promote sustainability in the bioeconomy. Enhanced metrics will enable a deeper understanding of how resources are utilized across different sectors, facilitating effective policy decisions. Additionally, incorporating these tailored indicators will provide insights into the environmental impacts of bioeconomic activities, further informing strategies for sustainable management of biological resources. Overall, adapting the CEMF to include specific bioeconomy indicators will strengthen its role in promoting circularity and sustainability within this critical sector.

Electronics and ICT

The CEMF facilitates circularity in the Electronics & ICT sector by tracking resource efficiency, waste generation and recycling rates. However, it currently lacks robust metrics for higher-level R-strategies and comprehensive lifecycle assessments, particularly regarding the reuse of electronic products and their components. Gaps also exist in measuring the efficiency of recycling processes, especially for critical raw materials. This project has developed specific indicators to address these deficiencies, including metrics on consumer preferences for refurbished electronics, the real recycling rate of ICT equipment and public sector purchases of second-hand devices. By focusing on these areas, the project strengthens the CEMF's ability to monitor circularity effectively. Furthermore, indicators assessing ecodesign compliance promote product durability and repairability, ensuring a longer lifecycle and improved end-of-life outcomes. These enhanced metrics align with the EU's Circular Economy Action Plan and provide policymakers with the necessary tools to drive innovation and reduce environmental impacts in the electronics sector.

PSS

The CEMF includes various indicators to evaluate resource efficiency, but these metrics do not adequately capture the nuances of PSS models. Current indicators focus on singular elements of the economy rather than the lifecycle of service-oriented models. This project addresses this limitation by testing indicators that consider the presence of policies supporting PSS, the market size of PSS models and consumer perceptions. For example, examining the impact of shared mobility services can provide insights into reducing private car use, thereby advancing circularity. Additionally, adapting existing CEMF indicators to incorporate data on PSS can improve the measurement of circular business models.

Textiles

The CEMF currently lacks specific indicators for the textile sector, despite including several applicable metrics. Key indicators such as waste generation monitor overall waste per capita, but textile waste has not been systematically tracked. The mandatory separate collection of textile waste, set to begin in 2025, highlights the need for improved monitoring in this area. Additionally, while the CEMF includes end-of-life recycling input rates for various materials, there are no metrics specifically assessing the share of recycled content in textile products available on the EU market.

The CEMF also tracks employment in circular economy sectors, but the data lacks granularity regarding specific activities related to textiles, such as recycling, repair and reuse. Crucially, there are no indicators for value retention strategies, such as increased repair and reuse, which are

essential for improving textile circularity. This project addresses these gaps by exploring potential indicators, such as tracking jobs in textile repair as a proxy for repair activity. However, additional metrics focusing on reuse and extended product lifetimes are necessary to capture the full scope of textile circularity strategies comprehensively.

4.2.3. Summary of indicator interactions with the CEMF

Table 13 summarises the identification of potential interactions between the shortlisted indicators and the CEMF. The analysis reveals significant insights regarding how project indicators align with existing CEMF metrics:

- Consumption Footprint: The indicators show a significant link to the 'Consumption footprint' category, accounting for 8% of the connections. This highlights the relevance of understanding consumer behaviour in achieving circularity.
- Resource Productivity: Indicators related to 'Resource productivity', 'Total waste generated per capita', 'Circular material use rate' and ‘EOL recycling input rates' each comprise 6% of the interactions. These metrics are essential for tracking the efficiency of resource use and waste management practices across the EU.
- Limited Links: Conversely, indicators with the least connection to the shortlisted indicators include 'Green public procurement', 'Food waste', 'Generation of packaging waste per capita', 'Generation of plastic packaging waste per capita', 'Recycling rate of overall packaging' and 'Recycling rate of plastic packaging', each at 1%. This indicates potential gaps in current monitoring efforts that the project can address.

On average, the shortlisted indicators link directly or indirectly to 11 CEMF indicators, underscoring their relevance in supporting existing monitoring frameworks. This integration provides a comprehensive picture of circularity efforts, enabling policymakers to make informed decisions.

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector																			x	x	x	x	x				x
	B2	B2	Share of local forestry by-products going to energy generation	x	x		x	x					x					x	x	x	x	x	x	x	x		x	x	x	x
	B2	B3	Share of organic fertiliser used in agricultural practices					x					x					x	x	x		x					x	x	x	x
	B1	B4	Number of products with the EU Ecolabel that are bio-based	x														x					x		x	x		x		x
	B1	B5	Level of engagement by companies in developing a bioeconomy,																	x	x	x	x	x	x				x	x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			categorised by the types of activity undertaken																											
	B1	B6	Cost savings through industrial symbioses using bio-based material		x		x	x		x	x	x	x		x			x	x	x		x	x	x	x		x	x	x
	B3	B7	Effects on local communities of a circular bioeconomy																				x	x			x	x		x
	B2	B8	Share of biological waste treated with AD	x	x		x	x	x	x			x	x				x	x	x	x	x	x	x	x		x	x	x	x
Batteries & vehicles	BV 1	BV 1	Car-sharing frequency rates		x													x									x			
		BV 2	Virgin vs. recycled plastic raw material used in the production of vehicles		x													x		x			x	x	x	x	x	x	x	x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
		BV 3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry		x		x										x	x	x	x	x	x				x	x	x	x	x
		BV 4	Ease of Disassembly Metric (eDIM)		x		x										x	x	x	x	x	x	x	x	x	x	x		x	
Cities & regions	CR 1	CR 1	Share of publicly purchased products following EU GPP criteria			x																					x			
	CR 1	CR 4	Share of public procurement notices that stipulate specific CE aspects			x																					x			
	CR 2	CR 6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems	x	x		x	x		x			x					x	x	x	x	x	x	x	x	x	x	x	x	x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
	CR 3	CR 7	Number of city resources implementing circular transition agendas				x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x
	CR 1	CR 8	Budget of public procurement notices that stipulate specific CE aspects			x																					x				
	CR 3	CR 9	Collaborative spaces equipped with material and equipment to encourage repair		x		x		x					x			x	x	x		x	x	x	x	x		x			x
	CR 2	CR 10	Number of regional development agencies providing CE programmes				x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x		x	x	x	x
Electronics & ICT	EI CT 1	EI CT 1	Percentage of citizens opting for sustainable alternatives instead of		x		x		x					x			x	x	x								x			

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			new purchases for Electronic or ICT products																											
		EI CT 2	Real recycling rate of electronic and ICT equipment		x		x		x					x			x	x	x		x						x		x
		EI CT 3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models		x	x	x										x	x	x								x		
		EI CT 5	Share of consumer electronics fulfilling ecodesign criteria															x	x		x		x	x	x	x	x	x		x
Households	H1	H1	Use of private vehicles, as a percentage of		x																						x			

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			kilometres travelled per person																											
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost	x																							x			x
	H1	H3	Share of household income spent on service models rather than related ownership of goods		x		x		x					x			x	x	x								x			
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials				x		x					x			x	x	x								x			

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
	H1	H5	Items of clothing repaired by households per year		x		x	x	x					x				x	x		x					x				
	H3	H6	Reuse of consumer goods via reuse centres		x		x		x					x			x	x	x		x	x		x	x		x			
	H1	H7	Household spending on maintenance and repair, across priority material streams		x		x		x					x			x	x	x		x			x	x		x			
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households		x		x	x	x					x				x	x		x					x	x			

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
	H2	H9	Water footprint of private consumption, at national level	x	x																					x			x
	H1	H10	Unused household goods, across priority products and material streams		x		x		x					x			x	x	x		x					x			
Packaging	Pa1	Pa1	A sustainable brand index for consumer packaged goods																				x	x	x	x	x	x		
		Pa2	Number of legislative incentives created to encourage circularity in the European packaging industry		x		x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x
		Pa3	Percentage by weight of packaging POM designed by circular principles		x		x	x	x		x	x	x	x	x	x		x	x	x	x		x	x	x	x	x	x	x	x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
		Pa 4	Changes in expenditure through applying the circular principle of ‘reuse’ in manufacturing businesses		x		x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
		Pa 5	Share of take-away meals and drinks provided in reusable packaging		x		x	x	x	x	x	x	x	x	x			x	x		x		x	x	x		x			x
Plastics	PL 1	PL 1	Number of pilot/demonstration projects on circular production and treatment of plastics	x	x							x				x		x	x	x	x	x	x	x	x	x	x	x	x	x
		PL 2	Number of legislative incentives created to encourage circularity in the plastics industry	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
		PL 3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU		x		x	x			x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
PSS	PS S1	PS S1	Consumer perception of the attractiveness of PSS models		x		x	x	x								x	x	x		x					x			
	PS S1	PS S2	Percentage of citizens who have used PSS models		x		x	x	x								x	x	x		x					x			
	PS S2	PS S3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased		x																					x			
	PS S3	PS S4	EU project funding allocated to research		x		x	x	x								x	x	x		x		x	x	x	x	x	x		x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																												
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			and development projects on PSS																													
	PS S2	PS S5	Number of companies offering PSS-solutions within the electronics and ICT sector		x		x		x								x	x	x		x		x	x	x		x	x		x
	PS S2	PS S6	The number of public procurement contracts for electronics and ICT that incorporate PSS models		x	x	x										x	x	x		x						x			
	PS S3	PS S7	Number of public financial incentives directed at PSS providers/models		x		x	x	x								x	x	x		x		x	x	x	x	x	x		x
	PS S3	PS S8	Number of countries that have included		x		x	x	x								x	x	x		x		x	x	x		x	x		x

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			PSS in their national CE strategies																											
Textiles	T1	T1	Number of jobs in the textile repair sector		x		x	x	x				x	x				x	x		x	x	x	x	x			x		x
		T2	Number of jobs in the textile recycling sector		x		x	x	x				x	x				x	x		x	x	x	x	x			x		x
		T3	Total amount of separately collected textiles		x		x	x	x				x	x				x	x		x	x	x	x	x	x		x		x
		T4	Total volume of secondary raw material output from textile recycling	x	x		x		x					x				x	x		x	x	x	x	x	x		x		x
		T5	Share of recycled content in textile products put on market	x	x															x		x	x	x	x	x	x	x	x	

Policy area	Case study group	URN	Indicator name	CEMF Indicators																										
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
			by EU brands and retailers																											
Food, water & nutrients	FWN1	FWN1	Presence of guidance (labelling) on climate impact of food product categories	x																x	x	x					x	x	x	
		FWN2	Presence of requirements for organic products in public-procurement of food			x																					x	x		
		FWN3	Sustainable Calorie intake per capita gap of animal-based food consumption		x	x				x																	x			x
Construction &	CB1	CB1	Share of building products with EPDs with circular properties																	x	x		x	x	x	x	x	x	x	

Policy area	Case study group	URN	Indicator name	CEMF Indicators																												
				Material footprint	Resource productivity	Green public procurement	Total waste generation per capita	Generation of waste excluding major mineral wastes	Generation of municipal waste per capita	Food waste	Generation of packaging waste per capita	Generation of plastic packaging waste per capita	Recycling rate of all waste excluding major mineral waste	Recycling rate of municipal waste	Recycling rate of overall packaging	Recycling rate of plastic packaging	Recycling rate of WEEE separately collected	Circular material use rate	End-of-life recycling input rates (EOL-RIR), aluminium	Imports from non-EU countries	Exports to non-EU countries	Intra EU trade	Private investments	Persons employed	Gross value added	Patents related to waste management and recycling	Consumption footprint	GHG emissions from production activities	Material import dependency	EU self-sufficiency for raw materials, aluminium
		CB 2	Number of building projects certified by schemes with circularity requirements																				X	X	X		X	X		
		CB 3	Utilisation rate of existing building stock		X		X											X	X								X	X		
TOTAL				11	42	7	37	23	28	8	9	8	16	22	9	5	20	43	40	20	36	24	33	34	34	22	51	34	20	34

Table 13: Shortlisted indicators' relation to CEMF indicators

4.3. Data baselining and gap analysis

During the case study testing period, the levels of data availability and accessibility across each of the indicators was closely recorded, noting successes, challenges and any significant gaps. The impacts and implications of identified data gaps are discussed in detail in the Limitations, and Conclusions, sections of each case study, but in general they have influenced the recommendations made for further development. Each indicator case study concludes with an overall recommendation of whether the indicator should be considered for further development or not, and for those that are, whether minor or significant work is required for realistic progress to be made. Data gaps, and potential mitigation actions such as legislative or technical developments, are a key part of this consideration. This is in conjunction with other aspects such as the relevance and value of the indicator for understanding, and therefore empowering the further facilitation by policy makers and industry players of, progress towards the broad goals of CE in each theme and sub-theme's specific context. For example, where data gaps and challenges are significant, but the indicator is deemed very valuable for these purposes, a recommendation is still made for the indicator to be further developed, with detailed actions steps suggested in the policy and technical recommendation tables.

A summary of the data availability for each of the sub-themes can be found in Table 14 to Table 24 below.

4.3.1. Batteries and vehicles

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
BV1	Car-sharing frequency rates	• Germany.	• Proportion of people taking part in informal car-sharing. • Days per week where a journey to work is shared with at least one other individual. • Vehicle type used for commute to work. • Average number of people also present in shared commute.	• Data on informal car sharing was obtained through YouGov citizen survey so no data gaps found. • Data on formal car sharing not available due to lack of engagement from car sharing schemes, though it is expected to be collected internally.	• Absence of incentives for stakeholders. • Commercial sensitivity.
BV2	Virgin vs. recycled plastic raw material used in the production of vehicles	• EU.	• Estimated weight composition of recycled content of top four plastics used in passenger cars in EU.	• Data unavailable from Tier 1/Tier 2 suppliers but provided contact information for suppliers. • Data unavailable from suppliers due to lack of engagement • Some limited data available from desk-based research.	• Absence of incentives for stakeholders. • Commercial sensitivity. • Legislative and regulatory gaps.
BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry	• The Netherlands.	• Weight of EOL vehicle batteries collected. • Weight of EOL vehicle batteries reused. • Weight of EOL vehicle batteries recycled.	• Data available for case study at national level but could not be broken down into region.	• Specificity/granularity shortfall.
BV4	Ease of disassembly Metric	• EU.	• Time taken to dismantle individual vehicle components.	• No data available as it is not currently collected with no consistent methodology.	• Lack of methodology. • Technical/resource constraints.

Table 14: Summary of data availability for ‘Batteries and vehicles’.

4.3.2. Bioeconomy

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector	• Grand Est, France. • Haute de France, France.	• GDP at country level, regional and company level, overall and related to bioeconomy. • Private sector investment at country level, regional and company level, overall and related to bioeconomy. • Jobs created at country level, regional and company level, overall and related to bioeconomy. • GVA at country level, regional and company level, overall and related to bioeconomy.	• GDP: available at country level and regional % via desk-based research. Unavailable at company level from stakeholder engagement. Available for bioeconomy using assumptions that three categories of activity are related to bioeconomy and excluding all others. • Private sector investment: GFCF used as proxy, available at country level, extrapolated for regional level based on GDP %. Unavailable at company level from stakeholder engagement. Available for bioeconomy using assumptions that three categories of activity are related to bioeconomy and excluding all others. • Jobs created: FTE used as proxy, available at country level, extrapolated for regional level based on GDP %. Unavailable at company level from stakeholder engagement. Available for bioeconomy using assumptions that three categories of activity are related to bioeconomy and excluding all others.	• Absence of incentives for stakeholders. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
				• GVA: available at country level, extrapolated for regional level based on GDP %. Unavailable at company level from stakeholder engagement. Available for bioeconomy using assumptions that three categories of activity are related to bioeconomy and excluding all others.	

B2	Share of local forestry by-products going to energy generation	• Bavaria, Germany.
		• South Savo, Finland.
		• BaySF.
			• Total wood going to energy generation (m^3).
			  ○ Energy wood.
			  ○ Fuelwood/firewood.
			• Total forestry by-products (m^3).
			  ○ Energy wood.
			  ○ Fuelwood/firewood.
			  ○ Industry wood.
			  ○ Unused wood (left on forest floor).
				• Majority of data available with some assumptions required for roundwood and wood left on forest floor due to differences in data collection.	• Methodological inconsistencies.

B3	Share of organic fertilizers used in agricultural practices	• Brandenburg, Germany. • Bavaria, Germany. • Opolskie, Poland.	• Total use of Synthetic fertilisers (tonnes). Total use of organic fertiliser (tonnes). Total area of agricultural land (hectares).	• Majority of data available with some assumptions required for synthetic fertilisers (Germany) and organic fertiliser (Poland). • Proxy data calculated using average annual fertiliser use and Utilised/Organic Agricultural Area.	• Methodological inconsistencies.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
B4	Number of products with the EU Ecolabel that are Bio-based	• Cyprus. • Slovenia. • Ireland. • Norway. • Luxembourg.	• Number of products with the EU Ecolabel. • Number of products which include any bio-based material/ingredient. • Type of bio-based product.	• Number of products with the EU Ecolabel: available but some products could not be traced further for material information. • Number of products which include any bio-based material/ingredient: some available - some products had lack of information to identify whether bio-based or not. • Type of bio-based product: some available - some products had lack of information to identify what type of bio-based material.	• Specificity/granularity shortfall.
B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activities undertaken	• Grand Est, France. • Normandy, France.	• Type of activity undertaken and time conversion for activities. Number of times activity was undertaken over 10 years.	• Type of activity undertaken and time conversion for activities: detailed by project team. • Number of times activity was undertaken over 10 years: unavailable via desk-based research or stakeholder engagement.	• Stakeholder engagement. • Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
B6	Cost savings through industrial symbioses using bio-based material	• Zealand, Denmark. • Grand Est, France. • Kalundborg Symbiosis. • GRID Granollers.	• Cost savings through industrial symbioses using bio-based material. Or: • Cost without/before industrial symbioses using bio-based material. • Cost with/after industrial symbioses using bio-based material.	• No data available due to lack of response from stakeholders, data-sharing authorisation protocols and lack of specific data/resource.	• Stakeholder engagement. • Availability and accessibility issues. • Commercial sensitivity.
B7	Effects on local communities of a circular bioeconomy	• N/A.	• Dependent on SLCA's chosen scope across a range of subcategories, including child labour, fair salary, health and safety, indigenous rights, local employment, education.	• N/A.	• No case studies conducted due to difficulty of data collection and analysis.
B8	Share of biological waste treated with AD	• Berlin, Germany. • Baden-Wurttemberg, Germany. • Saarland, Germany. • Malta, Malta. • Gozo, Malta.	• Total biological waste handled. • Total amount of this waste treated using AD.	German case-studies: • Total biological waste handled available at national level so was allocated to region using previous years' data. • Waste treated using AD available with assumption that all biowaste is treated with AD. • Maltese case studies: Total biological waste handled available via EWC codes (some codes relate to mixed waste so	• Methodological inconsistencies. • Stakeholder engagement. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
		• Company level data.		total biowaste is overestimated). • Waste treated using AD available. Company level data: • Unavailable due to lack of engagement from stakeholders.	

Table 15: Summary of data availability for 'Bioeconomy'.

4.3.3. Cities and regions

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
CR1	Share of publicly purchased products following EU GPP criteria	• Municipality of Lund. • Government of Catalonia.	• Total number of public procurement notices published in given period under given CPV code. • Number of public procurement notices following EU GPP criteria published in given period under given CPV code. • Value (in €) of each public procurement notice published in given period under given CPV code.	• All data available for Catalonia and confirmed via engagement with stakeholders. • All data unavailable for Lund due to lack of access to database and lack of engagement from stakeholders (though data is expected to be collected internally).	• Stakeholder engagement. • Availability and accessibility issues.
CR4	Share of public procurement notices that stipulate	• Municipality of Lund. • Government of Catalonia.	• Access to the public procurement platforms. • The total number of all public procurement notices published in	• All data available for Catalonia and confirmed via engagement with stakeholders. • All data unavailable for Lund due to lack of access to database	• Stakeholder engagement. • Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
	specific CE aspects		given period under given CPV codes. And the value (€) of all the public procurement notices published in given period under given CPV codes.	and lack of engagement from stakeholders (though data is expected to be collected internally).	
CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems	• Kalundborg Symbiosis. • Scheldt-Delta region. • Catalonia, Spain.	• Number of industrial symbiosis systems. • Quantity of byproducts valorised annually. • Types of byproducts valorised.	• Number of industrial symbiosis systems available through desk-based research/snowball method (though some may be missed through this method). • Majority of data unavailable due to lack of engagement from stakeholders, confidentiality/time/resource concerns.	• Stakeholder engagement. • Availability and accessibility issues. • Commercial sensitivity.
CR7	Number of city resources (public institutions etc) implementing circular transition agendas	• Leuven, Belgium. • Navarra, Spain.	• Number of city resources that report a CE commitment. • Number of city resources with a CE roadmap/strategy. • Number of city resources with CE KPIs.	• All data publicly available online, though does not consider depth/quality of commitments which could lead to gaps.	• N/A.
CR8	Budget of public procurement notices that stipulate specific CE aspects	• Municipality of Lund. • Government of Catalonia.	• Pre-defined CE key terms. • Access to the public procurement platforms. • The value (€) of all the public procurement notices published in	• All data available for Catalonia and confirmed via engagement with stakeholders. • All data unavailable for Lund due to lack of access to database and lack of engagement from stakeholders (though data is	• Stakeholder engagement. • Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
			given period under given CPV codes.	expected to be collected internally).	
CR9	Collaborative spaces equipped with materials and equipment to encourage repair	• Berlin, Germany. • Ghent, Belgium. • Prague, Czech Republic.	• Number of repair spaces. • Whether they are still operational. • Whether they exist on a temporary or permanent basis. • Number of employees. • Number of repairs undertaken.	• Number of repair spaces, whether they are still operational, whether they exist on a temporary or permanent basis - available via existing databases/desk-based research. • Number of employees, number of repairs undertaken - unavailable due to lack of engagement from stakeholders.	• Stakeholder engagement.
CR10	No. of regional development agencies providing CE programmes	• Prague, Czech Republic. • Rotterdam, Netherland. • Navarra, Spain.	• Number of development agencies that meet criteria and offer a CE programme.	• All data publicly available online, though does not consider size/scope of agency which could lead to gaps.	• N/A

Table 16: Summary of data availability for ‘Cities and regions’.

4.3.4. Construction and buildings

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
CB1	Share of building product EPDs with circular properties	• EPD Denmark.	• Number of building product EPDs. • Number of building product EPDs with recycled content. • Number of building product EPDs with recyclable content. • Number of building product EPDs with recycled and recyclable content.	• All data fully available with validation from stakeholder engagement but required resource-intensive manual review.	• N/A.
CB2	Number of building projects certified by schemes with circularity requirements	• Qualitative analysis of indicator.	• List of certification schemes. • List of circularity criteria. • Number of projects which fulfil circularity criteria per scheme.	• List of certification schemes – available. • List of circularity criteria - available but not consistent across schemes and therefore not comparable/calculable. • Number of projects which fulfil circularity criteria per scheme – unavailable.	• Methodological inconsistencies. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
CB3	Utilisation rate of existing dwelling stock	• Denmark. Netherlands. Finland. France.	• Total number of dwellings. • Total number of dwellings which are occupied.	• Data available from Eurostat (only up to 2011) or OECD (the four countries with most recent data were chosen). • Some differences in data collection (different reference years, methodologies e.g. housing surveys, population census etc.) and definitions (e.g. temporarily vacant dwellings, long-term vacant dwellings, second homes, homes vacant due to repairs/healthcare reasons etc.).	• Methodological inconsistencies.

Table 17: Summary of data availability for 'Construction and buildings'.

4.3.5. Electronics and ICT

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for electronic or ICT products	• Germany.	• Whether they chose an alternative to purchasing new electrical items and communications equipment (excluding batteries), and if so, what alternative. • Reason(s) for choosing an alternative to buying a new electrical item. • Reason(s) for not choosing an alternative to buying a new electrical item.	• All data available via citizen survey.	• N/A.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
EICT2	Real recycling rate of electronic and ICT equipment	• Netherlands. • Sweden. • Germany.	• Total mass of WEEE actually recycled (i.e., weight of material post-mechanical recycling). • Total mass of WEEE collected.	• Limited response from stakeholder engagement so total mass actually recycled not available. • Contingency developed to collect publicly available information on total mass collected, typical material recovery factors and typical material compositions of WEEE categories.	• Stakeholder engagement. • Commercial sensitivity. • Specificity/granularity shortfall.
EICT3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models	• Poland. • Spain. • Dublin, Ireland. • Madrid, Spain. • Catalonia, Spain. • Oslo and Viken, Norway.	• Total publicly purchased ICT equipment and services in the reporting year by value. • Publicly purchased ICT equipment that is second-hand or refurbished by value. • Publicly purchased ICT equipment that is purchased via a renting or leasing model by value.	For Poland, Spain, Dublin, Madrid: • No data available and no response from stakeholder engagement. For Catalonia and Oslo and Viken: • Total publicly purchased ICT equipment and services in the reporting year by value – available. • Publicly purchased ICT equipment that is second-hand or refurbished by value – unavailable.	• Stakeholder engagement. • Availability and accessibility issues. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
				• Publicly purchased ICT equipment that is purchased via a renting or leasing model by value – available.	
EICT5	Share of consumer electronics fulfilling ecodesign criteria	• Estonia. • Systemair (company).	• Number of products on sale. • Number of products which fulfil ecodesign criteria. • Which ecodesign criteria are fulfilled.	• No data available from desk-based research or stakeholder engagement for Estonia. • For Systemair, some products did not specify whether/which ecodesign criteria are fulfilled.	• Availability and accessibility issues. • Absence of incentives.

Table 18: Summary of data availability for 'Electronics and ICT'.

4.3.6. Food, water and nutrients

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
FWN1	Presence of guidance (labelling) on climate impact of food product categories	• Axfood (Swedish company). • Colruyt (Belgian company). • Netto (Danish company).	• Total amount of food retail sales by retailer. • Amount of food retail sales that bear a climate label.	• Underlying sales data not available for any case study. • Some availability of % of products or % of sales with eco-labels but no consistent methodology/scope of label.	• Methodological inconsistencies. • Commercial sensitivity. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
FWN2	Presence of requirements for organic products in public procurement of food	• Lund, Sweden. • Catalonia, Spain.	• Number of tender documents and amount of food procured. • Number of tender documents and amount of food procured with organic requirements.	• Number of tender documents and amount of food procured - available for framework contracts. • Number of tender documents and amount of food procured with organic requirements - available for framework contracts (Catalonia using CPV code categorisations).	• Availability and accessibility issues. • Specificity/granularity shortfall.
FWN3	Sustainable Calorie intake per capita gap of animal-based food consumption	• EU27.	• Total animal calorie intake per capita per country. • Animal Calorie Intake Benchmark (ideal level of consumption per capita).	• All data available.	• N/A

Table 19: Summary of data availability for 'Food, water and nutrients'.

4.3.7. Households

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H1	Use of private vehicles, as a percentage of kilometres travelled per person, at city/regional level	• Germany.	• Average distance travelled per week. • Proportion of weekly travel undertaken in private vehicle. • Alternative modes of transport used.	• All data available via citizen survey.	• N/A.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H2	Impacts of differing food consumption on European biodiversity through potential species lost	• Romania. • Italy. • Hungary.	• Food consumption per person per day (in g/day) by food group. • Average people per household by nation. • Area of land required to produce the amount of the food group to be calculated in sq m per kg. • Potential species loss/m2 of land use. • Area required to produce 1kg of a product.	• Food consumption per person per day (in g/day) by food group: data fully available. • Average People per household by nation: data fully available. • Area of land required to produce the amount of the food group to be calculated in sq m per kg: data fully available. • Potential species loss/m2 of land use: data fully available. • Area required to produce 1kg of a product: data fully available. Assumptions made: • All food produced within country of consumption. • Separate calculations for high, medium and low intensity farming though a mix of intensities is more likely. • Some foods considered out of scope of indicator.	• Methodological inconsistencies. • Specificity/granularity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H3	Share of household income spent on service models rather than related ownership of goods, at city/regional level	• Germany.	• Use of service-models in 2023. • Annual household spending on goods and services in 2023. • Annual household income in 2023. • Household spend on service models in 2023. • Share of household income spent on service-models (% of income).	• Use of service-models in 2023: data fully available. • Annual household spending on goods and services in 2023: not requested through citizen survey due to challenge for participant to calculate. • Annual household income in 2023: data fully available as alternative for spending on goods and services. • Household spend on service models in 2023: data fully available. • Share of household income spent on service-models (% of income): data fully available.	• Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials, at city/regional level	• Germany.	• Use of peer-to-peer use and sharing models. • Household use of peer-to-peer use and sharing models in 2023. • Change in opinion of peer-to-peer use and sharing models after having used one. • Reasons for using peer-to-peer use and sharing model in 2023. • Reasons for not using peer-to-peer use and sharing models in 2023.	• All data available via citizen survey.	• N/A.
H5	Items of clothing repaired by households per year, at city/regional level	• France.	• Average number of items repaired by households across the key clothing types. • Frequency of clothing repairs. • Barriers to repairing broken clothing. • Frequency of repair across the key clothing types. • Common types of repairs across the key clothing types.	• All data available via citizen survey.	• N/A.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H6	Reuse of consumer goods via reuse centres, at national level (kg/person)	• Flanders, Belgium. • Netherlands.	• Weight of goods reused across product areas. • 2020 – 2022 population data.	• No reuse data available for Belgium nationally so Flanders used as alternative. • For Flanders and Netherlands, weight of goods reused across product areas was available for certain reuse networks only. • Population data fully available and used to extrapolate above data.	• Stakeholder engagement. • Availability and accessibility issues.
H7	Household spending on maintenance and repair, across priority material streams, at city/regional level	• France.	Household spend on the maintenance and repair of priority products.	• All data available via citizen survey, though insufficient data gathered on wider socio-economic factors; recommended that additional qualitative questions are included.	• N/A.
H8	Comparison of life of household furniture as estimated by manufacturers and the actual use time by households, at a European level	• France.	• Estimated technical lifetime at a point of manufacture (provided by the manufacturer). • Average use time from point of purchase to disposal (provided by consumer).	• Estimated technical lifetime at a point of manufacture (provided by the manufacturer): data estimated (default service life scenario used). • Average use time from point of purchase to disposal (provided by consumer): data fully available via citizen survey.	• Stakeholder engagement. • Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
H9	Water footprint of private consumption, at national level	• Netherlands. • Bulgaria.	• Population (household level). • Direct household water usage: consumption from water mains (e.g. taps). • Indirect household water usage: food consumption, electricity consumption, transportation consumption, clothing consumption.	• Population (household level): data fully available. • Direct household water usage: consumption from water mains (e.g. taps): data fully available. • Indirect household water usage: food consumption, electricity consumption, transportation consumption, clothing consumption: data available but variation in data gaps between countries, and a number of assumptions were required.	• Methodological inconsistencies. • Availability and accessibility issues. • Granularity/specificity shortfall.
H10	Unused household goods, across priority products and material streams, by city/regional level	• France.	• Average estimated number of unused high priority products across households. • Unused high priority products. • Estimated number of years high priority products have been unused for by households. • Reasons for households owning unused goods.	• All data available via citizen survey.	• N/A.

Table 20: Summary of data availability for ‘Households’.

4.3.8. Packaging

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
Pa1	A sustainable brand index for consumer packaged goods	• Netherlands.	• Importance of shop/brand sustainability. • Sustainability factors useful for making purchase decisions. • Importance on public availability of brand sustainability report.	• All data fully available via citizen survey.	• N/A.
Pa2	Number of legislative incentives created to encourage circularity in the EU packaging industry	• Germany. • Poland.	• Number of legislative incentives that encourage circularity.	• All data fully available via desk-based research, no response from stakeholders.	• Stakeholder engagement.
Pa3	Percentage by weight of packaging POM designed by circular principles	• France.	• Total tonnes of reusable packaging placed on the market. • Percentage of reusable packaging designed with circular principles in mind.	• Total tonnes of reusable packaging placed on the market: data not fully available, estimates made based on 2022 data of packaging units. • Percentage of reusable packaging designed with circular principles in mind: data not fully available, only available for three product sectors rather than all packaging • No response from stakeholders.	• Stakeholder engagement. • Accessibility and availability issues. • Granularity/specificity shortfall.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
Pa4	Changes in expenditure through applying the circular principle of 'reuse' in manufacturing businesses	• N/A.	• Expenditure before implementation of circular principle. • Expenditure after implementation of circular principle. • Difference in expenditure.	• N/A	• No case studies conducted due to difficulty of data collection and analysis.
Pa5	Share of takeaway meals and drinks provided in reusable packaging	• Netherlands.	• Number of takeaway food/drink items purchased in a typical week. • Proportion of purchased takeaway food/drink items supplied in reusable packaging. • Use of personal reusable packaging when purchasing takeaway food/drink items. • How reusable packaging was usually disposed of.	• All data fully available via citizen survey.	• N/A

Table 21: Summary of data availability for 'Packaging'.

4.3.9. Plastics

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
PL1	Number of pilot/demonstration projects on circular production and treatment of plastics	• Spain. • Luxembourg.	• Participating country (including whether the country is a lead contributor to the project). • Pilot project title. • Project starting year. • Link to the project. • Summary of the project.	• For publicly-funded projects - all data fully available. • For privately-funded projects - project title, starting year, summary and theme of project fully available. Project value generally unavailable, details on	• Commercial sensitivity.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
			• Theme of the project. • Project source. • Project value.	project participants unavailable with exception of lead countries.	
PL2	Number of legislative incentives created to encourage circularity in the plastics industry	• Germany. • Poland.	• Name of legislative incentive. • Type of legislative incentive. • Publish date. • Implementation date. • Summary of legislative incentive. • Theme of legislative incentive. • Source of legislative incentive.	• All data fully available.	• N/A.
PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU	• Kalundborg, Denmark. • Scheldt-Delta region, Denmark. • Catalonia, Spain. • Ile de France, France.	• Industrial symbiosis (IS) networks within the region. • The total quantity of plastic purchased. • The total quantity of waste plastic produced. • The total quantity of plastic recovered (recycled or incinerated for energy production) within the IS network. • The total quantity of plastic reused within the IS network.	• Industrial symbiosis (IS) networks within the region: some data available via desk-based research/stakeholder engagement. • The total quantity of plastic purchased: unavailable. • The total quantity of waste plastic produced: unavailable. • The total quantity of plastic recovered (recycled or incinerated for energy production)	• Stakeholder engagement. • Availability and accessibility issues. • Commercial sensitivity. • Methodological inconsistencies.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
				within the IS network: very limited availability. • The total quantity of plastic reused within the IS network: unavailable.	

Table 22: Summary of data availability for ‘Plastics’.

4.3.10. Product service systems

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
PSS1	Consumer perception of the attractiveness of PSS models	• Germany.	Citizen survey - perceptions of different PSS models.	• All data fully available via citizen survey.	• N/A
PSS2	Percentage of citizens who have used PSS models	• Germany.	Citizen survey - percentage who have used different PSS models.	• All data fully available via citizen survey.	• N/A
PSS3	The percentage of electric vehicles (EVs), in the category of passenger cars, that are operationally leased	• Sweden. • Austria.	• Total amount of EVs in traffic and/or newly registered, all ownership types. • Total amount of EVs in traffic and/or newly registered through operational leasing.	• All data fully available from National Statistical Institutes (NSIs).	• N/A
PSS4	EU project funding allocated to research and development (R&D) projects on PSS	• EU.	• EU contribution to research and development (euros). • EU contribution to research and development on PSS.	• All data fully available from CORDIS.	• N/A.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
PSS5	No. of companies offering PSS-solutions within the electronics and ICT sector	• Denmark. • Sweden.	• Number of companies operating within electronics and ICT sector (specific NACE criteria). • Number of companies offering PSS-solutions within electronics and ICT sector (specific NACE criteria).	• All data available for 25 random sampled companies but data not thought to be available on wider scale - lack of engagement from stakeholders, resource-intensive manual review.	• Stakeholder engagement. • Availability and accessibility issues.
PSS6	The number of public procurement contracts for electronics and ICT that incorporate PSS models	• Denmark. • Sweden.	• Number of public procurement contracts for electronics and ICT. • Number of contracts that incorporate PSS models.	• Limited data availability due to lack of stakeholder engagement - responsive stakeholders were able to provide data, suggesting that some data collection is undertaken.	• Stakeholder engagement.
PSS7	No. of public financial incentives directed at PSS providers/models	• Finland. • Romania. • Spain.	• Number of financial incentives.	• All data fully available through desk-based research and stakeholder engagement, though "financial incentive" does not have a clear definition.	• N/A.
PSS8	No. of countries that have included PSS in their national CE strategies	• Finland. • Romania. • Spain.	Number of countries with PSS considerations.	• All data fully available.	• N/A.

Table 23: Summary of data availability for ‘Product service systems’.

4.3.11. Textiles

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
T1	Number of Jobs in textile repair	• France.	• Number of companies operating in the textile repair sector. • Number of employees. • Number of self-employed individuals.	• Number of companies operating in the textile repair sector: data available but not at ideal granularity so some assumptions made. • Number of employees: data not fully available, assumed in proportion with number of companies. • Number of self-employed individuals: data not fully available, assumptions made.	• Specificity/granularity shortfall. • Availability and accessibility issues.
T2	Number of Jobs in textile recycling	• EU. • Switzerland.	Number of jobs in textile recycling in EU and Switzerland.	• Data not available, estimations made by MicKinsey study (best possible estimation). • Data gathered from previous studies, country-specific reports, national statistics, information from expert interviews.	• Specificity/granularity shortfall. • Availability and accessibility issues.
T3	Total amount of separately collected textiles	• EU.	Total volume of separately collected textiles (tonnes per year).	• Data available for some Member States from ETC questionnaire (most recent year of data varied), excluding illegal collection and trade.	• Availability and accessibility issues.

URN	Indicator	Case study(ies)	Data requirements	Data availability	Reason(s) for data gaps
T4	Total volume of secondary raw material output from textile recycling	• EU.	Total volume of secondary raw material output from textile recycling.	• Data unavailable, alternative data on capacity of textile recycling collected instead. • Varying interpretations of 'capacity' with methodological differences between reports.	• Availability and accessibility issues. • Methodological inconsistencies.
T5	Share of recycled content in products put on market by European brand and retailers	• EU.	• Volume of post-consumer textile uptake. • Total volume of material uptake. • Percentage of post-consumer recycled textiles in the total weight of textile products put on the market by European textile brands.	• Volume of post-consumer textile uptake: data available via third party, but not reliable - self-reported data by companies likely to skew towards best-practice and is not verified by third party. • Total volume of material uptake: data available via third party, but not reliable as above. • Percentage of post-consumer recycled textiles in the total weight of textile products put on the market by European textile brands: calculated using unreliable data.	• Quality and reliability issues.

Table 24: Summary of data availability for ‘Textiles’

4.4. Performance review of the indicators after testing

Once the testing process for each indicator was complete, with learnings on limitations, challenges and potential next steps developed, a post-testing RACER assessment was carried out, once again applying the standardised approach detailed in **Error! Reference source not found.**.

This second assessment reconsidered the scores in light of the learnings from the testing methodologies applied. After testing, none of the scores remained completely unchanged, with 16 scoring higher than the pre-testing assessment, 8 having the same overall score but with fluctuations between the criteria, and 36 scoring lower than originally. This shows the benefit of the testing process followed, as key strengths and challenges have been teased out via the range of in-depth research, data collection and analysis, and stakeholder engagement.

On average, the Relevance score increased slightly by 0.1 point, with all others decreasing, Acceptability by 0.3, Ease and Robustness by 0.4, and Credibility showing the largest average decrease of 0.7 points.

The Credibility criterion refers to whether the indicator is transparent, trustworthy and easy to interpret, in essence assessing whether there is a well-defined methodology in existence, and how simple it is to communicate to stakeholders. The very nature of this project is to investigate potentially innovative indicators, and as such it is not surprising that, upon delving into potential methodologies for monitoring, a need for further work to define and communicate credible approaches has been identified as a trend. This is reflected in the range of next steps suggested in the legislative and technical recommendations tables.

Similar conclusions can be drawn for the decrease in Ease and Robustness scores, with the testing process identifying significant challenges around relevant data availability and collection routes.

A summary of the before and after RACER performance of each indicator is shown in Table 25.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector	2	3	2	3	2	12	3	3	3	3	2	14	2	Trend seems to be impacted by significant events related to the bioeconomy sector. Data was mostly readily available from the INSEE's website.
	B2	B2	Share of local forestry by-products going to energy generation	3	3	3	3	2	14	3	3	2	2	1	11	-3	Data lacks clarity on the uses of harvested wood and therefore is only partially transparent.
	B2	B3	Share of organic fertiliser used in agricultural practices	3	2	3	2	2	12	3	3	2	2	1	11	-1	Data on fertiliser consumption is collected by some EU Member States through agricultural census. The ease of monitoring data varied across regions, influenced by technological and data collection capabilities.
	B1	B4	Number of products with the EU Ecolabel that are bio-based	3	2	2	2	2	11	3	3	3	1	2	12	1	EU Ecolabel widely used across the EU and has strong recognition links to the Circular Economy. Data collection was challenging due to data gaps, the use of assumptions and the additional time needed to conduct wider research into whether the product was 'bio-based'.
	B1	B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activity undertaken	3	3	2	1	2	11	3	1	3	2	2	11	0	Lack of response from the regional stakeholders engaged with shows that this indicator is not accepted yet. A transparency, trustworthy and easy to interpret definition and methodology were developed.
	B1	B6	Cost savings through industrial symbioses using bio-based material	3	2	3	3	3	14	3	2	3	1	2	11	-3	Data collection efforts were insufficient to accurately assess the indicator. Concerns of ambiguity regarding the definition of "bio-based materials" and challenges in establishing cost-saving boundaries.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
	B3	B7	Effects on local communities of a circular bioeconomy	3	3	3	2	3	14	3	2	2	1	2	10	-4	Social LCA methodology is still in its infancy and therefore has limited uptake beyond academia. Requires significant time and technical expertise to conduct. Due to the new methodology, the data required is not currently readily available.
	B2	B8	Share of biological waste treated with anaerobic digestion	3	2	3	2	2	12	3	3	2	2	1	11	-1	Required data already being collected and used by policymakers and industry. The data was incomplete as no regional or company level data was available and the biowaste data represented only municipal biowaste or biowaste which could not be separated from others.
Batteries & vehicles	BV1	BV1	Car-sharing frequency rates	3	2	3	2	2	12	3	2	3	1	2	11	-1	Difficulties with attaining data from formalised car-sharing schemes, as well as the total journeys taken across Member States.
		BV2	Virgin vs. recycled plastic raw material used in the production of vehicles	2	3	3	3	3	14	3	2	3	1	3	12	-2	Significant importance to progressing CE in the automotive sector. Limited feedback and progress received throughout the stakeholder engagement phase. Concerns from OEMs/Tier 1 suppliers around commercial sensitivity and intellectual property of vehicle design.
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry	3	2	3	2	2	12	3	2	3	1	2	11	-1	Difficulties with attaining the required data, despite it likely existing.
		BV4	Ease of Disassembly Metric (eDIM)	3	3	3	2	3	14	3	1	3	1	3	11	-3	Limited progress made through the stakeholder engagement phase. Concerns from OEMs/Tier 1 suppliers around commercial sensitivity of vehicle disassembly time for individual components. No agreed methodology for calculating eDIM.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
Cities & regions	CR1	CR1	Share of publicly purchased products following EU GPP criteria	3	2	3	2	2	12	3	2	2	1	2	10	-2	No easily applicable methodology that could be adopted by municipalities, due to the differences in how local and regional administrations manage public procurement. Standardisation of procurement systems is needed to enable the wide-scale use of the web-scraping tool.
	CR1	CR4	Share of public procurement notices that stipulate specific CE aspects	3	2	3	2	2	12	3	2	2	1	2	10	-2	No easily applicable methodology that could be adopted by municipalities, due to the differences in how local and regional administrations manage public procurement. Standardisation of procurement systems is needed to enable the wide-scale use of the web-scraping tool.
	CR2	CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems	3	3	3	3	3	15	3	2	2	1	3	11	-4	Concerns regarding data confidentiality at organisational-level. Existing methodologies vary in complexity and application across regions and industries. Data is resource intensive for companies to collect.
	CR3	CR7	Number of city resources implementing transition agendas	3	3	3	3	3	15	2	2	2	2	1	9	-6	Concerns around the exclusion of private sector organisations. Currently no existing methodology and not being measured at the local/regional level. The consistency of how transition agendas are developed and evidenced varies.
	CR1	CR8	Budget of public procurement notices that stipulate specific CE aspects	3	2	3	2	2	12	3	2	2	1	2	10	-2	No easily applicable methodology that could be adopted by municipalities, due to the differences in how local and regional administrations manage public procurement. Standardisation of procurement systems is needed to enable the wide-scale use of the web-scraping tool.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
	CR3	CR9	Collaborative spaces equipped with material and equipment to encourage repair	3	3	3	3	3	**15**	2	1	1	2	2	**8**	-7	No reference to population size may result in misleading interpretations. Restricted access to data and lack of stakeholder engagement. Methodology was deemed limited but consistent.
	CR2	CR10	Number of regional development agencies providing circular economy programmes	3	3	3	3	3	**15**	3	2	2	3	3	**13**	-2	Some concerns related to the value this would provide in monitoring the circular transition. Regional differences in how each city/region defines the remit of a 'development agency'.
Electronics & ICT	EICT1	EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products	3	2	2	2	2	**11**	3	2	2	3	2	**12**	1	Use of citizens survey increased ease of data collection and resulted in a large sample size.
		EICT2	Real recycling rate of electronic and ICT equipment	3	3	3	1	3	**13**	3	2	3	1	2	**11**	-2	Availability of mass balance data within recycling facilities is likely limited to within the waste treatment facilities themselves. There was an unwillingness to provide data due to confidentiality concerns.
		EICT3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models	1	1	3	1	2	**8**	3	2	3	1	2	**11**	3	Supportive of circular public procurement and high value added opportunities (such as reuse, refurbishment and PSS). Low response rate from procurement stakeholders implies there is little motivation or need for public procurement databases to record the required data.
		EICT5	Share of consumer electronics put on market fulfilling ecodesign criteria	3	1	3	1	1	**9**	3	1	2	1	1	**8**	-1	Challenges associated with data collection made it difficult to obtain complete and reliable data.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person	3	2	3	2	2	12	3	2	2	3	2	12	0	Use of citizens survey increased ease of data collection but decreased level of accuracy.
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost	3	3	2	2	2	12	3	3	2	1	1	10	-2	High level of assumptions made.
	H1	H3	Share of household income spent on service models rather than related ownership of goods	3	2	2	2	1	10	3	2	2	2	2	11	1	A consistent methodology for data collection was developed via the citizens survey.
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials	3	3	2	1	1	10	3	3	2	3	2	13	3	Use of citizens survey increased ease of data collection and resulted in a large sample size. A consistent methodology was developed.
	H1	H5	Items of clothing repaired by households per year	3	3	3	2	1	12	3	3	3	3	2	14	2	Use of citizens survey increased ease of data collection and provided robust results through a large sample size.
	H3	H6	Reuse of consumer goods via reuse centres	3	2	2	2	1	10	3	2	2	1	1	9	-1	Reuse centres lacked a motivation to share the necessary data which created difficulties. Assumptions had to be applied as data received was not at a national level.
	H1	H7	Household spending on maintenance and repair, across priority material streams	3	2	3	1	2	11	2	2	3	3	2	12	1	Use of citizens survey increased ease of data collection and provided robust results through a large sample size. Measuring this at a regional/city level did not result in enough regional disparities to justify the additional effort.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households.	2	3	2	3	2	**12**	3	2	1	2	1	**9**	-3	Change in indicator name and scope increased the complexity of the data collection, but increased its relevance to the project. True technical lifetimes of furniture were not located through publicly available EPDs.
	H2	H9	Water footprint of private consumption	3	3	2	2	2	**12**	3	3	2	1	2	**11**	-1	Required data was not readily available and lacked reliability.
	H1	H10	Unused household goods, across priority products and material streams	2	2	1	1	1	**7**	2	2	2	2	2	**10**	3	Use of citizens survey increased ease of data collection and provided robust results through a large sample size.
Packaging	Pa1	Pa1	A sustainable brand index for packaging products and manufacturers	3	2	3	2	2	**12**	3	2	2	2	2	**11**	-1	The testing programme only focused on one Member State.
		Pa2	No. of legislative incentives created to encourage circularity	3	3	3	2	2	**13**	3	3	2	3	2	**13**	0	Unable to secure stakeholder interviews (as per the original methodology) to sense check the data. However, the data was easier to access and collect than originally thought.
		Pa3	Percentage by weight of packaging POM which has been designed according to circular principles	3	2	3	2	2	**12**	2	2	3	1	1	**9**	-3	Online information only related to three sectors, meaning the data did not cover all reusable packaging placed on the market. The indicator was challenging to monitor due to lack of information online, particularly in relation to placed on the market data.
		Pa4	Changes in expenditure through applying circular principles throughout the packaging value chain	3	3	2	2	2	**12**	3	3	2	1	2	**11**	-1	The required data was not readily available.
		Pa5	Share of take-away meals and drinks provided in reusable packaging	3	3	2	2	2	**12**	3	3	2	3	1	**12**	0	Use of citizens survey increased ease of data collection. The indicator failed to consider the number of times reusable packaging was reused before disposal.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics	3	2	3	2	3	**13**	2	2	2	3	2	**11**	-2	Relevance could be improved by collecting data on the value of the pilot projects. Lacked standardisation in the data collection process. Data collection was easy and required limited technical knowledge.
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry	3	3	3	3	3	**15**	3	3	3	3	2	**14**	-1	Lacked transparency and information may be misinterpreted.
		PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives	3	2	3	2	3	**13**	3	2	1	1	1	**8**	-5	Challenges associated with data collection made it difficult to obtain complete and reliable data, and when communicating the indicator to key stakeholders. No consistent methodology or dataset available.
PSS	PSS1	PSS 1	Consumer perception of the attractiveness of PSS models	3	2	2	1	1	**9**	3	3	2	2	2	**12**	3	Information on consumer preferences for circular solutions is useful and necessary for businesses/public authorities engaging with this sector. There is no authoritative data collection on this indicator, but it is simple to collect via surveys.
	PSS1	PSS 2	Percentage of citizens who have used PSS models	3	2	1	2	1	**9**	3	3	2	2	2	**12**	3	Information on consumer preferences for circular solutions is useful and necessary for business/public authorities engaging with this sector. There is no authoritative data collection on this indicator, but it is simple to collect via surveys.
	PSS2	PSS 3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased	3	3	2	1	1	**10**	2	3	3	3	3	**14**	4	Change of indicator name and scope. Leasing is not the most promising form of PSS compared with shared mobility solutions. Use of existing standards makes it easy to communicate to stakeholders. Required data is readily available.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
	PSS3	PSS 4	EU project funding allocated to research and development projects on PSS	2	2	3	2	1	**10**	3	2	2	2	1	**10**	0	Change of indicator name and scope to increase relevance. The data collection method is not EU-defined and involves several issues in terms of reliability and robustness.
	PSS2	PSS 5	No. of companies offering PSS-solutions within the electronics and ICT sector	3	2	2	1	1	**9**	3	3	1	1	1	**9**	0	Change of indicator name and scope. The presence of PSS for electronics and ICT makes it clear whether the provision of PSS-models is growing and if the industry is providing the circular business models that are emphasised on a policy level.
	PSS2	PSS 6	The number of public procurement contracts for electronics and ICT that incorporate PSS models	2	2	1	1	1	**7**	3	2	2	1	2	**10**	3	Change of indicator name and scope to increase relevance. Methodology developed which was simple and easy to understand/communicate to stakeholders.
	PSS3	PSS 7	No. of public financial incentives directed at PSS providers/models	3	1	1	2	1	**8**	3	2	1	2	2	**10**	2	Change of indicator name and scope. No existing methodology and no clear definitions on what constitute financial incentives in the case of PSS. Data could however be collected from EU Member States.
	PSS3	PSS 8	No. of countries that have included PSS in their national CE strategies	2	2	2	2	1	**9**	2	2	1	3	2	**10**	1	Change of indicator name and scope. No existing methodology for testing this indicator. Relied upon the trustworthiness and completeness of the public information provided online by national authorities.
Textiles	T1	T1	Number of jobs in the textile repair sector	3	3	2	1	2	**11**	3	3	3	1	2	**12**	1	A comprehensive methodology was identified which already existed and was developed by ADEME.
		T2	Number of jobs in the textile recycling sector	3	3	2	1	2	**11**	3	2	2	1	1	**9**	-2	Key stakeholders (like EURATEX) currently measure how many jobs could be created, rather than how many currently exist. Challenges experienced in data collection and only an estimate could be provided.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
		T3	Total amount of separately collected textiles	3	3	3	1	2	**12**	3	3	1	1	1	**9**	-3	Member States have varying definitions of what is considered 'textile waste', and there are no EU-wide reporting requirements for used textiles that are not classified as waste. This results in significant data gaps and inconsistencies.
		T4	Total volume of secondary raw material output from textile recycling	3	1	3	2	2	**11**	2	1	1	1	2	**7**	-4	Measuring the capacity and output volume of recycling companies does not indicate how much recycled material is fed back into the economy. Significant differences in the calculations of recycling capacity and inconsistencies reduce the credibility of the data.
		T5	Presence of guidance (labelling) on climate impact of food product categories	3	2	3	1	2	**11**	3	2	2	1	1	**9**	-2	Data from Textile Exchange was global, rather than European. This data is considered biased towards better-performing companies who are willing to self-report.
Food, water & nutrients	FWN1	FW N1	Presence of guidance (labelling) on climate impact of food product categories	2	3	2	3	3	**13**	3	2	2	3	2	**12**	-1	Complementary to existing EU level indicators and would contribute to a better and broader understanding of circularity in the food sector. Motivation to report this indicator needs to be further assessed to have full picture of acceptability. Data is not yet widely available.
		FW N2	Presence of requirements for organic products in public-procurement of food	3	3	3	2	3	**14**	3	3	3	2	3	**14**	0	NA.
		FW N3	Sustainable Calorie intake per capita gap of animal-based food consumption	3	2	3	3	2	**13**	3	2	3	3	2	**13**	0	NA.

Policy area	Case Study Group	URN	Indicator name	RACER assessment before testing						RACER assessment after testing						Difference	Justification for amendments
				Relevance	Acceptability	Credibility	Ease	Robustness	Total score	Relevance	Acceptability	Credibility	Ease	Robustness	Total score		
Construction & buildings	CB1	CB1	Share of building products with EPDs with circular properties	1	3	3	3	3	**13**	2	2	2	2	2	**10**	-3	Indicator name and scope changed to be more relevant. Challenges of harmonisation the data collection. Increased complexity of identifying circular properties rather than simply listing the number of EPDs.
		CB2	Number of building projects certified by schemes with circularity requirements	2	3	1	3	3	**12**	2	3	2	2	2	**11**	-1	Indicator considered as a proxy for the more ambitious part of the industry. Necessary to conduct regular reviews of the schemes to ensure that they continue to follow the minimum requirements. Data collection was complex.
		CB3	Utilisation rate of existing building stock	2	2	3	2	2	**11**	2	2	2	2	2	**10**	-1	The current differences in definitions of unoccupied dwellings across the EU and approaches to data collection are challenging.

Table 25: Pre- and post- testing comparison of RACER performance

4.5. Suggested name changes

Following the completion of the testing phase and an analysis of the performance, recommendations have been made to update the names of some indicators.

Table 26 provides a summary of these indicators, alongside a justification for why they have been changed. It is strongly encouraged that these recommendations are considered if the indicator has been selected for further development and consultation.

URN	Indicator name at start of testing process	Updated name suggestion of indicator following testing/investigation	Justification for change
B2	Share of local forestry and agricultural waste by-products going to energy generation	Share of local forestry by-products going to energy generation	• Focus on one industry to allow for a more accurate output and measure of circularity. • The term 'waste' was removed from the name after consultation with forestry industry stakeholders revealed that all by-products have a use and are not considered waste.
CB1	Share of building product EPDs with circular properties	Share of construction product EPDs with circular properties – defined according to product groups.	• To ensure the gathering of valid statistics in the future, the EPD reporting format must be standardised, and data must be harmonised, including the definition of circular properties. Significantly, the definition of circular properties should include product specific benchmarks.
CR4	Share of public procurement notices that stipulate specific CE aspects	Share of public procurement calls for competition that stipulate non-price related CE criteria aimed at reducing the environmental impact of goods, works and services throughout their lifecycle	• Improves upon the previous description by drawing a causal link between the introduction of CE criteria and the objective to reduce environmental impacts. • In turn provides a mechanism by which public procurers can actively engage with suppliers and evaluate the provision of CE goods and services.
CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems.	Total quantity of byproducts valorised annually due to regional industrial symbioses systems and partnerships.	• Given the challenges and insights from testing, the original name remains fit for purpose. • However, the suggested update would enhance the indicator through better reflecting the inclusion of smaller scale IS partnerships, such as between SMEs that may not form part of a more mature IS network within a region.

URN	Indicator name at start of testing process	Updated name suggestion of indicator following testing/investigation	Justification for change
CR7	Number of city resources (public institutions) implementing circular transition agendas	The number of local and regional entities implementing circular transition agendas aligned with regional targets.	• The scope of this indicator should be expanded to include private sector entities that ascribe and/or commit to CE targets set by the local and/or regional public administration. • While broadening the scope of the indicator may increase the administrative burden placed on bodies responsible for reporting on this indicator, it would create an incentive for private sector entities (such as SMEs and local business networks) to disclose their activities in regard to broader regional CE transition efforts.
CR8	Budget of public procurement notices that stipulate specific CE aspects	Potentially two indictors of worth to consider: Number and value of public contracts awarded based on CE criteria aimed at reducing the environmental impacts of goods, works and services throughout their lifecycle.	• Improves upon the previous description by drawing a causal link between the introduction of CE criteria and the objective to reduce environmental impacts. • In turn provides a mechanism by which public procurers can actively engage with suppliers and evaluate the provision of CE goods and services.
CR9	Collaborative spaces equipped with materials and equipment to encourage repair	The number of repair spaces by population size.	• This would make the purpose and parameters of the indicator more easily understood and communicated to policymakers and the public, thereby improving the robustness and acceptability of the indicator.

URN	Indicator name at start of testing process	Updated name suggestion of indicator following testing/investigation	Justification for change
CR10	Number of regional development agencies providing CE programmes	The number of public, private and semi-private entities providing regional CE support programmes.	• Limiting the indicator to not-for-profit organisations would have the effect of excluding highly competent private and semi-private entities that are actively seeking to support the development of CE capabilities within the local public and private sectors. • Some organisations and agencies providing these CE programmes within a particular city or region, may actually be located elsewhere. In these cases, these external organisations must be able to provide evidence of continued and substantive CE programmes within that territory, rather than one-off projects. This is to ensure local policymakers have a more accurate understanding of the types of CE support services available in this region.
EICT2	Real recycling rate of electronic and ICT equipment	Actual recycling rate of electronic and ICT equipment	• Additional clarity of terminology.
FWN2	Presence of requirements for organic products in public procurement of food	Share of organic food in public procurement	• The share of publicly purchased food is a more accurate indicator than presence of requirements, as it measures the tangible outcome of procurement and circumvents the system boundary issues and issues with non-standardisation of the initial indicator.
FWN3	Sustainable Calorie Intake per capita gap of animal-based food consumption	Animal-Based Dietary Imbalance Index	• The Sustainable Calorie Intake gap represents a composite measure that assesses the deviation of actual animal-based calorie intake from an optimal benchmark and offers a valuable tool for evaluating dietary patterns across the EU. However, it should be noted that this serves as a proxy indicator, lacking differentiation among EU Member State dietary patterns and demographics such as sex, age, and occupation. The suggested change alleviates this ambiguity and provides greater clarity on the scope and objective of the indicator.

URN	Indicator name at start of testing process	Updated name suggestion of indicator following testing/investigation	Justification for change
H3	Share of household income spent on service models rather than related ownership of goods.	Share of household income spent on service models in relation to overall household spend.	• Due to the granularity of data required for the original indicator, it was felt that data collection would be too difficult at a Member State level. For example, households would need to provide details on the individual service models used each year and the cost of purchasing the product instead. • For ease of data collection, it is recommended that the indicator should measure annual household spend on service models as a proportion of overall annual household spend.
H10	Unused household goods, across priority products and material streams.	Unused household goods and associated materials, across priority products and material streams.	• One recommendation made for this indicator is to further explore how it could be translated from products into materials. This would help the EC to understand the amount and type of materials within these products which could be recirculated back into the economy. • The indicator would be more useful from a CE perspective, as it provides greater levels of granularity.
PL3	Total weight of plastic material recovered and reused through Industrial Symbiosis initiatives in the EU	Two potential indicators of worth to consider: Number and capacity of industrial symbiosis initiatives involved in plastic recovery or reuse	• A simplified alternative metric version in the short term. • Could provide the EU with a better understanding of the proliferation of IS principles and networks, giving an indication of the adoption of circularity over a period of time. • This would enable a transition to the more robust indicator focusing on quantities of plastic recovered, as all relevant networks would already be known to the monitoring team, making communication significantly simpler. • It would also allow for the EC to provide more bespoke training and guidance for any networks that may need additional support understanding its reporting requirements.

URN	Indicator name at start of testing process	Updated name suggestion of indicator following testing/investigation	Justification for change
T3	Total amount of separately collected textiles	Volume of separately collected used textiles and textile waste	• This title gives some nuance to the understanding of the difference between 'used' textiles and textile waste, and would emphasise that the textiles are collected for reuse and recycling, depending on their state, material composition, properties and quality – with the remaining share going to landfill and incineration.
T4	Total volume of secondary raw material output from textile recycling	Total volume of secondary raw material output from mechanical and chemical textile-to-textile recycling	• More specific on the materials and the recycling process being tracked.
T5	Share of recycled content in textile products put on the European market	Share of recycled post-consumer textile-to-textile content put on the market by European brands and retailers	• Gives a specification of materials as well as a change in scope (European brands and retailers rather than the European market), which was found to be necessary to facilitate realistic progress for the indicator.

Table 26: Summary of indicators with updated name suggestions.

4.6. Recommendations for further development

Each indicator report includes specific recommended actions for further consideration, as well as a headline recommendation on whether the indicator should be considered for further development. The headline recommendations followed a red, amber, green (RAG) approach with red denoting a recommendation that the indicator should not be further developed at this stage, amber that it should, but with significant work required to make it viable, and green a recommendation for further development with relatively minor work required. These recommendations are not made purely on individual or total RACER criteria scores, but rather on a combination of those, the expected timescale and complexity of recommended actions, and the overall perception of the potential value and strength of the indicator to meaningfully enhance the EU's understanding of progress towards true circularity for the focus policy theme.

For the indicators recommended for further development, the difference between 'significant' and 'minor' further work required is appraised as a combination of the expected timescale required for the implementation of suggested actions, their complexity in terms of the technical requirements and the range and capacity of the stakeholders required to be involved for success.

In summary, five indicators received recommendations for no further continuation at this point, 34 for further development with significant work, and 21 for further development with minor work required. All indicator case studies are available online[16]. They include detailed discussion of this assessment process and recommended actions, with the 21 green recommended indicators forming the focus of Section 5 of this report, which constitutes a roadmap for action to progress the key indicators. Across the 11 policy themes and sub-themes, the only ones with no green recommendations are Cities and Regions (which has seven amber recommendations), Packaging and Textiles (each with four amber and one red). In large part, this could be explained by the fact that this project aimed predominantly to investigate innovative indicators which are not currently well monitored or in development. For Cities and Regions this meant attempting to avoid crossover, and searching for complementarity, with the theme-specific work being done by the EU funded CCRI[17], which led to investigation of more exploratory, longer-term options. A similar line could be argued for Packaging and Textiles, where material footprint and use rates, and waste generation rates, are key metrics for understanding circularity progress which are already monitored at large scale via the CEMF. The headline recommendations for each of the 60 indicators are summarised in Table 27 below.

[16] https://www.ricardo.com/ce-indicators

[17] https://circular-cities-and-regions.ec.europa.eu/about

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector		Key metrics (private sector investment, number of jobs created, and GVA) are objective, replicable and widely accepted. Sources are credible and reliable as data comes from national databases or businesses directly. Data is robust, direct and readily available, though its robustness and availability could be enhanced through minor data collection improvements.	
	B2	B2	Share of local forestry by-products going to energy generation		Indicates how efficiently wood resources are used with the current economy. While the data is not publicly available for individual forests and certain EU regions, the indicator is widely accepted by stakeholders and the required data is likely to be collected by most forests. Clearer definitions and reporting guidelines around by-product categories are needed.	
	B2	B3	Share of organic fertiliser used in agricultural practices		The indicator is widely accepted by stakeholders as it aligns with the EU's Farm to Fork strategy targets. Measuring the use of organic fertilisers will also be required to monitor the progress of Member States' CAP Strategic Plans. However, the testing phase of indicator revealed that methodological refinements are necessary to improve the indicator's accuracy and robustness.	
	B1	B4	Number of products with the EU Ecolabel that are bio-based		EU Ecolabel is already a credible and reputable policy instrument for the environment. Therefore, if data is improved and product material availability is universally available across the EU, it would be suitable for development as CE metric.	
	B1	B5	Level of engagement by companies in developing a bioeconomy, categorised by the types of activity undertaken		Identifying which activity has the most used routes of engagement will be useful when prioritising funding. The methodology should be consistent across EU Member States since it is easily replicable. Challenges identified such as unavailability of data and unresponsiveness from stakeholders to data collection requests.	
	B1	B6	Cost savings through industrial symbioses using bio-based material		Provides useful insight into the effectiveness of regional and organisational policies for supporting the development of industrial symbiosis networks. A well-defined methodology for calculating cost savings needs to be developed, which can isolate the savings resulting from the use of bio-based materials within the partnership.	
	B3	B7	Effects on local communities of a circular bioeconomy		Assessing the social impact of circular bioeconomy projects on local communities will be central to transitioning to a fair, equitable CE and meeting the EU's commitments in the CEAP and Social Pillar action plan. SLCA is one of several potential methodologies to underpin this indicator. The EC need to consider more explicitly what types of social impacts should be assessed as a minimum and whether this should be limited to only the local community and the bioeconomy, or expanded further.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
	B2	B8	Share of biological waste treated with anaerobic digestion		Supports regions to assess the effectiveness of their waste management approaches and track progress towards achieving CE goals. As most regional governments and Member States already collect waste-related data, it is expected that only very minimal adjustments to the data collection protocols will be required.	
Batteries & vehicles	BV1	BV1	Car-sharing frequency rates		Supportive of CE strategies higher up the waste hierarchy, such as refuse, rethink, and reduce. Due to difficulties obtaining data from formal car-sharing schemes, it is recommended in the future to expand the citizens survey to also measure the use of formal car-sharing schemes.	
		BV2	Virgin vs. recycled plastic raw material used in the production of vehicles		Direct alignment with the wider goals and proposed future regulations likely to result from the ELV Directive. The data on recycled plastic content, although presented as ranges and gathered primarily through interviews, indicates that such information is available. The primary challenge lies in the willingness and incentivisation for stakeholders to share this data.	
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry		Tracks the reuse of end-of-life vehicle batteries which is critical for achieving a circular automotive industry. The data collection process found that a number of end-of-life vehicle battery sorting and reprocessing facilities cover large collection areas, making it difficult to collect regional data. Therefore, it is recommended that this indicator is measured at a national level.	
		BV4	Ease of Disassembly Metric (eDIM)		The challenges around methodology and data collection are significant and are likely to present challenges in gaining consensus and support from key stakeholders. Gaining “buy-in” from the automotive sector is critical to ensuring the success of this indicator – the sector needs to be prepared prior to development, ensuring the relevant data can be accessed.	
Cities & regions	CR1	CR1	Share of publicly purchased products following EU GPP criteria		Testing has demonstrated that it is feasible to measure this data and despite some limitations it is considered suitable for future development. Due to key differences in terms of data availability and public procurement platforms used across EU Member States, significant coordination work and capacity-building is needed to enable systematic and coherent monitoring.	
	CR1	CR4	Share of public procurement notices that stipulate specific CE aspects		By stipulating CE aspects within public procurement notices, cities and regions are able to stimulate sustainable innovation and increase demand for circular product and service offerings. Due to key differences in terms of data availability and public procurement platforms used across EU Member States, significant coordination work and capacity-building is needed to enable systematic and coherent monitoring.	
	CR2	CR6	Total quantity of byproducts valorised annually due to regional industrial symbioses systems		Data is not readily available, and stakeholders were not responsive to data requests. Nevertheless, it was suitable for measuring CE progress, and such data is being collected in well-established industrial symbiosis clusters. Given the substantial time and resources required for organisations to gather necessary data, testing this indicator at the regional level may be difficult without additional support.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
	CR3	CR7	Number of city resources implementing transition agendas		Monitors the extent to which public sector entities have committed to a circular transition in alignment with a city and/or region's CE policies. There are concerns surrounding the robustness and objectivity of the data, and it is recommended for the EC to develop a mandatory reporting framework that requires cities and regions within EU Member States to regularly report on their progress in implementing CE initiatives.	
	CR1	CR8	Budget of public procurement notices that stipulate specific CE aspects		By stipulating CE aspects within public procurement notices, cities and regions are able to stimulate sustainable innovation and increase demand for circular product and service offerings. Due to key differences in terms of data availability and public procurement platforms used across EU Member States, significant coordination work and capacity-building is needed to enable systematic and coherent monitoring.	
	CR3	CR9	Collaborative spaces equipped with material and equipment to encourage repair		Enables local and municipal decision makers to evaluate the effectiveness of circular awareness campaigns. However, accessing complete and comparable information is challenging, in part due to the informal nature of the repair spaces identified. Going forward, the indicator should measure the total number of collaborative repair spaces according to population and/or size of a city or region.	
	CR2	CR10	Number of regional development agencies providing circular economy programmes		Directly feeds into the objectives of the CEAP and Just Transition. Future iterations of this indicator should reflect other statutorily distinct organisations who may provide similar services and CE programmes.	
Electronics & ICT	EICT1	EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products		Supportive of increasing the number of second-hand purchases, repairs, and sharing between citizens. Robust indicators will be needed to reliably monitor the success of policy instruments associated with the uptake of sustainable alternatives to purchasing new products (such as ESPR).	
		EICT2	Real recycling rate of electronic and ICT equipment		Findings could be used to reprioritise efforts to improve recycling processes, to maximise material recovery from the categories with the lowest real recycling rate. A number of improvements are recommended to the current method of calculating real recycling rates across the EU, to enable robust and reliable usage of the proposed indicator.	
		EICT3	ICT equipment and services purchased by the public sector that are either second-hand/refurbished or acquired through renting/leasing models		The methodology is straightforward and easy to communicate to stakeholders, requiring a small number of data points of the same measurement unit. However, there is a degree of subjectivity and room for error that is introduced in the data collection process, regarding product inclusion classifications for example.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
		EIC T5	Share of consumer electronics put on market fulfilling ecodesign criteria		While this indicator is closely aligned with the EU's efforts to promote and embed ecodesign thinking within industry, there was a lack of confidence in the robustness of the results when the indicator is reliant on those producers with non-compliant products voluntarily reporting their non-compliance. Similar challenges are faced with regard to the reporting of illegal activities such as illegal exports of electronic waste.	
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person		Reducing the use of private vehicles is an essential step for the EC to achieve a truly CE across all Member States. The indicator would also benefit from the development of a clear, EU-wide definition of the term 'private vehicle'. This will help to ensure accurate and consistent reporting in future.	
	H2	H2	Impacts of differing food consumption on European biodiversity through potential species lost		Due to the comprehensive data requirements required to accurately measure the household level impacts on biodiversity, advancing this indicator is likely to be feasible, but greater detail is required in a number of areas. Examining biodiversity impacts would likely be better studied at a higher level such as city/region rather than at household level.	
	H1	H3	Share of household income spent on service models rather than related ownership of goods		Incentivising product-as-a-service models has been highlighted in the CEAP as a key component designing sustainable products. To support the continual improvement in the performance of this indicator, tax incentives should be considered to both encourage consumers to use service offerings when available, as well as encouraging retailers and manufacturers to offer service models.	
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials		Increasing the uptake of peer-to-peer use and sharing models and gaining a better understanding of household opinions of these models, is a key step for the EC to reach their goal of achieving circularity. Due to the large number of respondents that were unaware of peer-to-peer use and sharing models, it is recommended that public facing guidance is developed to educate households on topics such as what a peer-to-peer use and sharing model is, what the benefits are, and the availability of these models.	
	H1	H5	Items of clothing repaired by households per year		Repair is an essential process for reaching the EC's ultimate goal of 'true circularity', in order to reduce production and consumption rates, and extend product lifespans. With repair being increasingly passed into national and EU legislation, it is essential to develop indicators to measure the performance and success of these existing and upcoming policy instruments.	
	H3	H6	Reuse of consumer goods via reuse centres		Reuse is an essential facet of the CE, ranking high in the waste hierarchy. One recommendation to assist in the measurement of this indicator is to implement mandatory volume reporting for reuse centres across Europe. This should guide reuse centres on what data to collect, the frequency of the data collection, and the priority products that should be used for categorisation purposes.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
	H1	H7	Household spending on maintenance and repair		Repair is an essential process for reaching the EC's ultimate goal of 'true circularity', in order to reduce production and consumption rates, and extend product lifespans. With repair being increasingly passed into national and EU legislation, it is essential to develop indicators to measure the performance and success of these existing and upcoming policy instruments.	
	H3	H8	Comparison of the estimated technical lifetime of furniture products by manufacturers and the actual use time by households.		Maximising the life expectancy of products is a key aspect of the CE in order to decrease demand for new replacements and subsequently reduce the extraction and consumption of raw materials. The development of clear, EU-wide definitions for the key terms used within this indicator methodology is essential (such as 'technical lifetimes' and 'use time'). A furniture classification system needs to be developed and agreed on by industry and other key stakeholders.	
	H2	H9	Water footprint of private consumption		Assessing the water footprint of products and services is a good step towards the evaluation of water circularity. Additional water consumption data at a household level across different countries should be collected and made available to use to improve the robustness and reliability of the indicator. Food consumption data should be further improved to increase the robustness, reliability and replicability of the water footprint (particularly as food accounts for 95% of total household water use).	
	H1	H10	Unused household goods, across priority products and material streams		Monitoring this indicator is expected to help quantify the 'lost opportunity' in terms of the products that are stored in unused household products, which could alternatively be shifted to value retention processes (such as material recycling and reuse). This is currently poorly understood. A robust definition for 'unused' products must be developed through consultation with industry.	
Packaging	Pa1	Pa1	A sustainable brand index for packaging products and manufacturers		To support comprehensive testing of the sustainable brand index, further work is necessary to assess the validity of the criteria, determine the ease of scoring, estimate the effort and time needed for scoring, and fine tune the interpreting of results.	
		Pa2	No. of legislative incentives created to encourage circularity		Will provide insight into the implementation of circularity-promoting legislation across the EU, not only via the EU directives but also any specific national legislation which may go above and beyond the requirements outlined in EU Directives. It is recommended to also gather data on the value or quantity of fines or taxes that have been charged to companies and compare this across different member states.	
		Pa3	Percentage by weight of packaging POM which has been designed according to circular principles		Relates to a number of legislations involving the CE and reusable packaging. As some countries are only just beginning to record EPR data for packaging, so it is expected that more information will become available in the coming years.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
		Pa4	Changes in expenditure through applying circular principles throughout the packaging value chain		Whilst exploring the expenditure change due to reuse activities would be beneficial for the EC and its understanding of the impact of CE; and would allow the EC to develop clear and tangible case studies of real-life business operations where the principle of 'reuse' has been applied, there are too many variables to take into consideration, combined with the effort it would take to implement we consider this to be an unusable indicator.	
		Pa5	Share of take-away meals and drinks provided in reusable packaging		This is a relevant indicator to measure the success of upcoming initiatives such as the Farm to Fork strategy. It is recommended that the indicator considers the type or material of reusable packaging used in future.	
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics		The required data was readily available, credible and useful for drawing conclusions on the level of innovation in the plastics sector of the countries under study. The results of the indicator can be normalised against factors like population count and GERD which further strengthens the conclusions that are able to be drawn.	
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry		The required information on implemented legislation appears to be readily available and transparent based on this testing process, and when tracked over a number of years, can provide useful conclusions on the proactivity of countries to react to the growing challenge of plastic waste. Some minor changes will improve the quality of data collected and further increase the indicator's utility.	
		PL3	Total weight of plastic material recovered and reused through industrial symbiosis initiatives in the EU		While it could represent an opportunity to track the progress on circularity in the plastics sector as well as adoption of industrial symbiosis principles it is felt that the changes and work required to ensure effective data collection would be too complex at this stage.	
PSS	PSS1	PSS 1	Consumer perception of the attractiveness of PSS models		Tracking consumer preferences is very relevant for providing insights on progress towards the goals of the CEAP and various regulatory initiatives targeting consumer uptake of circular business models, including PSS.	
	PSS1	PSS 2	Percentage of citizens who have used PSS models		Tracking consumer preferences is very relevant for providing insights on progress towards the goals of the CEAP and various regulatory initiatives targeting consumer uptake of circular business models, including PSS.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
	PSS2	PSS 3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased		Leasing of EVs can be seen as an early step in a circular transition to higher-level PSS models in the sector. Ideally this indicator would be combined with other indicators for the EV industry to give a comprehensive perspective on the circularity of the sector.	
	PSS3	PSS 4	EU project funding allocated to research and development projects on PSS		The indicator is relevant for measuring the implementation of the CEAP on the specific topic of R&D funding in relation to PSS and builds on publicly available information in the CORDIS database managed by the EU. Several challenges have been identified related to identifying data and the reliability of the data analysis, including concerns about the ability to identify all relevant projects and subjectiveness in the scoring of PSS elements in projects.	
	PSS2	PSS 5	No. of companies offering PSS-solutions within the electronics and ICT sector		It is clear from the policy priorities and many measures on an EU level, which aim at improving the circularity of the electronics and ICT sector, that the focus of the indicator is highly relevant and acceptable by EU stakeholders. Challenges identified around the availability of data and the ease of data collection.	
	PSS2	PSS 6	The percentage of public procurement contracts for electronics and ICT that incorporate PSS models		The indicator is highly relevant, but the advancement of it in the EU is significantly challenged by the lack of available data and the feasibility of new data collection efforts. Further development is highly dependent on the interest and commitment of key stakeholders to develop reporting and data collection frameworks to allow for analysing and monitoring the indicator across the EU MS.	
	PSS3	PSS 7	No. of public financial incentives directed at PSS providers/models		This indicator remains relevant because national financial incentives supporting PSS can be a strong method for promoting the transition to the CE and progress towards the priorities of the CEAP. But, its implementation requires significant efforts to clarify the applicability of high-level measures of financial incentives for PSS as well as the potential methodology for collecting such data across EU MS.	
	PSS3	PSS 8	No. of countries that have included PSS in their national CE strategies		Assessing and monitoring this indicator holds significance, as national commitments and strategies are the cornerstone for driving local initiatives and guaranteeing a particular focus on the subject matter. Collecting data on the indicator through a desk study approach is straightforward, when assuming that publicly available information on national strategies is sufficient to score the various MS' implementation.	
Textiles	T1	T1	Number of jobs in the textile repair sector		The number of jobs in the textile repair sector reflects the overall developments in the sector, such as the economic viability of professional textile repair and the number of items being repaired. It is recommended to also include social dimensions of employment to provide a more robust picture of the employment in the textile repair sector.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
		T2	Number of jobs in the textile recycling sector		This indicator demands extensive data collection based on a material flow analysis, and faces many challenges related to the indirect approach followed and the limited availability and reliability of data on collection rates and textile waste volumes being processed across Member States. Non-disclosure agreements for company data further impede its replicability.	
		T3	Total amount of separately collected textiles		The separate collection of textile waste is the first step to ensure that the materials used for clothing, footwear and household textiles remain circulating at the highest possible level, either entering the reuse market or becoming available for recycling. A clear definition “textile waste” needs to be developed (ideally in the ongoing revision of the WFD).	
		T4	Total volume of secondary raw material output from textile recycling		Being sensitive to supply and demand, an indicator monitoring the output of recycling can contribute to knowledge of the demand for circular materials. However, facilitating the progress of the indicator requires significant work because the data available at the moment is static and very inconsistent.	
		T5	Share of recycled content in textile products put on market by EU brands and retailers		Has potential to create efficiencies in measuring circularity in new textiles. If it is found sufficient to use voluntary self-reported aggregated brand data, it will require work to facilitate its progress, as the data is currently only available at a global scale.	
Food, water & nutrients	FWN1	FWN1	Presence of guidance (labelling) on climate impact of food product categories		Will encourage major retailers to consider the climate impact of food products, incentivising them to rethink their product selection and general responsibility for the sustainability of the food products they sell. A sound definition of climate label and the necessary research to develop this.	
		FWN2	Presence of requirements for organic products in public-procurement of food		Measures the tangible outcome of procurement and circumvents the system boundary issues and issues with non-standardisation of the initial indicator. The identified challenges can largely be overcome by making the change from “presence of requirements for organic food in public procurement” to “share of organic food in public procurement”.	
		FWN3	Sustainable Calorie intake per capita gap of animal-based food consumption		Accessible datasets, readily available through FAOSTAT, are based on established methodologies and provide a solid foundation for their implementation. However, it should be noted that this serves as a proxy indicator, lacking differentiation among EU MS dietary patterns and demographics such as sex, age, and occupation.	
Construction & buildings	CB1	CB1	Share of building products with EPDs with circular properties		Current regulatory developments will likely push development towards more certified EPDs and an increased focus on circularity. To ensure the gathering of valid statistics in the future, the EPD reporting format must be standardised, and data must be harmonised, including the definition of circular properties.	

Policy area	Case Study Group	URN	Indicator name	Recommendation for future implementation	Justification	
		CB2	Number of building projects certified by schemes with circularity requirements		Certification schemes such as DGNB incorporating circularity principles can be used as a proxy indicator to monitor circular development in construction over time. The indicator provides information on the ambitious part of the industry willing to exceed the minimum legal requirements to achieve certification.	
		CB3	Utilisation rate of existing building stock		The indicator test has demonstrated potential, but challenges must be addressed before using the indicator for cross-country comparison. To provide a full overview of the utilisation of existing building stock, data should be gathered in separate categories, such as dwellings, non-residential commercial buildings, and non-residential public buildings.	

Table 27: Recommendations for further development

5. Roadmap for key indicators

The 21 indicators with green recommendations, for further development with 'minor' work required are presented in Table 28. The following sections discuss the recommended next steps actions, both legislative and technical, from the task 5 case studies, and suggestions for potential targets and associated data collection plans resulting from the task 6 activities.

Policy area	Case Study Group	URN	Indicator name
Bioeconomy	B1	B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector
	B2	B2	Share of local forestry by-products going to energy generation
	B1	B4	Number of products with the EU Ecolabel that are bio-based
	B2	B8	Share of biological waste treated with anaerobic digestion
Batteries & vehicles	BV1	BV2	Virgin vs. recycled plastic raw material used in the production of vehicles
		BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry
Electronics & ICT	EICT1	EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products
Households	H1	H1	Use of private vehicles, as a percentage of kilometres travelled per person
	H1	H3	Share of household income spent on service models rather than related ownership of goods
	H1	H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials
	H1	H5	Items of clothing repaired by households per year
	H1	H7	Household spending on maintenance and repair
Plastics	PL1	PL1	Number of pilot/demonstration projects on circular production and treatment of plastics
		PL2	Number of legislative incentives created to encourage circularity in the plastics industry
PSS	PSS1	PSS1	Consumer perception of the attractiveness of PSS models
	PSS1	PSS2	Percentage of citizens who have used PSS models
	PSS2	PSS3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased
	PSS3	PSS8	No. of countries that have included PSS in their national CE strategies
Food, water & nutrients	FWN1	FWN2	Presence of requirements for organic products in public-procurement of food
Construction & buildings	CB1	CB2	Number of building projects certified by schemes with circularity requirements
		CB3	Utilisation rate of existing building stock

Table 28: Key recommended indicators.

5.1. Regulatory & policy plan

The policy recommendations for the key indicators are summarised in Table 29 to Table 32 below. Each policy recommendation has been assessed for its benefits, drawbacks and associated risks, as well as the stakeholders that would need to be consulted to develop the policy recommendation. This assessment also highlights the expected time frame for policy implementation, and the level (EU-wide, National or Regional) at which it would have best impact. Key stakeholders expected to be required to drive the recommendations forward have been classified with a Responsible, Accountable, Consulted, Informed (RACI) matrix, to denote their suggested level of involvement.

Policy recommendations primarily centred around improving the availability and transparency of data and developing incentives for both consumers and businesses to increase their circularity.

Several of the indicators that were tested faced issues surrounding data accessibility, and so policy recommendations have been made that mandate relevant stakeholders to collect and report more comprehensive data. Where data is believed to already be collected internally, recommendations include the development of reporting platforms to make the process of data reporting frictionless and limit the additional burden placed on stakeholders. It is acknowledged, however, that requiring the reporting of additional data will inevitably result in additional cost and resource burdens and so it is also recommended that sufficient guidance be developed, and support be offered to ensure that businesses can meet the new requirements.

The other main trend in recommendations centred around the introduction of incentives to encourage the adoption of circularity. The focus on incentives highlights that there are sometimes significant barriers to circular behaviour, particularly financial barriers, and so care must be taken to ensure that any policies or targets that are progressed do not have unforeseen negative consequences.

5.1.1. Batteries and vehicles

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
BV2	Introduction of a recycled plastics content target in new vehicles manufactured in the EU, aligned with the proposed EOL Vehicles Directive. Implementation of proposed target of: "***at least 25% of plastic used to build a vehicle comes from recycling by 2031 for newly-type approved vehicles only – of which 25% is to come from closed-loop production, recycled ELVs***." Incentivisation will likely be required to increase the sharing of recycled plastic content data for new vehicles manufactured and sold in the EU. This may come in the form of tax incentives or subsidies for organisations that comply.	**Benefits:** • Supports the ELV Directive. • Reduced environmental impact. **Drawbacks:** • Additional cost for companies to comply with new targets.	EU	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s. **Informed:** All stakeholders within EU automotive industry.	Medium term (1.5 – 5 years).
	Introduction of legislation to require the mandatory annual reporting of recycled plastic content (%) in vehicles manufactured and sold across EU Member States is essential to access data required to successfully implement this indicator. Consultation required with National Governments and European automotive Original Equipment Manufacturers (OEMs).	**Benefits:** • Increased transparency in reporting processes. • Wider ESG benefits. **Drawbacks:** • Time and effort required by companies to complete reporting process.	EU	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Medium term (1.5 – 5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
	Introduction of legislation to require the submission of BOM, and/or material/vehicle design specifications alongside quoted recycled plastic content ranges, as evidence to confirm validity. Legislation mandating the submission of this evidence is essential to ensure reliable data is used when implementing this indicator. Consultation required with national governments and European automotive OEMs.	**Benefits:** • Increased transparency. **Drawbacks:** • Challenges around data collection.	EU	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Medium term (1.5 – 5 years).
BV3	Legislation should be implemented to make data reporting mandatory for EOL vehicle battery handlers/processors. Consultation required with National governments, EOL vehicle battery handlers.	**Benefits:** • Increased transparency, greater consumer awareness. **Drawbacks:** • Additional cost to streamline reporting process.	EU	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** National Governments, EOL vehicle battery handlers. **Informed:** All stakeholders within EU automotive industry.	Medium term (1.5 – 5 years).
	Legislation should be implemented to incentivise the reuse of EOL vehicle batteries.	**Benefits:** • Reduced waste. • Lower environmental impact. • Aligns with key CE principles (refuse, reuse, and rethink). **Drawbacks:** Additional cost to repair batteries.	EU	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** National Governments, EOL vehicle battery handlers. **Informed:** All stakeholders within EU automotive industry.	Medium term (1.5 – 5 years).

Table 29: Summary of policy options and assessment for “Batteries and Vehicles”

5.1.2. Bioeconomy

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
B1	Improve national statistics databases so regional and bioeconomy sector data is readily available. Consultation would be required with national statistic organisations to identify potential data collection method improvements.	**Benefits:** • Monitors the performance of the bioeconomy. • Complements the EU CEMF. • Would encourage cross industry collaboration between the bioeconomy sector to share resources regarding private investment, jobs and gross value added related to the bioeconomy sector. **Drawbacks:** • Additional cost to create the national statistics database platform. • Challenges to streamline data collection. • Data collection methods must be improved further.	National	**Responsible:** EC. **Accountable:** National statistics organisations. **Consulted:** Relevant trade bodies. **Informed:** Relevant companies.	Short-term (0.5-1.5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
	Support data collection at company level. Consultation required with company level stakeholders to identify and overcome current challenges companies' face in the collection of data relating to private investment, jobs and gross value added in the bioeconomy sector.	**Benefits:** • Complements the EU CEMF. • Improved data collection would lead to better decision making, better future planning, efficiency. • Improve communication to organisations and to the public around the CE and the bioeconomy and developing relevant strategies would improve the measurement of this indicator. **Drawbacks:** • Additional cost to set up and maintain accurate data collection for companies. • Companies may not be willing to share data. • Current challenges to collect data at the company level. • There may need to be incentives in place for companies to collect data.	National	**Responsible:** EC. **Accountable:** Member States. **Consulted:** Relevant trade bodies. **Informed:** Relevant companies.	Medium-term (1.5-5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
B2	Introduce legislation to ensure wood energy is sourced solely from by-products, and not in conjunction with roundwood from the forest, to ensure wood is used according to the cascading uses of wood. Consultation would be required with EU national governments, relevant industry bodies, forest owners and relevant companies to improve data collection.	**Benefits:** • Resource-efficient use of residues. • Reduced environmental impact. • Technology sustainability advances. • Follows the principles of Sustainable Forestry Management. • Embodied carbon in wood remains sequestered for as long as possible. • Complements the EU CEMF. **Drawbacks:** • Potential increased fuel costs. • Data is not readily available for individual forests and certain EU regions.	EU	**Responsible:** EC. **Accountable:** EC and National EU governments. **Consulted:** Relevant industry bodies and forestry owners. **Informed:** EU regions and relevant companies and public.	Medium term (1.5 – 5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
B4	Legislation required to ensure companies with EU Ecolabel products list all materials / ingredients of the product composition as a mandatory obligation. They should also identify if the product is bio-based or not and make this data available to consumers. This will allow consumers to make more informed choices with regard to the bioeconomy and will ensure data gaps are closed for the future EU Ecolabel indicators. The EU Ecolabel is already a credible and reputable EU metric for the environment. Therefore, it is recommended to build on this framework to leverage its credibility.	**Benefits:** • Greater consumer awareness/more informed decision making. • Verified low ecological impact information. • More informed decision making. • Complements the EU CEMF. • Supports the collection of data on secondary raw materials through the circular material use rate indicators. **Drawbacks:** • Administrative costs in development of the labelling framework • Saturated labels with excess information • Lifecycle impacts of bio-based versus non-bio-based products should also be considered.	EU	**Responsible:** EC. **Accountable:** Member States. **Consulted:** Trade bodies. **Informed:** Manufacturers.	Medium term (1.5 – 5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
B8	Broaden data collection efforts to include all biowaste streams, such as agricultural waste, which are not typically monitored as closely as municipal waste streams.	**Benefits:** • Gives a much fuller understanding of real value of target materials. • Enhances the credibility of the indicator, and the ease with which it can be accurately assessed. **Drawbacks:** • Additional costs to develop, communicate and support new data collection systems. • Complexities and variations in sources of biowaste streams across MS could make it difficult to ensure overall consistency and comparability of data reported.	EU	**Responsible:** EC. **Accountable:** EU. Member States **Consulted:** Relevant trade bodies. **Informed:** Relevant companies.	Medium (1.5 – 5 years).
	Foster greater participation from companies in the monitoring of this indicator through economic or commercial incentives such as subsidies for new Anaerobic Digestion (AD plants or Feed-in Tariffs.	**Benefits:** • Increased acceptance and engagement with the indicator's ambitions. • Increased AD capacity and therefore increased valuable use of biowastes. **Drawbacks:** • Additional cost to develop and administer incentives.	EU	**Responsible:** EC. **Accountable:** EU. Member States **Consulted:** Relevant trade bodies. **Informed:** Relevant companies.	Medium (1.5 – 5 years).

Table 30: Summary of policy options and assessment for “Bioeconomy”

5.1.3. Electronics and ICT

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
EICT1	Incentives encouraging alternatives to purchasing new household electrical items and communications equipment.	**Benefits:** • Minimises the number of new products purchased by households leading to lower environmental impact. **Drawbacks:** • Additional cost to put incentives in place.	National		Medium-term (1.5 – 5 years).

Table 31: Summary of policy options and assessment for “Electronics and ICT”

5.1.4. Households

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
H1	Incentives encouraging the use of public transport and other more eco-friendly forms of transport. To promote public transport use and decrease car dependency, extensive stakeholder consultation with national governments and public transport providers is recommended to facilitate	**Benefits:** • Reduced usage of private cars, lower environmental impact, improved fuel efficiency, reduced air pollution and reduced road congestion.	National	**Responsible:** EC. **Accountable:** National governments. **Consulted:** National governments, public transport providers, citizens.	Medium-term (1.5-5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
	national-level expansion of public transport infrastructure.	**Drawbacks:** • Potentially additional cost to increase share of public transport. • Difficulty accessing public transport in certain regions. • Data collection challenges.		**Informed:** All stakeholders within EU transport industry.	
H3	Tax incentives to encourage the use of service-models. Policy should be considered providing there is a tiered-reporting approach which doesn't overburden smaller reuse centres. There needs to be emphasis on proportionality and support needs to be provided for smaller centres for capacity building. Additionally, considerations should include qualitative data collection on the condition and types of goods being reused so that comprehensive reporting of the reuse activity is possible.	**Benefits:** • Economic benefits (cheaper to rent than buy). • Improved element of choice for consumers. • Predictable revenue streams for suppliers. • Empowers manufacturers to properly maintain and repair products. **Drawbacks:** • Potentially costly to implement.	National	**Responsible:** EC **Accountable:** National Governments. **Consulted:** National Governments, service-model providers, citizens. **Informed:** All stakeholders within the EU service-model industry.	Medium-term (1.5 – 5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
H4	Explore the appropriateness of including this indicator within the regular EU-wide consumer surveys disseminated by the EC. To ensure robust data collection, a short-term pilot test is recommended with a limited sample size to refine surveys before full implementation. Expert consultation could guarantee all relevant aspects of peer-to-peer sharing are captured. Clear communication of the methodology is crucial to avoid misinterpretations.	**Benefits:** • Informs CE policy and improves understanding of consumer behaviours while facilitating city-level comparisons. **Drawbacks:** • Increased survey administration. • Data analysis requires expertise. • Relies on self-reporting which could be a consumer burden or skew data.	EU	**Responsible:** EC. **Accountable:** EC. **Consulted:** EC. **Informed:** Households/citizens.	Short-term (0.5-1.5 years).
	Incentives encouraging the use of peer-to-peer use and sharing models. A policy is recommended to develop incentives for responsible sharing practices that discourage wasteful consumption. This phased approach allows for trialling different incentive structures across regions, fostering collaboration and public-private partnerships to identify the most effective models.	**Benefits:** • Increased peer-to-peer adoption leads to longer product lifespans and reduced waste. • Can foster strong community relationships. **Drawbacks:** • Designing and administering effective incentives can be additional cost. • Incentive misuse and dependence on funding are potential risks.	EU	**Responsible:** EC **Accountable:** National governments. **Consulted:** National governments, peer-to-peer use and sharing platforms, citizens. **Informed:** All stakeholders within EU, the peer-to-peer use and sharing industry.	Medium term (1.5 – 5 years).

URN	Policy Option	Policy Analysis	Level of implementation	Key Stakeholders	Timescale
H5	Tax incentives to encourage repair activities for citizens.	**Benefits:** • Greater levels of repair keep priority products and materials in valuable circulation. • Raise awareness of general CE principles and governmental support for their proliferation. **Drawbacks:** • Designing and administering effective incentives can be additional cost. • Incentive misuse and dependence on funding are potential risks.	National	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** National Governments, repair organisations/centres, citizens. **Informed:** All stakeholders within the EU textile industry.	Medium (1.5 – 5 years).

Table 32: Summary of policy options and assessment for the “Household”

5.2. Technical action plan

This section highlights the recommendations proposed for the suggested CE indicators. The tables presented here outline a series of targeted actions, ranging from collaboration with research institutions to explore existing knowledge gaps to potential funding allocations for propelling specific areas of research and development. By implementing these recommendations, there is scope for refining the proposed indicators and ensuring their effectiveness in measuring progress towards a CE.

The technical recommendations that were made generally fit into three overall categories: recommendations around data collection methodologies; the provision of guidance and information to both consumers and businesses; and stakeholder engagement.

For several of the indicators, further iterations of the testing process are recommended to standardise the methodology, definitions of key terms and system boundaries. This will enable the collection of high-quality and easily comparable data, providing a robust evidence base for the EU to track progress towards circularity. Additional recommendations to the data collection process include the development of digital reporting platforms, to remove potential barriers to reporting, and outreach activities to encourage reporting on the indicators where this is voluntary, not legally required. The EU could also consider providing financial support to organisations to ease the burden of data collection or integrate reporting requirements into any existing certification schemes to ensure that they work smoothly together.

In terms of information provision, it was acknowledged that several of the indicators were poorly understood at this stage and so sufficient guidance and support must be provided to businesses that are subject to new requirements to ensure that they are not negatively impacted. It may also be useful to conduct further stakeholder engagement activities to understand what barriers exist for businesses regarding reporting against the proposed indicators and consider adjusting the scope and requirements of more complex indicators to ease these burdens.

Overall, the focus moving forwards should be on refining the scopes and methodologies of the proposed indicators and ensuring that they are understood and accepted by industry using stakeholder engagement activities, guidance documents and other support opportunities.

The technical actions identified in the 21 key indicators, with an initial high-level assessment of timescales and key stakeholders, are presented in Table 33 to Table 40 below. As with the regulatory and policy actions discussed in Section 5.1 stakeholders have been classified with a RACI matrix, to denote their suggested level of involvement. These recommendations have been categorised into seven main types:

- Citizen engagement – i.e. through surveys or information campaigns.
- Data collection – enhancing or expanding the actual data currently collected.
- Data support – Facilitation actions to allow easier or more effective data collection, such as the development of new tools or portals.
- Guidance & information – provision of extra guidance materials, training or contextual support, to increase understanding of the indicator and its aims.
- Indicator scoping and development – further research or definition work on the indicator itself.
- R&D – research and development work on topics connected to the indicator.
- Sector engagement – stakeholder engagement with sector or policy-them specific groups.

Further discussion of cross-theme requirements for extra resources, both human and financial, for the general trend recommendations of data collection improvement and information provision, is given in Section 6.

5.2.1. Batteries and vehicles

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
BV2	Data collection	Encourage voluntary reporting of recycled plastic content prior to introduction of legislation in 2031. This is to capture as much data as possible prior to the data being formally collected.	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Short (<1.5 years).
	Indicator scoping and development	Scope of the indicator should be expanded to include other materials such as metals, electronics, textiles, and other materials critical to vehicle manufacturing. Development and implementation of a roadmap for gradually including other materials will provide a more comprehensive view for the metric.	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Long (> 5 years).
	Data support	Develop a digital reporting platform to make it easier for OEMs and Tier 1 suppliers to submit their data.	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Long (> 5 years).

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Guidance and information	Develop and implement training programme for automotive manufacturers looking at the benefits and methodology for incorporating and monitoring recycled materials.	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Medium (1.5 – 5 years).
	Data support	Address concerns around data privacy issues - Develop an anonymised data reporting system or a secure data sharing platforms that protects confidential information.	**Responsible:** EC. **Accountable:** European Automotive OEMs and Tier 1s, National Governments. **Consulted:** National. Governments, European Automotive OEMs, Tier 1s and Tier 2s, National Governments. **Informed:** All stakeholders within EU automotive industry.	Long (> 5 years).
BV3	Data collection	A framework should be developed and implemented to ensure standardised data collection and reporting practices across Member States.	**Responsible:** EC. **Accountable:** EC **Consulted:** National Governments, EOL vehicle battery handlers. **Informed:** EOL vehicle battery handlers.	Medium (1.5 – 5 years).

Table 33: Summary of technical recommendations for “Batteries and Vehicles”

5.2.2. Bioeconomy

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
B1	Data support	Support data collection at company level	**Responsible:** EC **Accountable:** Member States **Consulted:** relevant trade bodies **Informed:** relevant companies	Medium (1.5 – 5 years).
	Data support	Develop and adopt standard data formats and protocols for the	**Responsible**: EC **Accountable:** Member States	Short (0.5 – 1.5 years).

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
		bioeconomy sector to facilitate data sharing and integration across Member States, regions and companies.	**Consulted:** relevant trade bodies **Informed:** relevant companies	
	Data support	Implement capacity building and training programmes for stakeholders in the bioeconomy sector to improve data literacy, collection and reporting practices.	**Responsible: EC** **Accountable:** Member States **Consulted:** relevant trade bodies **Informed:** relevant companies	Short (0.5 – 1.5 years).
	Sector engagement	Support overall data collection and the bioeconomy sector in general.	**Responsible:** Member States **Accountable:** regional public organisations **Consulted:** relevant trade bodies **Informed:** relevant companies and public	Short (0.5 – 1.5 years).
B2	Data collection	Regions and companies should aim to record energy wood sourced directly and indirectly, as demonstrated by South Savo data.	**Responsible:** EC. **Accountable:** EC and National EU governments. **Consulted:** relevant industry bodies and forestry owners. **Informed:** relevant companies and public.	Short (0.5-1.5 years).
	Data support	Better guidance around definitions and data collection should be provided to support data collection for large companies and private forestry owners.	**Responsible:** EC. **Accountable:** EU Member States and regional governments. **Consulted:** relevant industry bodies and forestry owners. **Informed:** relevant companies and public.	Short (0.5-1.5 years).
	Indicator scoping and development	Monitor indicator alongside a more detailed set of indicators including share of forestry by-products to sawn logs, pulpwood, and the share remaining on forest floor, to enable better monitoring of biomass utilisation efficiency.	**Responsible**: EC. **Accountable:** EC. **Consulted:** relevant industry bodies and forestry owners. **Informed:** National governments, relevant companies and public.	Medium (1.5-5 years).

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Data collection	Integrating data reporting requirements into certification schemes or compliance regulations for sustainable forestry and bioenergy production could incentivise accurate and timely data collection and reporting.	**Responsible**: EC. **Accountable:** EU Member States and regional governments. **Consulted:** relevant industry bodies and forestry owners. **Informed:** relevant companies and public.	Short (0.5-1.5 years).
B4	Data support	The EU Ecolabel e-catalogue could include more descriptive names of the products, or a webpage link to the product specification due to the difficulties discussed around locating the EU Ecolabel products online. This will allow consumers to find the products with an EU Ecolabel.	**Responsible**: EC. **Accountable:** Manufacturers. **Consulted:** Trade bodies. **Informed:** Consumers.	Short (0.5 – 1.5 years).
		The EU Ecolabel e-catalogue may require updating before further development of this indicator due to some products not being found (which may suggest they have been discounted or discontinued) and some duplicates potentially due to errors in the upload.	**Responsible:** EC. **Accountable:** Manufacturers. **Consulted**: Trade bodies. **Informed**: Consumers.	Short (0.5 – 1.5 years).
	Indicator scoping and development	Establishing a clear threshold and clear guidelines and testing methods to assess bio-based content.	**Responsible:** EC. **Accountable**: Manufacturers. **Consulted:** Trade bodies. **Informed:** Consumers.	Short (0.5 – 1.5 years).
B8	Data collection	Enhance the collection and publication of biowaste data at both the regional and company levels by national statistical agencies	**Responsible**: EC. **Accountable**: EU Member States. **Consulted:** Relevant trade bodies. **Informed**: Relevant companies.	Short (0.5-1.5 years).

URN	Type of recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Data support	Develop and implement standardised data formats and reporting protocols for biowaste and AD operation data to ensure consistency and comparability across regions, Member States and companies.	**Responsible**: EC. **Accountable:** EU Member States. **Consulted:** Relevant trade bodies **Informed:** Relevant companies	Short (0.5-1.5 years).
	Sector engagement	Enhance engagement mechanisms with all stakeholders involved in biowaste generation and AD treatment. This could include regular workshops, forums and feedback sessions to understand data challenges and improve reporting willingness and accuracy.	**Responsible**: EC. **Accountable**: EU Member States. **Consulted**: Relevant trade bodies. **Informed**: Relevant companies.	Short (0.5-1.5 years).
	Guidance and information	Develop and provide targeted training programme for stakeholders at the regional and company levels on data collection, reporting standards, and the importance of accurate data and encourage the adoption of best practices in data management.	**Responsible:** EC. **Accountable:** EU Member States. **Consulted**: Relevant trade bodies. **Informed**: Relevant companies.	Medium (1.5 – 5 years).

Table 34: Summary of technical recommendations for “Bioeconomy”

5.2.3. Construction and Buildings

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
CB2	Indicator scoping and development	To define which certification schemes should comprise the indicator, a minimum criterion might be that the national and international certification schemes as a minimum follow the guidelines of the European framework for sustainable buildings, Level(s).	EC will need to initiate cross-country data collection. To decide criteria for which certification schemes to include, DGNB in Germany and selected national schemes could take part in a working group with the EC. The working group can also provide input for a data collection plan.	Medium (1.5 – 5 years).
	Sector engagement	Identify and notify the certification schemes to be comprised by the indicator. This can involve requests to maintain updated databases at the time of the annual data collection.	Based on the decisions of the working group, the EC can subsequently identify the certification schemes to include and start implementing a data collection plan. This will include regular screening and checks for schemes' compliance with circularity criteria.	Medium (1.5 – 5 years).
CB3	Data support	Eurostat's formal request for standardisation addressed to the National Statistics offices could support the provision of current, comparative, and easily accessible data at the EU level. It should provide clear specification the frequency of data collection and publishing of statistics.	Eurostat, EU member states' national statistical bodies.	Medium (1.5 – 5 years).
	Data support	Eurostat can issue concise methodological guidelines to ensure harmonisation of data.	Eurostat, EU member states' national statistical bodies.	Medium (1.5 – 5 years).

Table 35: Summary of technical recommendations for "Construction and Buildings"

5.2.4. Electronics and ICT

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
EICT 1	Data collection	Surveys should be integrated into existing EC conducted EU-wide surveys.	**Responsible:** EC. **Accountable:** EC. **Consulted:** National governments, citizens. **Informed:** Citizens.	Short (0.5 – 1.5 years).
		Collect data at regular intervals to allow for trends and policy impacts to be tracked.	**Responsible:** EC. **Accountable:** EC. **Consulted:** National governments, citizens. **Informed:** Citizens.	Long (5+ years).
		Survey could be broken down into further granularity to allow for the tracking of different trends.	**Responsible:** EC. **Accountable:** EC. **Consulted:** National governments, citizens. **Informed:** Citizens.	Medium (1.5 – 5 years).
	Guidance and information	Development of public facing guidance to encourage sustainable alternatives to purchasing new electrical items.	**Responsible:** EC. **Accountable:** EU Member States. **Consulted:** Electrical and communication item manufacturers, retailers and repairers. **Informed:** All stakeholders within EU electronics and ICT industry, citizens.	Short (0.5 – 1.5 years).

Table 36: Summary of technical recommendations for “Electronics and ICT”

5.2.5. Food, water and nutrients

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
FWN 2	Indicator scoping and development	Scope which other Member States have national statistics like in the case of Sweden and identify best practice in terms of methodology for data gathering. In the case of Sweden, it appears survey methodology / requesting the data in an email is a successful approach	Local and national stakeholders working with procurement of food and/or data collection.	Short (0.5 – 1.5 years).

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Data collection	Collect national data where existing (e.g. Sweden as of April 2024), and sub-national data by surveying municipalities and/or other relevant procurement actors for data on all of their procurement of food for the previous year, including whether it was organic and if possible, including numbers on cost, quantity (kg), and products.	Local and national stakeholders working with procurement of food and/or data collection.	Short (0.5 – 1.5 years).
	Data support	Use data to create statistics on share of organic food both as share of total food cost, weight.	Statistics team at Eurostat.	Short (0.5 – 1.5 years).
	Indicator scoping and development	Update the EU organic label to be more in line with recent developments in CE for food to create better alignment between the indicator and CE objectives, as well as increase acceptability for this indicator.	Legislators, researchers.	Medium (1.5 – 5 years).

Table 37: Summary of technical recommendations for “Food, Water and Nutrients”

5.2.6. Households

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
H1	Guidance and information	Develop guidance on how cities/regions can improve their infrastructure and encourage alternatives to private vehicle use (e.g. making walkable cities, increasing bus and bicycle infrastructure).	**Responsible:** EC. **Accountable:** National governments. **Consulted:** National governments, citizens. **Informed:** All stakeholders within EU transport industry.	Medium (1.5 – 5 years).
	Data collection	Surveys should be integrated into existing EC conducted EU-wide surveys.	**Responsible:** EC. **Accountable:** EC. **Consulted:** National governments, citizens. **Informed:** Citizens.	Short (0.5 – 1.5 years).

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
	R&D	Benchmarks should be developed to assess private vehicle use and access to alternative modes of transport across urban/rural areas (or specific regions/cities).	**Responsible:** EC. **Accountable:** EC, National governments. **Consulted:** National governments, local authorities, public transport providers, citizens. **Informed:** National governments, local authorities, citizens.	Medium (1.5 – 5 years).
H3	R&D	R&D to quantify the potential environmental impacts of service-models.	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** Manufacturers, service-providers, households/citizens. **Informed:** Households/citizens, service providers.	Short (0.5 – 1.5 years).
	Data collection	If this indicator is implemented in the future, it is recommended to measure the annual household spend on service models as a proportion of overall annual household spend. The indicator should also measure household spend on different service model offerings. As a result, indicator name should be changed to: “Share of household spend on service models in relation to overall household spend”.	**Responsible:** EC. **Accountable:** EC. **Consulted:** NA. **Informed:** Households/citizens.	Medium (1.5 – 5 years).
	Data collection	Due to the complexity of some of the data inputs required from survey participants, it is recommended that sufficient time is allowed for respondents to provide accurate results.	**Responsible:** EC. **Accountable:** EC. **Consulted:** Households/citizens. **Informed:** Households/citizens.	Short (0.5 – 1.5 years).

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
H4	Guidance and information	Develop public facing guidance to educate them on the use of peer-to-peer use and sharing models (e.g. what they are, how they can be accessed, and the benefits of using them).	**Responsible:** EC. **Accountable:** National governments, peer-to-peer use and sharing platforms. **Consulted:** National governments, the peer-to-peer use and sharing platforms, citizens. **Informed:** All stakeholders within EU peer-to-peer use and sharing industry.	Medium (1.5 – 5 years).
	Guidance and information	Invest in digital infrastructure and literacy across regions with a low adoption rate. This may increase the reach of peer-to-peer use and sharing models.	**Responsible:** EC **Accountable:** EC, national governments. **Consulted:** National governments, citizens. **Informed:** Citizens.	Medium (1.5 – 5 years).
	Data Collection	Surveys should be integrated into existing EC conducted EU-wide surveys.	**Responsible:** EC. **Accountable:** EC **Consulted:** National governments, citizens. **Informed:** Citizens.	Short (0.5 – 1.5 years).
H5	Citizen engagement	Development of a website to find the closest repair shop and provide guidance on how to self-repair.	**Responsible:** National Governments. **Accountable:** EC. **Consulted:** Repair organisations/centres, recyclers. **Informed:** Households/citizens.	Medium (1.5 – 5 years).
		Capacity building and awareness programmes for repair to build skills/knowledge and raise awareness across households.	**Responsible:** National Governments. **Accountable:** Local municipalities. **Consulted:** Repair organisations/centres, households/citizens. **Informed:** Households/citizens.	Short (0.5 – 1.5 years).

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Indicator scoping and development	Harmonisation of textile/clothing categories across EU and individual EU Member States.	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** National trade associations, Extended Producer Responsibility Schemes. **Informed:** All stakeholders within the EU textile industry.	Short (0.5 – 1.5 years).
		Assess the suitability of rolling this indicator out to other high priority products (such as electronics and ICT and furniture).	**Responsible:** EC. **Accountable:** National Governments. **Consulted:** Households. **Informed:** Households.	Short (0.5 – 1.5 years).
H7	Guidance and information	Circular design guidance to ensure the priority products are 'designed for repairability' (i.e. can be easily disassembled, upgraded, cleaned, etc.).	**Responsible:** National governments. **Accountable:** EC. **Consulted:** Repair organisations/centres, recyclers, manufacturers, citizens. **Informed:** Product manufacturers and industry.	Medium (1.5 – 5 years).

Table 38: Summary of technical recommendations for "Households"

5.2.7. Plastics

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
PL1	Data collection	Inclusion of project value and projects led by non-EU countries will improve the quality of data collection.	EC, Member states.	Short (0.5 – 1.5 years).
	Data support	An online platform for pilot projects to self-report their operations and facilitate engagement.	EC, Member states, regional/municipal governments, relevant industry bodies, businesses involved in pilot projects.	Medium (1.5 – 5 years)

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
	Data support	Increase the granularity of dataset on GERD by field of study in order to better compare results of this indicator.	EC, Member states, regional/municipal governments, industry bodies.	Medium (1.5 – 5 years).
	Guidance and information	Clear definitions and guidelines for what information must be reported about each pilot project, including detailed descriptions of project objectives, technologies used, and outcomes.	EC, Member states, regional/municipal governments, relevant industry bodies, businesses involved in pilot projects.	Medium (1.5 – 5 years).
PL2	Guidance and information	Develop a rubric to confirm whether a given legislation is within scope of the indicator, including whether it is an amendment, supplementary document or regarding a topic other than plastic	EC, Member states, IS networks, trade groups.	Short (0.5 – 1.5 years).
	Indicator scoping and development	Consider tracking indicator over multi-year period to increase the statistical significance of the results.	EC.	Short (0.5 – 1.5 years).
	Data collection Member States' plastic legislation	Develop a baseline understanding of Member States' plastic legislation. Undertake an exercise to understand current numbers of plastic legislation for more effective interpretation of results.	EC.	Short (0.5 – 1.5 years).
	Data support	Develop a digital portal where Member States can directly report information on legislative incentives to EC.	EC.	Medium (1.5 – 5 years).

Table 39: Summary of technical recommendations for "Plastics"

5.2.8. Product service systems

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
PSS1	Sector engagement	Initiate a research and stakeholder engagement effort to progress towards implementing consumer surveys concerning perception of PSS models, and other CE topics, across EU Member States. Required efforts include defining products and product groups to survey and clarify the potential of integrating surveys in existing systems or the need for new efforts.	**Responsible:** EC. **Accountable:** EU Member States. **Consulted:** Research institutions and international organisations (e.g. EEA). **Informed:** Business associations.	Medium (1.5 – 5 years).
PSS2	Sector engagement	Initiate a research and stakeholder engagement effort to progress towards implementing citizen surveys concerning use of PSS models, and other CE topics, across EU Member States. Required efforts include defining products and product groups to survey and clarifying the potential of integrating surveys in existing systems or the need for new efforts.	**Responsible:** EC. **Accountable**: EU Member states. **Consulted:** Research institutions and international organisations (e.g. EEA). **Informed**: Business associations.	Medium (1.5 – 5 years).
PSS3	Sector engagement	Clarify the data availability and gaps across all EU countries through a consultation process	DG-RTD to initiate and manage the consultation. NSIs and Lease Europe to provide perspectives and input in the consultation. DG-ENV to be informed on the process.	Short (0.5-1.5 years).
	R&D	Call/funding for research project regarding the potential for increased circularity related to operational leasing of EV passenger cars.	DG-RTD / DG-ENV to initiate the funding of the research project. Leasing operators, car manufacturers, auto repair business associations, employee associations and other value chain actors to provide relevant insights. Universities or	Medium (1.5 - 5 years).

URN	Type of Recommendation	Recommendation and benefits	Key stakeholders	Timeline
			research institutions to develop research proposals.	
PSS8	Sector engagement	Engage with national Member State ministries and EU institutions to assess the potential of collecting data on and/or including the indicator in reporting mechanisms to advance the inclusion of PSS in national policies and strategies.	DG RTD to initiate a stakeholder engagement process with Member State, Eurostat, the European Economic and/or Social Committee (reg. the CE Stakeholder Platform) to guide further development of the indicator.	Short (0.5 – 1.5 years).
	Indicator scoping and development	Developing a scoring system or a set of criteria to evaluate the depth and breadth of PSS integration into national strategies. This system could consider factors like the specificity of actions outlined, allocated funding, implementation timelines and measurable targets.	**Responsible:** DG RTD. **Accountable:** EC. **Consulted**: DG ENV, EU. Member States Informed: Business Associations.	Medium (1,5 – 5 years).

Table 40: Summary of technical recommendations for “Product Service Systems”

5.3. Target setting

The final stage of the project (task 6) was focused on reviewing the outputs from all previous tasks delivered and outlining recommendations to ensure the successful implementation of those indicators listed for further development. This began with a thorough assessment of existing CE targets to identify priority themes for new target development; as well as developing a corresponding data collection plan for the key indicators emerging from task 5. This was further progressed to inform policymaking and decision-taking, including regulatory policy planning and a technical action plan – such as research and innovation programming in CE.

5.3.1. Review of existing CE targets

To develop a clear understanding of the current types of circularity targets across the EU, a desktop review was carried out to confirm and assess existing CE targets in the EU, across all levels of interest. This included building on the task 1 and 2 literature reviews, referring to knowledge accrued during the stakeholder engagement work in task 4, and identifying any additional policy and academic literature to develop a thorough understanding and baseline to build upon.

One of the strategic aims of the overall project was to develop a deeper understanding of activity and impact of high-value circular activities than the tradition focus on recycling performance has allowed thus far. To aid the move towards this understanding, by developing a baseline understanding of the level of target coverage of different types of circularity, the target review adopted the 10-Rs framework in its analysis.

5.3.1.1. Desktop research summary

Before starting the desk-based search, the sources used to conduct task 1 and 2 literature reviews were collated and re-examined. Then, in the same document CE targets found in the sources reviewed were logged. Once a target was identified, the information required was then recorded.

From the 81 sources identified across tasks 1 and 2:

- Three were not reviewed for the following reasons:
  - One was in a foreign language and the document format did not allow for a reliable translation using online tools.
  - One was a methodology designed by the EC and aimed at policy and decision-makers.
  - One did not have the relevant documents readily accessible online.
- 30 did not have targets.
- A total of 281 targets were logged.

5.3.1.2. Target gap analysis

Table 41 below shows an initial existing target gap analysis against the R themes.

The R theme most covered by existing targets was 'Recycle' with 39 existing targets identified (14%) monitoring this theme. It is followed by 'Reduce' covered by 29 existing targets identified (10%) and 'Reuse', covered by 24 existing targets identified (9%). Four R themes were found to not be covered by existing targets identified, namely 'Repurpose', 'Remanufacture', 'Refurbish' and 'Refuse'. 38 existing targets identified (14%) were classified as 'Other' and were excluded from the final analysis. These are United Nations (UN) Sustainable Development Goals (SDGs) related targets that were found to be linked to the CE but only as enablers, therefore not supporting the direct monitoring of the CE. 111 existing targets identified (40%) were flagged as 'Multiple (specify)' and where further investigated. Results can be found in Table 41.

R theme	Targets Count	Percentage (%)
Recover	10	4
Recycle	39	14
Repurpose	0	0
Remanufacture	0	0
Refurbish	0	0
Repair	9	3
Reuse	24	9
Reduce	29	10
Rethink	21	7
Refuse	0	0
Multiple (specify)	111	40
Other	38	14
TOTAL	**281**	**100**

Table 41: Initial existing targets gap analysis against R themes

Table 42 below presents the analysis of the existing targets identified labelled as 'Multiple (specify)'.

Of the 111 existing targets identified labelled 'Multiple (specify)', 18 (16%) could be reassigned against specific R themes, to which they could be considered relevant. However, 93 existing targets identified (84%) could not be mapped against an R-theme, since the themes covered were not considered to be directly linked to one specific CE R-strategy, or the target was difficult to attribute to a single R-strategy due of its nature. Therefore, these were excluded from the final analysis. Some examples of these targets which could not be classified against a single specific R-theme included the following:

- "Create up to 300,000 additional jobs, including in new professions".
- "From 2019, adapt professional skills for better production at the national and regional levels."
- "By 2019, propose services related to the circular economy (purchase of second-hand products, services related to the product services systems, etc.) via the UGAP (Union of Public Purchasing Groups)."
- "Preparation for reuse, recycling and recovery of municipal waste: 55% by weight by 2025, 60% by weight by 2030, 65% by weight by 2035".

Reason	Count	Percentage (%)
Does not specify which R strategy, various / all could be involved	93	84
Recycle, Recover	2	2
Recycle, Recover, Reuse	10	9
Recycle, Rethink	1	1
Recycle, Reuse	3	3
Repair, Refurbish, Remanufacture, Repurpose, Reuse	1	1
Reuse, Reduce	1	1
TOTAL	**111**	**100**

Table 42: 'Multiple (specify)' targets analysis.

Table 43 below presents the final gap analysis of existing targets against R themes.

After reallocating some existing targets identified to specific R themes and excluding existing targets identified that could not be mapped against R themes, it was found that final results were quite similar to the initial analysis. Indeed, 'Recycle' is still the R theme the most covered by existing targets identified with 55 targets (30%) monitoring this theme. It is followed by 'Reuse', monitored by 39 existing targets identified (22%) and 'Reduce', monitored by 30 existing targets identified (17%). The R themes the least covered are unchanged ('Repurpose', 'Remanufacture', Refurbish', and 'Refuse').

R theme	Target count	Percentage (%)
Recover	22	12
Recycle	55	30
Repurpose	1	1
Remanufacture	1	1
Refurbish	1	1

R theme	Target count	Percentage (%)
Repair	10	6
Reuse	39	22
Reduce	30	17
Rethink	22	12
Refuse	0	0
TOTAL	**181***	**100**

** The total number of targets in this table is different from the total number of targets logged as some targets were found to cover multiple R themes.*

Table 43: Final existing targets gap analysis against R themes

5.3.1.3. Correlate with relevant indicators.

Table 44 below presents the analysis of the proposed indicators against the R themes.

A total of 60 indicators were investigated for this study, however, most of them were found to cover more than one R theme. Therefore, it was found that overall, the indicators studied covered a R theme a total of 176 times, with a partially homogenous cover of each theme (coverage ranging from 5% to 16%). However, eight indicators (5%) were found to not being relevant against any of the R theme and were therefore excluded from this analysis. This is because they are related to wider topics such as transition agendas, or social life cycle assessment. These 8 proposed indicators categorised as “N/A” and excluded from this analysis were as follows:

- CR7 - Number of city resources (public institutions etc) implementing circular transition agendas.
- H1 - Use of private vehicles, as a percentage of kilometres travelled per person, at regional/city level.
- B1 - Private investment, jobs and gross value added related to the bioeconomy sector.
- B4 - Number of products with the EU Ecolabel that are bio-based.
- B5 - Level of engagement of various types needed for companies to develop a bioeconomy that supports the biosphere around them.
- B7 - Effects on local communities of a circular bioeconomy.
- PL1 - Number of pilot/demonstration projects on circular production and treatment of plastics.
- PL2 - Number of legislative incentives created to encourage circularity in the plastics industry.

R theme	Indicators count	Percentage (%)
Recover	9	5
Recycle	18	10
Repurpose	10	6
Remanufacture	11	6
Refurbish	14	8
Repair	18	10

R theme	Indicators count	Percentage (%)
Reuse	26	15
Reduce	23	13
Rethink	28	16
Refuse	11	6
N/A	8	5
TOTAL	**176**	**100**

Table 44: Investigated indicators mapping against R themes.

Table 45 below presents the results of the correlation of existing targets identified with proposed indicators.

The gap was calculated by subtracting the share of proposed indicators covering a R theme by the share of existing targets identified covering the same R theme. A positive gap indicates that the proposed indicators are covering a R theme that are currently underrepresented by existing targets. Conversely, a negative gap suggests an overlap where, proposed indicators cover areas already addressed by existing targets.

Results show that the proposed indicators are covering more significantly the R themes that are not being already covered by existing targets identified, which was expected from the work undertaken in task 4. The analysis reveals significant coverage gaps in the R themes of 'Refurbish', 'Refuse', 'Remanufacture', and 'Repurpose'. These findings suggest prioritising these themes in future target setting to address current deficiencies.

R theme	Targets count	Indicators count	Targets % (a)	Indicators % (b)	Gap (b - a)	Rank
Recover	22	9	12%	5%	- 0.07	9
Recycle	55	18	30%	10%	- 0.20	10
Repurpose	1	10	1%	6%	0.05	4
Remanufacture	1	11	1%	6%	0.06	3
Refurbish	1	14	1%	8%	0.07	1
Repair	10	18	6%	10%	0.05	5
Reuse	39	26	22%	15%	- 0.07	8
Reduce	30	23	17%	13%	- 0.04	7
Rethink	22	28	12%	16%	0.04	6
Refuse	0	11	0%	6%	0.06	2
TOTAL	**181**	**168**	**100%**	**100%**	**N/A**	**N/A**

Table 45: Correlation between existing targets identified and proposed indicators against R themes.

5.3.2. Approach to target setting.

National governments play a crucial role in translating EU directives into actionable policies and strategies tailored to their specific contexts. Setting CE targets at the national level involves aligning with EU objectives while addressing country specific challenges and opportunities. This may include setting targets for increasing the use of recycled materials, promoting ecodesign principles, and investing in circular innovation. Of the 21 key recommended indicators, examples where potential national targets can drive the transition to CE, and scale up to EU level monitoring, include:

- B1: Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector.
- B4: Number of products with the EU Ecolabel that are bio-based.
- B8: Share of biological waste treated with AD.
- PL1: Number of pilot/demonstration projects on circular production and treatment of plastics

Regional authorities can further refine CE targets to reflect local priorities and conditions. This involves identifying regional strengths and weaknesses, engaging stakeholders, and developing targeted initiatives to promote circularity within specific geographic areas. Regional targets may focus on areas such as waste management infrastructure, circular procurement practices and support for circular innovation. Examples from the key recommended indicators where regional refinements and approaches to target setting could be appropriate are:

- B2: Share of local forestry by-products going to energy generation
- EICT1: Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products
- H1: Use of private vehicles, as a percentage of kilometres travelled per person.
- H3: Share of household income spent on service models rather than related ownership of goods.
- H4: Level and perception of peer-to-peer use and sharing across a range of products/ materials.
- H5: Items of clothing repaired by households per year, at city/regional level.
- PSS1: Consumer perception of the attractiveness of PSS models
- PSS2: Percentage of citizens who have used PSS models.
- FWN2: Presence of requirements for organic products in public-procurement of food.

Companies play a pivotal role in driving the transition to a CE through their operations, supply chains, products and services. Setting CE targets at the company level involves assessing current resource use, waste generation and environmental impacts, and identifying opportunities for improvement. Targets may include reducing material consumption, increasing product lifespan and implementing circular business models such as product-as-a-service. Of the key recommend indicators from this study, those where company level targets could be set to incentivise the development of greater circularity at ground-level include:

- BV2: Virgin vs. recycled plastic raw material used in the production of vehicles.
- BV3: Quantity of end-of-use batteries retained for reuse in the EU automotive industry.
- CB2: Number of building projects certified by schemes with circularity requirements.

Applying a consistent approach to target-setting is important to ensure effective collaboration between monitoring bodies and stakeholders. Following a thorough review, where the indicators were cross-referenced and assessed with existing target-setting methodologies, two appropriate

methodologies for target-setting have been identified: The Circular Economy Target-Setting Initiative (CETS) [18] developed by DG-RTD and the Key Performance Indicator (KPI) model developed by the Circular Economy Indicators Coalition (CEIC) [19]. These target-based methodologies were specifically selected for their ability to deliver clear guidance measures through the use of coordinating metrics and monitoring properties, and represent best practice in promoting circular activity, specifically in the context of the EU. These standardised frameworks offer consistency across different levels of implementation (EU, national, regional, etc.), align with the EU's CE principles, and can be used in conjunction with relevant European legislation supporting a CE in policy focus areas and sectors. They are systematic frameworks which help guide regional and national bodies implement measurable policies, while supporting businesses and communities in providing a step-process on how to optimise their resource and material usage, whilst adhering to regulatory standards.

These frameworks allow national and regional decision makers to strategically adapt their strategies, while monitoring them against other regions with similar economies that align with circular EU policies. With regards to businesses committing to implementing more stringent CE practises, these frameworks provide guidance to align short- and long-term targets.

CETS is a strategic framework developed to provide guidance in setting measurable objectives with regards to waste management and sustainable development. The guide seeks to provide coordination across the circular metrics landscape, giving organisations a holistic view of resource usage throughout their value chain, whilst providing tools on how to monitor progress and track efficiency. Details within the framework highlight the effective use of different standards to enable companies and policymakers to set ambitious yet measurable goals through credible and recognised circular definitions. Within the wider context of supporting circular objectives outlined by European Directives, the CETS guide can support national and regional bodies to develop clear action plans that promote best-practice circularity. However, the model does bring some challenges, specifically attributed to implementation and variability. For example, as this framework aims to harmonise waste management properties and stimulate a CE across various levels (EU, national, regional, etc.), it requires significant consistency and accuracy of data. This framework requires reporting bodies to continually collect updated data, establish viable reporting systems and align their practices with updated standardised frameworks.

CEIC developed a similar strategic framework used to optimise circular target-setting within organisations. Rather than replicating or replacing existing circular tools, the goal of this approach is to facilitate alignment, and bridge gaps in circular target-setting across organisations and wider circular practices. This is titled, the Outcome KPI model[20], which focuses on the entire value chain of resources and materials within businesses and identifies opportunities for waste reduction and resource efficiency. By aligning KPIs and metrics, companies can better track resource use, and waste consumption and reduction values. This guide can provide a roadmap for businesses to set meaningful circular targets, measure their impact, and effectively contribute to progressing Europe’s circular transition. However, there are certain data challenges that organisations face when looking to implement this. For example, the KPI model relies on specific metrics to assess circular performance. Organisations need accurate and consistent data to calculate these indicators. Gathering relevant information can be resource-intensive, especially for smaller companies or regions with limited data infrastructure. Ensuring data quality and comparability across diverse contexts remains a challenge.

However, there are steps that can be taken in order to overcome the challenges highlighted above for each framework. For example, collaborative data partnerships between stakeholders and governing bodies can provide a clearer supply of updated information between all parties that strive to boost circularity. Establishing connections with universities and research centres can provide a deeper pool of reliable and relevant data. Additionally, for challenges attributed to implementation,

[18] PACE_Circular targets initative_POV_vFinal_0.pdf (pacecircular.org)

[19] Circular Economy Indicators Coalition (CEIC) (circle-economy.com)

[20] Methodology for the implementation of a circular economy at the local and regional scale.pdf (europa.eu)

adopting a subset of target-based reuse strategies on an incremental basis can give the target setter the opportunity builds a greater platform and capacity for circular development in the short- and long-term future.

The principles of these frameworks, and the process followed in the indicator testing for this study, have been used to develop and propose a combined methodology to set targets aligned to each of the indicators recommended for further progression. The steps of this target-setting methodology, and how they feed reciprocally into each other, are summarised in Figure 8, followed by brief further discussion.

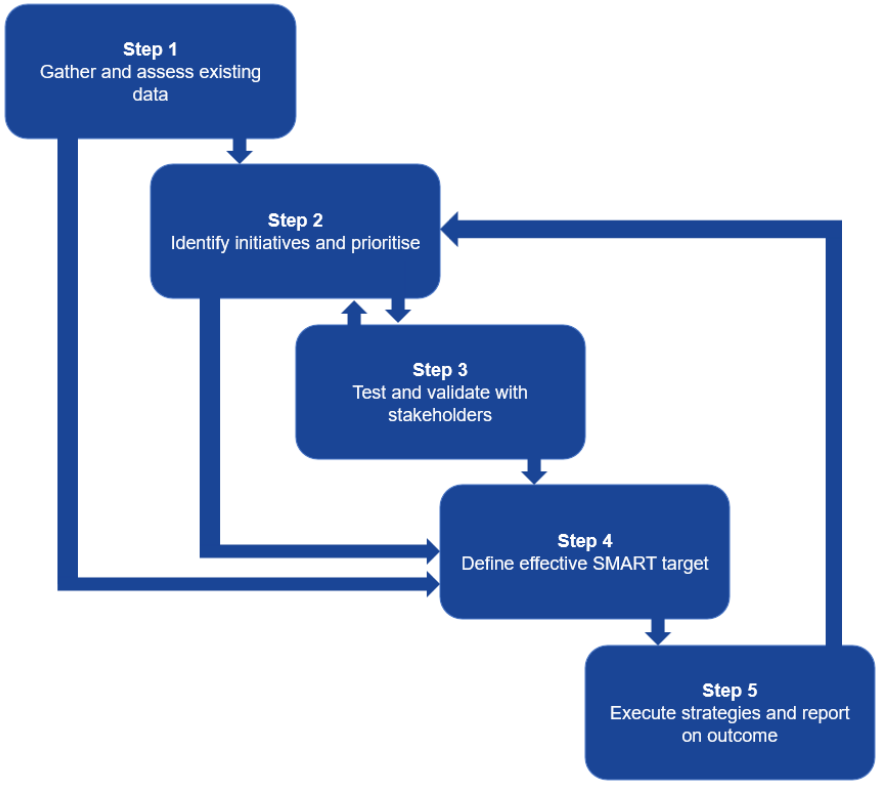


Figure 8: Proposed target setting methodology.

Step 1: Gather and assess existing data.

At the initial stage, target setters should record and evaluate existing data for the variable/variables being measured. Gathering this data involves a myriad of quantitative and qualitative measurements, analysing the entire resource flows, waste streams and material usage. This step allows for the establishment of baseline values from which circular targets can be set and monitored following the redevelopment process.

For example, from the Cities and Region policy area, one existing target identified was the EC's plan to double the use of recycled material from 11.5% in 2022, to a target of 23.2% by 2030, companies must assess the streamlined recycled material usage to identify potential areas that can add value and efficiency, while reducing their overall waste generation. Carrying out quantifiable and qualitative measurements, companies have the capacity to accurately set baseline assessments, and align them with projected targets that address current recycling rates and material consumption, respectively. This can be a valuable stage when looking to increase recycled material content in the future.

Step 2: Identify initiatives and prioritise.

Once the relevant data has been gathered and assessed, target setters can then scope out and identify relevant initiatives that align with the objective of progressing towards greater circularity for the area or material stream in question. This is a crucial stage of the process as target setters can work within current and proposed legislative or regulatory contexts that support and promote the development of circularity with specific regions or highlight gaps within those frameworks and identify new policy options to fill them. Thus, combining the understanding of the current situation derived from the data work in Step 1 with knowledge of existing theme or sector-specific regulatory provisions decisions can be made on which actions and activities to prioritise.

There could be an overarching need for the development of new policy at the relevant level, or there could be opportunity to focus on more practical activities to drive progress within the existing landscape. For example, the EU CEAP seeks to establish a more robust analysis of the entire life cycle of products. The plan focusses on the direct design and use of products, while ensuring that sustainable consumption is prioritised to ensure that resources used are kept in the EU economy for as long as possible. Thus, in conjunction with the 2030 target, national and regional policy makers can use this action plan as a platform to formulate their own strategy to optimising the direct use and management of recycled materials and develop a roadmap to match the EC's goal.

Step 3: Test and validate with stakeholders.

Any policy or practical initiatives or activities designed to incentivise and drive progress towards a true CE have a much better chance of success if they have the buy-in of the relevant stakeholders who will be required to contribute to their success, and/or who will be affected by them in any way. At the scale of EU policy making, the Better Regulation agenda and guidelines lay out best practice principles for the mapping and engaging of affected stakeholders. These principles can be applied effectively at all levels, and in the case of stakeholder engagement are summarised thus:

It is good practice to plan consultations using a simple, concise strategy that identifies relevant stakeholders and targets them with a range of activities, in order to gather all relevant evidence (data, other information and views). For maximum usefulness and inclusivity, it is important to consult as widely as possible (while avoiding 'consultation fatigue'), giving all interested parties the opportunity to contribute to the timely evaluation or development of effective policies. All relevant stakeholders should have a reasonable period, in which to make informed and effective contributions. Subsequently, the respondents should receive feedback on how their contributions have been used.[21]

The identification and mapping of stakeholders can be assisted by the application of a RACI framework as employed in this study.

Once policy or initiative options have been discussed in this way with key stakeholders, and the relevant outputs considered, they can be refined and prioritised for action based on a combination of their ambition in incentivisation towards true theme or sector-specific circularity, and a practical assessment of their acceptability and chances for success.

Step 4: Define effective SMART target.

This step combines the output of the first three to define and communicate a target which is Specific, Measurable, and Achievable, Relevant, and Time-bound (SMART). Targets should be informed by the understanding of the current situation, the rate and impact of implementation of any identified activities or initiatives, and the capacity of the stakeholders required to deliver the actions identified. For maximum clarity and conciseness, target should be:

- Specific: What exactly is going to be measured, and against which baseline?
- Measurable: Does the required data exist, or is there a clear plan of how to attain it?

[21] https://commission.europa.eu/document/download/d0bbd77f-bee5-4ee5-b5c4-6110c7605476_en?filename=swd2021_305_en.pdf

- Achievable: Is the suggested rate of progress realistic?
- Relevant: Would accomplishment actually contribute to the wider goal of true circularity?
- Time-bound: What is the specific timeline for the target?

Examples of potential SMART targets for the 21 key recommended indicators from this study, and examples where no specific target has been suggested as they could not at this stage meet all of these criteria, are given in Section 5.3.3

Step 5: Execute strategies and report on outcome.

Execution involves implementing the activities and initiatives identified and selected to achieve circularity goals. A key aspect of this stage is effective transparency between stakeholders and policymakers to monitor progress. Establishing a collaborative engagement between all parties opens opportunities to share knowledge, evaluate the steps being taken, measure impacts of the implementation, and highlight and share best practice.

Standardised reporting systems should be developed and employed to allow relevant bodies to disclose the data required to monitor progress.

Consistent and honest evaluation of progress can be used to drive continuous improvement by aligning policy adjustments with reporting standards and prioritised actions. By highlighting areas of improvement or drawing upon milestones achieved through the roll out of these strategies, evaluation can be an essential component for refining and optimising CE initiatives.

Despite the above methodology being transferable for various indicators in different sectors, it is also important to review and consider any sector-specific directives or standards which will inform the target setting process. Therefore, it would be recommended to contextualise strategies and tailor them accordingly to cater for their respective regional boundaries. For example, different sectors have varying unique challenges, resource flows and regulatory frameworks, such as industries that are material and textile heavy and may have heavier constraints on their ability to redevelop their waste streams. Thus, considering sector-specific factors ensures that circular initiatives align with the regulations in each respective policy focus area.

5.3.3. Target proposals

The next stage of the research involved reviewing the 21 key indicators from task 5 recommendations and defining SMART targets to address the target gaps identified in previous stages.

These indicators were assessed alongside the other targets identified through the desktop research conducted in task 1 and task 2. Table 46 below presents a summary of the targets proposed, alongside the relevant indicators. The table also highlights where targets already exist, having been implemented or proposed before the testing of the indicator as part of this project. Indicators marked with an asterisk in the table are those with updated name suggestions from the testing process, as discussed in Section 4.5.

During the task 5 process, data collection presented challenges for many indicators due to limited access to information during desk-based research and insufficient engagement with stakeholders within the testing period timescale. As a result, the task 5 case studies only draw up a limited number of detailed targets for the indicators at this stage, with others being given high level suggestions of potential targets, pending further development and implementation of the legislative and technical actions discussed in Section 5.

For those indicators without detailed targets, the target-setting methodology developed, which is transferable across the different indicator groups, is recommended for implementation once the required roadmap actions have been begun, to progress the indicators further.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
B1	Private sector investment, number of jobs created, and gross value added related to the bioeconomy sector	N/A	Not discussed in case study directly.	5% increases year-on-year in investment, jobs added and GVA related to the bioeconomy sector, from a 2025 baseline.
B2	Share of local forestry by-products going to energy generation*	N/A	Not discussed in case study directly.	5% decrease year-on-year in the share of wood energy sourced directly from forestry by-products, from a 2025 baseline.
B4	Number of products with the EU Ecolabel that are bio-based	N/A	Not discussed in case study directly.	5% increase year-on-year in number of EU Ecolabel product with verified minimum of 50% bio-based materials, from a 2025 baseline.
B8	Share of biological waste treated with AD	N/A	Potential for development of targets for share of biowaste treated by AD.	10% increase year-on-year in share of biowaste treated by AD, from a 2024 baseline.
BV2	Virgin vs. recycled plastic raw material used in the production of vehicles	Proposed ELV Directive from EC (2023) "in 2031…at least 25% of plastic used to build a vehicle comes from recycling – of which 25% is to come from recycled ELVs."	Not discussed in case study directly.	25% minimum recycled content in vehicle plastic, of which 25% to come from closed-loop ELV production, by 2031.
BV3	Quantity of end-of-use batteries retained for reuse in the EU automotive industry	Batteries Regulation (2023) The regulation provides for mandatory minimum levels of recycled content for industrial, SLI	Not discussed in case study directly.	5% increase year-on-year in number of end-of-use batteries retained for reuse in the EU automotive industry, from a 2025 baseline.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
		batteries and EV batteries. These are initially set at 16% for cobalt, 85% for lead, 6% for lithium and 6% for nickel. Batteries will have to hold a recycled content documentation.		
EICT1	Percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products	N/A	Not discussed in case study directly.	5% increase year-on-year in percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products, from a 2024 baseline.
H1	Use of private vehicles, as a percentage of kilometres travelled per person	N/A	Not discussed in case study directly.	10% decrease year-on-year in self-reported percentage of total kilometres travelled in private vehicles by citizens, from a 2025 baseline.
H3	Share of household income spent on service models in relation to overall household spend*	N/A	Not discussed in case study directly.	5% increase year-on-year in self-reported share of household income spent on service models in relation to overall household spend, from a 2025 baseline.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
H4	Level and perception of peer-to-peer use and sharing across a range of products/ materials	N/A	Not discussed in case study directly.	10% increase year-on-year in both the self-reported levels and positive perception of peer-to-peer use and sharing models, from a 2025 baseline.
H5	Items of clothing repaired by households per year, at city/regional level	N/A	Repair rate of all priority products to be implemented within the framework of the Ecodesign for Sustainable Products Regulation (ESPR). Also supportive of developments from the EU 'Right to Repair'.	5% increase year-on-year in self-reported repair rate of clothing by households, from a 2025 baseline.
H7	Household spending on maintenance and repair, across priority product and material streams, at city/regional level	N/A	Repair rate of all priority products to be implemented within the framework of the ESPR. Also supportive of developments from the EU 'Right to Repair'.	N/A[22]
PL1	Number of pilot/demonstration projects on circular production and treatment of plastics	N/A	It is not recommended that any targets be introduced regarding the raw number of pilot projects. This is because the number of projects alone does not account for the value of these projects or how the number relates to population, GERD or any other variables that might impact a country's capacity. However, the EU could consider either a target to increase the number of pilot projects on a percentage basis from a baseline year, or a	5% increase year-on-year in pilot/demonstration projects on circular production and treatment of plastics, from a 2025 baseline. **Or**

[22] Whilst this indicator is considered to have the potential to give valuable insight to the rate of repair for priority products, it is not appropriate to set a specific target for it. The aim is not to increase the level of household spending on such activities, but to use the intelligence as a barometer for progress in their availability and proliferation.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
			target based on the total spending on pilot projects per year.	5% increase year-on-year in share of total national R&D expenditure going towards pilot/demonstration projects on circular production and treatment of plastics, from a 2025 baseline.
PL2	Number of legislative incentives created to encourage circularity in the plastics industry	N/A	It is not recommended that any targets be introduced regarding the raw number of legislative incentives, because this would not provide any information regarding the topics of the incentives or their effectiveness, and does not take into account how well developed a given country's plastic-related legislation was prior to the tracking of this indicator. However, the indicator can still provide a useful snapshot on how countries are taking the initiative to tackle plastic pollution over time and given that this data is anticipated to be freely available across the EU, should not have a significant administrative burden associated. As more work is done to harmonise plastic laws across the EU, a target based on innovation in the legislative system could be considered.	N/A at this stage of development, as per column to the left.
PSS1	Consumer perception of the attractiveness of PSS models	N/A	Not discussed in case study directly.	10% increase year-on-year in self-reported levels of positive perception of PSS models, from a 2025 baseline.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
PSS2	Percentage of citizens who have used PSS models	N/A	Not discussed in case study directly.	10% increase year-on-year in self-reported levels of citizens using PSS models, from a 2025 baseline.
PSS3	The percentage of electric vehicles, in the category of passenger cars, that are operationally leased	N/A	Not discussed in case study directly.	N/A[23]
PSS8	No. of countries that have included PSS in their national CE strategies	N/A	It could be relevant to consider a target on the number of countries who integrate PSS in their national CE strategies. This is appropriate for 'Rethink' since integrating PSS in national strategies has the potential to shape national initiatives for incentivizing, data collecting/research, funding etc. regarding the development of PSS models, which has a potential to support systemic/structural changes on circular business models supporting the CE transition.	All new and updated national CE strategies, from 2025, to consider PSS strategies and how they could be implemented.

[23] No direct target setting is considered relevant for this indicator at this stage. While leasing is not the most promising of all PSS models for EVs in terms of increasing circularity, since shared mobility solutions and other transport forms, such as cycling and public transit, have greater environmental and social benefits. Leasing of EVs can, however, be seen as an early step in a circular transition to higher-level PSS models in the sector. The quality and availability of data for this indicator gives a strong position as a stepping point to greater circularity.

URN	Indicator	Existing or proposed target(s)	Task 5 Target Discussion	Potential SMART Target(s)
FWN2	Presence of requirements for organic products in public-procurement of food	N/A	Not discussed in case study directly.	10% increase year-on-year in the share of organic food, by weight, in total public food procurement, from a 2025 baseline.
CB2	Number of building projects certified by schemes with circularity requirements	N/A	Not discussed in case study directly.	10% increase year-on-year in the number of building projects certified by schemes with circularity requirements, from a 2025 baseline.
CB3	Utilisation rate of existing building stock	N/A	Not discussed in case study directly.	N/A at this stage of development.[24]

Table 46: Summary of existing and proposed targets recommended for progression alongside key indicators.

[24] While this indicator shows good potential to promote more renovation and repurposing of vacant buildings rather than demolishing and constructing new buildings, there is still work to be done on developing harmonised definitions of several aspects, such as the types of buildings to be focussed upon (dwellings, commercial buildings etc.). Once work is done to progress is, as per the recommendations made, a meaningful target will be easier to derive.

5.3.4. Data collection plan

Table 47 below details the high-level recommendations for data collection for the indicators for which data was perceived to be available. The table gives a RAG status of the gaps in data availability discussed in Section 4.3, with mitigation actions to fill those gaps forming a large proportion of the recommendations in Section 5.2.

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
BV2	25% minimum recycled content in vehicle plastic, of which 25% to come from closed-loop ELV production, by 2031.	*orange*	*orange*	A data collection plan was not developed for this indicator due to uncertainties around data availability			
BV3	5% increase year-on-year in number of end-of-use batteries retained for reuse in the EU automotive industry, from a 2025 baseline.	*orange*	*orange*	A data collection plan was not developed for this indicator due to uncertainties around data availability			
B1	5% increases year-on-year in investment, jobs added and GVA related to the bioeconomy sector, from a 2025 baseline.	*orange*	*orange*	A data collection plan was not developed for this indicator due to uncertainties around data availability			

[25] Green = data was fully available or available with minor assumptions. Orange = some data was available or available with major assumptions or available at alternative levels. Red = no data available.

[26] Green = following testing of the indicator, data is perceived to be collected and reported externally. Orange = following testing of the indicator, data is perceived to be collected and reported internally or some data is reported externally but with limited granularity. Red = following testing of the indicator, no data is perceived to be collected and reported, internally or externally.

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
B2	5% decrease year-on-year in the share of wood energy sourced directly from forestry by-products, from a 2025 baseline.	*green*	*green*	MFA	At city/region level: data request to all relevant forestry organisations At company level: data request to company	Annual	Member state level, reporting up to EU for aggregation
B4	5% increase year-on-year in number of EU Ecolabel product with verified minimum of 50% bio-based materials, from a 2025 baseline.	*orange*	*green*	Monitoring via EU Ecolabel database	Data can be collected by National Statistics Institutes At city/region level: internal data from all relevant forestry organisations should be collated and reported At company level: all data should be collected by the company	Data should be requested on an annual basis as part of Eurostat's European Forest Accounts (EFA) (annual data collection on forest resources and economic activity in forestry and logging industry	Eurostat should collect and monitor this data as part of the EFA. Member States should collect the data via their National Statistics Institutes
B8	10% increase year-on-year in share of biowaste treated by AD, from a 2024 baseline.	*orange*	*green*	MFA: At city/region level: data request to all relevant waste management plants At company level: data request to company	Scope of the EU Ecolabel database should be expanded to include data on sustainability criteria including bio-based content	Annual monitoring of bio-based products in database. Manufacturers should be prompted annually to update the database	Data monitoring should be conducted by the EU Ecolabel using information reported by companies selling products with an Ecolabel

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
CB2	10% increase year-on-year in the number of building projects certified by schemes with circularity requirements, from a 2025 baseline.	*orange*	*orange*	A data collection plan was not developed for this indicator due to uncertainties around data availability	Data should be collected from EPDs via EPD programme databases	Data should be reported on an annual basis	EPD programmes should be responsible for collating and reporting this data
CB3	N/A at this stage of development.[27]	*orange*	*green*	Data request to Member States via housing census			
EICT1	5% increase year-on-year in percentage of citizens opting for sustainable alternatives instead of new purchases for Electronic or ICT products, from a 2024 baseline	*green*	*green*	Citizen survey	Data can be collected via already existing housing censuses	Housing censuses occur roughly every 5 years, though could potentially be conducted more regularly to get more granular data	Eurostat should collect and monitor this data. Member States should collect the data via their housing censuses
FWN2	10% increase year-on-year in the share of organic food, by weight, in total public food procurement, from a 2025 baseline	*orange*	*green*	Scanning of public procurement portals of national and regional public bodies	Public procurement portal outputs	Annual reporting basis	National and regional public bodies

[27] While this indicator shows good potential to promote more renovation and repurposing of vacant buildings rather than demolishing and constructing new buildings, there is still work to be done on developing harmonised definitions of several aspects, such as the types of buildings to be focussed upon (dwellings, commercial buildings etc.). Once work is done to progress is, as per the recommendations made, a meaningful target will be easier to derive, as will further definition for a data collection plan.

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
H1	10% decrease year-on-year in self-reported percentage of total kilometres travelled in private vehicles by citizens, from a 2025 baseline.	*green*	*green*	Citizen survey	FAOSTAT already tracks data on calorie consumption, which can be compared with ideal calorie consumption figures	Data should be reported on an annual basis	FAOSTAT should be responsible for tracking calorie consumption. EAT-Lancet Commission should be responsible for tracking ideal calorie consumption
H3	5% increase year-on-year in self-reported share of household income spent on service models rather than related ownership of goods, from a 2025 baseline.	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
H4	10% increases year-on-year in both the self-reported levels and positive perception of peer-to-peer use and sharing models, from a 2025 baseline.	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
H5	5% increase year-on-year in self-reported repair rate of clothing by households, from a 2025 baseline.	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
H7	N/A[28]	*green*	*green*				
PL1	5% increase year-on-year in pilot/demonstration projects on circular production and treatment of plastics, from a 2025 baseline. **Or** 5% increase year-on-year in share of total national R&D expenditure going towards pilot/demonstration projects on circular production and treatment of plastics, from a 2025 baseline	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
PL2	N/A at this stage of development.	*green*	*green*	Data request to Member States	Data should be sourced from EU databases for publicly-funded projects and via desk-based research for privately-funded projects	Data should be reported on an annual basis	Member State governments should be responsible for collating and reporting this data

[28] Whilst this indicator is considered to have the potential to give valuable insight to the rate of repair for priority products, it is not appropriate to set a specific target for it. The aim is not to increase the level of household spending on such activities, but to use the intelligence as a barometer for progress in their availability and proliferation.

URN	SMART target suggested	Data availability[25]	Current data collection practice?[26]	Data collection methodology	Data sources	Data collection frequency	Data monitoring responsibility
PSS1	10% increase year-on-year in self-reported levels of positive perception of PSS models, from a 2025 baseline.	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
PSS2	10% increase year-on-year in self-reported levels of citizens using PSS models, from a 2025 baseline.	*green*	*green*	Citizen survey	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
PSS3	N/A[29]	*green*	*green*	Data request to Member States via National Statistics Institutes	Data should be collected via a citizen survey	A survey should be conducted annually	EU should collect and monitor this data through the Eurobarometer survey
PSS8	All new and updated national CE strategies, from 2025, to consider PSS strategies and how they could be implemented.	*green*	*green*	Desk-based research	Data should be sourced from Member State legislative databases	Data should be reported on an annual basis	EU should collect and monitor this data through the Eurobarometer survey

Table 47: Data collection plans for recommended indicators

[29] No direct target setting is considered relevant for this indicator at this stage. While leasing is not the most promising of all PSS models for EVs in terms of increasing circularity, since shared mobility solutions and other transport forms, such as cycling and public transit, have greater environmental and social benefits. Leasing of EVs can, however, be seen as an early step in a circular transition to higher-level PSS models in the sector. The quality and availability of data for this indicator gives a strong position as a stepping point to greater circularity.

6. Conclusion and learnings

This two-year study has progressed through an evaluation of the CE policy and funding landscape for 11 key policy themes and sub-themes, through the collation, classification, and analysis of a long-list of over 700 currently used or theoretical indicators and metrics, to the in-depth investigation and development of future recommendations for a selected shortlist of 60 of those. The selection of indicators for detailed testing and development was influenced by extensive stakeholder engagement, and an assessment of the indicators' combination of innovativeness and potential to measure the progress towards 'true' circularity in their respective sectors.

This focus on innovative indicators (i.e. those not already being closely monitored or well understood in the policy areas or at the levels of implementation considered in the testing phase) led to the natural identification of their limitations and the challenges they present. Where this has occurred, the individual indicator case studies have identified and outlined recommended actions to progress towards overcoming any obstacles. Despite these challenges, only five of the 60 indicators tested were not recommended for further development, where the level and complexity of the suggested actions outweighed the deemed potential value of the indicator for measuring and incentivising a significant shift towards higher levels of circularity for the region.

For the remaining 55 indicators, the benefits were considered worth the required effort as outlined in the recommended actions. Of these 55, 34 were classed as having 'significant' work required for further progress, and 21 as having 'minor' work required. The difference between significant and minor work was appraised on a combination of the expected timescale required for the implementation of suggested actions, and their complexity in terms of the technical requirements and the range and capacity of the stakeholders required to be involved for success.

The recommendations for the 21 key indicators are summarised in this report in the form a roadmap consisting of legislative and technical action plans, and an outline approach to setting potential targets for them has been developed. These items form part of a 'toolkit' for policy makers interested in driving and monitoring the transition to CE, alongside other key project outputs. The toolkit consists of:

- Policy Framework Report (Appendix 7.1)
  - Developed during task 1 of the project, discussing the policy and funding landscape for the 11 policy focus themes and sub-themes.
- CE Indicators MCA tool (Appendix 0)
  - The full long list of existing and theoretical CE indicators collated and taxonomised in task 2, with advanced MCA and shortlist selection functionality developed in during tasks 3 and 4.
- Indicator testing case studies (Appendix 7.3)
  - As developed during task 5, 60 in-depth indicator case studies, collated across 19 reports.
- Roadmap for key indicators (Section 5)
  - A combination of summary outputs of task 5, and target setting development in task 6, incorporating:
    - Regulatory & policy plan.
    - Technical action plan.
    - Outline target setting methodology.
    - Suggested potential targets and initial data collection plans.

Several learnings and conclusions both in specific policy area contexts and from cross-cutting themes in challenges and recommendations can be drawn from the approaches taken in this study, and the outputs of the testing and post-testing analysis processes deployed. These are discussed at the relevant points in this report and the individual case studies and are summarised below.

6.1. Policy theme summaries

The concept of 'true' circularity differs between the policy areas and material streams studied in this project. As such, bespoke policy landscapes and corresponding monitoring frameworks are required to develop a full and valuable understanding of the progress of, and challenges facing, the transition to CE. As discussed in Section 4.2, The CEMF provides a holistic overview of levels of circularity, and the rate of transition, at Member State and EU level, but it does not always give the granular insight at individual policy focus area and material stream required to track the bespoke policy landscapes discussed above.

By investigating indicators deemed innovative and relevant to the bespoke concept of 'true' circularity for each focus area, this study has sought to develop an understanding of how gaps in monitoring of area-specific 'true' circularity could be filled, and developed proposal for an 'ideal' suite of indicators for each. These suites incorporate, where relevant, indicators already included in the CEMF, those tested as part of this study, and any others analysed in early stages but not fully tested.

6.1.1. Bioeconomy

6.1.1.1. Current state of play and Gap analysis

Introduction

The EU Bioeconomy Strategy[30]. defines the bioeconomy as covering "all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services." However, for the purpose of this project, we narrowed the bioeconomy to bio-based material streams sourced from renewable biological resources.

The bioeconomy plays a crucial role in increasing strategic autonomy and supporting the green transition through reducing dependency on fossil fuels and addressing climate change. The current policy landscape in the EU supports the bioeconomy through frameworks such as the EU Bioeconomy Strategy and the CEAP, which outline key objectives to enhance the production and consumption of bio-based products. As the EU strives for climate neutrality by 2050, the bioeconomy is increasingly recognised as vital for achieving sustainable development. The bioeconomy in the EU can encompass all three triple-bottom-line elements of sustainability, offering the potential to generate jobs, foster innovation and stimulate economic growth while tackling environmental challenges.

This policy landscape illustrates how the bioeconomy can support the CE, as it addresses the R-strategies of **Refuse**, **Reduce** and **Recycle**. The focus on **Refuse** is evident through efforts to limit pesticide use and promote environmentally friendly agricultural practices. The **Reduce** strategy is supported by initiatives aimed at minimising resource consumption and addressing food waste, which are crucial for enhancing sustainability. The **Recycle** strategy is highlighted in policies promoting the recycling of organic materials and other bio-based products.

Gap analysis

Despite the progress made in these areas, several challenges and gaps impede the full potential of the bioeconomy. The EU Bioeconomy Strategy through the Bioeconomy Monitoring System

[30] A sustainable bioeconomy for Europe: Strengthening the connection between economy, society and the environment, European Commission, 2018: https://research-and-innovation.ec.europa.eu/research-area/environment/bioeconomy/bioeconomy-strategy_en

(BMS) managed by the Knowledge Centre for Bioeconomy[31] includes indicators such as employment in bioeconomy sectors, gross value added, investment levels, and the production of bio-based products. However, significant gaps remain regarding the comprehensive monitoring of these indicators.

While some R-strategies are adequately addressed, others - such as Reuse, Repair, Refurbish, Remanufacture and Repurpose - remain underutilised within the current policy landscape. Their absence does not necessarily indicate a gap that needs to be filled but reflects a limited scope in addressing the full range of circularity principles.

Despite a rise in private sector investment within the bioeconomy, data on job creation and gross value added specific to the sector remain limited, although good analysis attempts exist as shown in Ronzon et al., 2022 and JRC BMS reports[32]. This information is essential for evaluating the economic impact of bioeconomic activities and informing future investments and policy decisions. Additionally, quantifying the proportion of local forestry by-products used for energy generation is necessary to assess the efficiency and sustainability of this practice. There is a growing interest in utilising these resources to support energy transition goals however, the share of local forestry by-products directed toward energy generation requires accurate quantification to evaluate its effectiveness.

Similarly, the use of organic fertilisers in agricultural practices is critical for improving soil health and reducing reliance on chemical fertilisers. Understanding the share of organic fertiliser used can guide efforts to promote sustainable agriculture. Another important consideration is the number of products that carry the EU Ecolabel and are bio-based. This label serves as a powerful marketing tool, signifying products that meet strict environmental criteria. Tracking the number of eco-label bio-based products is essential for promoting consumer awareness and market uptake.

Alignment with the CEMF[33]

The CEMF is integral to measuring progress toward circularity within the bioeconomy. It encompasses various indicators that collectively support circularity improvements across different sectors, including agriculture, waste management and resource efficiency. Currently, the CEMF includes indicators that assess aspects such as resource productivity, recycling rates and GHG emissions, which are crucial for understanding and enhancing bioeconomic dynamics.

However, while the CEMF provides a foundational framework for monitoring circularity, it has notable gaps concerning the specificities of the bioeconomy. For instance, the existing indicators often lack granularity. While the CEMF measures overall resource productivity, it does not specifically address the productivity of bio-based materials, which is essential for formulating targeted policies and initiatives. Additionally, the circular material use rate, which indicates the proportion of materials that are reused or recycled, currently fails to provide detailed insights into bio-based materials. This highlights the need for tailored metrics that can better capture the unique dynamics of the bioeconomy.

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[31] https://knowledge4policy.ec.europa.eu/bioeconomy_en

[32] Ronzon, T., Iost, S., & Philippidis, G. (2022). An output-based measurement of EU bioeconomy services: Marrying statistics with policy insight. *Structural Change and Economic Dynamics, 60*, 290-301.

Lasarte-Lopez, J., Ronzon, T., Van Leeuwen, M., Rossi Cervi, W. and M`barek, R., 2022. Estimating employment and value added in the bioeconomy of EU regions, EUR 31058 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-52269-0, doi:10.2760/850726, JRC128984.

Lasarte-Lopez, J., González Hermoso, H., Rossi Cervi, W., Van Leeuwen, M. and M`barek, R., 2023a. BioRegEU. A pilot dataset for regional employment and value added in the EU bioeconomy, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/307097, JRC135346.

Lasarte-López, J., Ronzon, T., M'barek, R., Carus, M., Tamošiūnas, S., 2023b.: Jobs and wealth in the EU bioeconomy / JRC - Bioeconomics. European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/7d7d5481-2d02-4b36-8e79-697b04fa4278

[33] Please note that the EU Bioeconomy Monitoring System was not similarly assessed at this stage of this project to ensure the methodology was consistent across all the key policy areas under consideration.

Furthermore, the CEMF's focus on GHG emissions from production activities is vital for evaluating the environmental impacts of various practices. However it could benefit from a deeper understanding of how these emissions are influenced by the use of bio-based materials and practices within the sector.

In addressing these gaps, the tested indicators can enhance and support the CEMF by providing more comprehensive data tailored to the bioeconomy. For example, indicators that specifically measure the use and impact of bio-based materials can complement existing CEMF metrics, enhancing the understanding of resource efficiency in this sector. Additionally, indicators focused on consumer behaviour regarding eco-labelling can contribute to insights about market uptake of bio-based products, thereby enriching the CEMF's ability to assess progress over time.

By integrating these tested indicators, the CEMF can evolve to include tailored metrics that reflect the unique characteristics and challenges of the bioeconomy. This will not only improve the monitoring of circularity in this sub-policy area but also foster more informed policymaking aimed at achieving the EU's broader sustainability and circularity objectives.

Recommendations

To enhance the assessment of the bioeconomy, a refined suite of complementary indicators is proposed, focusing on what is achievable and can be effectively monitored both in the short and long term. These indicators aim to address gaps in the existing CEMF metrics while ensuring alignment with the EU Bioeconomy Strategy.

Table 48 provides the 'ideal' suite of indicators to adequately assess the policy gaps and the assessment of the bioeconomy. The proposed indicators provide a clear path forward for enhancing the bioeconomy, aligning with the CEMF and addressing the identified gaps.

High-level theme	Specific indicator	Source	Justification for inclusion
Socio-economic benefits	Number of jobs created related to the bioeconomy sector	Tested / EU Bioeconomy Strategy	Provides insights into the economic impact of the bioeconomy and informs policy decisions
	Gross value added related to the private bioeconomy sector	Tested / EU Bioeconomy Strategy	Helps measure the economic contributions of the bioeconomy and assess growth potential
Environmental benefits	Number of products with the EU Ecolabel that are bio-based	Tested	Encourages consumer awareness and market uptake of sustainable products.
	Specific productivity of bio-based materials	CEMF	Provides insights into how efficiently bio-based resources are utilised, allowing for targeted policy initiatives
	Proportion of bio-based materials reused, recycled, or reintroduced into the economy	CEMF	Enhances understanding of the circularity of bio-based materials and supports the development of targeted policies
	GHG emissions associated with bio-based production	CEMF	Crucial for assessing environmental impacts and guiding sustainable practices within the bioeconomy.

High-level theme	Specific indicator	Source	Justification for inclusion
	practices (excluding **Net GHG emissions from agriculture and from LULUCF)**		Currently, the BMS includes 2 related indicators: **Net GHG emissions from agriculture and from LULUCF**
Resource Management	Share of local forestry by-products going to energy generation	Tested	Evaluates resource utilisation and supports energy transition goals
	Share of renewable resources used	EU Bioeconomy Strategy	Gauges the transition from fossil-based to bio-based materials
	Amount of organic waste recycled or used in bio-based applications	EU Bioeconomy Strategy	Reflects circularity and resource management in the bioeconomy
	Share of biological waste treated with anaerobic digestion (AD)	Tested	Provides insights into waste management practices and identifies opportunities for resource recovery

Table 48. Summary of the 'ideal' suite of indicators for bioeconomy.

Figure 9 **Error! Reference source not found.**presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

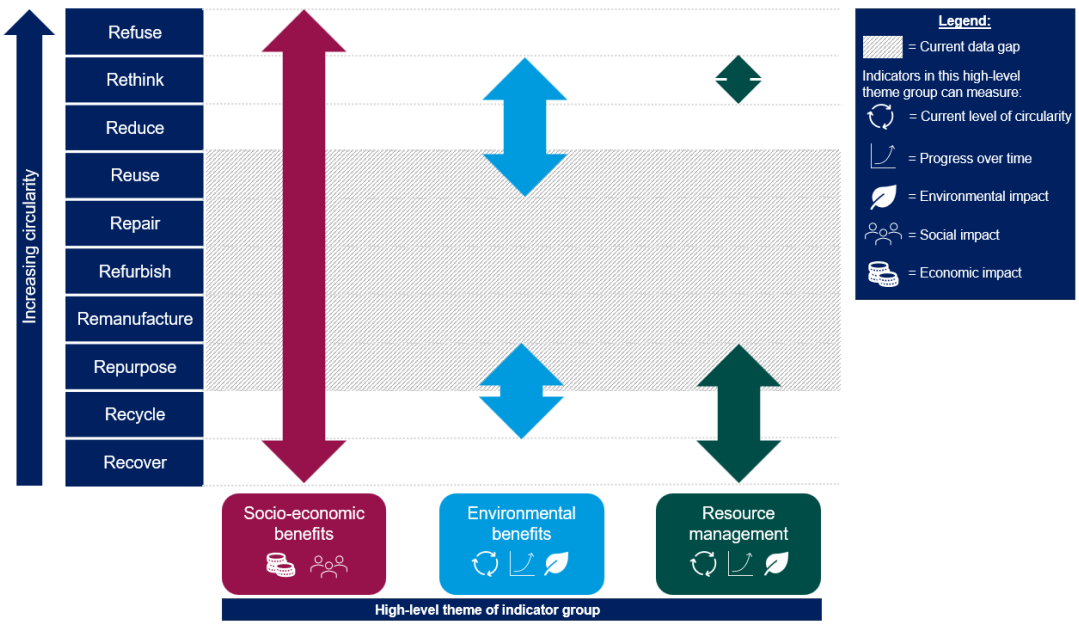

Figure 9. Overview of the ‘ideal’ suite of indicators for ‘Bioeconomy’, mapped against the R-Strategies and three facets.

Table 49 outlines the actions needed to implement these recommendations effectively.

Type of recommendation	Recommendation	Timeline
Policy development	Strengthen policies to align bioeconomy principles with circular economy strategies, focusing on measurable outcomes. This includes establishing specific quantitative targets for bio-based materials to enhance current levels of circularity.	Medium (1.5 – 5 years)
Data support	Develop robust data collection methods that specifically measure bio-based material flows. This includes assessing current levels of circularity through baseline data and monitoring progress over time with regular updates.	Medium (1.5 – 5 years)
Technical support	Provide guidance for industries on best practices for utilising bio-based materials. This will help businesses improve their operational efficiency and contribute to circularity, thereby supporting positive triple bottom line impacts.	Short (0.5 – 1.5 years)
Industry engagement	Foster collaboration among stakeholders, including government agencies, industry bodies and communities. Engaging stakeholders will raise awareness of bioeconomy practices and support the assessment of triple bottom line impacts.	Short (0.5 – 1.5 years)

Table 49. Recommendations for monitoring of ‘Bioeconomy’.

6.1.2. Product-service systems

6.1.2.1. Current state of play and gap analysis

Introduction

The various types of product service systems (PSS) often referred to in the EU as product-as-a-service models, play a critical role in promoting circularity. The CEAP defines PSS as a business model in which producers keep ownership of the product or the responsibility for its performance throughout its lifecycle. PSS models are also specifically mentioned in the EU Strategy for Sustainable and Circular Textiles, the EU Chemicals Strategy for Sustainability, the new EU Taxonomy and the Corporate Social Responsibility Directive. This highlights the relevance of PSS

models for circularity and sustainability in EU policy. The key existing policies with PSS-related objectives are:

- A New Circular Economy Action Plan – For a cleaner and more competitive Europe (2020)
  - To incentivise product-as-a-service (use-oriented PSS models) and other models with embedded producer-ownership of products provided, whereby business providers are responsible for product performance throughout the product lifecycle.
  - Improving the business and regulatory environment for sustainable and circular textiles, hereunder providing incentives and support to products-as-a-service models.
  - Reduced virgin material consumption through application of product-as-a-service.
- EU Strategy for Sustainable and Circular Textiles (2022)[34]
  - Reshaping the consumption habits of EU citizens through circular business models such as product-as-a-service models.
- Chemical Strategy for Sustainability Towards a Toxic-Free Environment (2020)[35]
  - Exploration and promotion of chemicals-as-a-service to shift from traditional chemical production and use (including chemical leasing, services such as logistical, development of specific chemical processes and applications, and waste management).

While these policies have broad objectives to incentivise PSS – type models, they do not carry specific relevant targets, and therefore monitoring of success against the R-Strategies is not well developed.

Gap analysis

The project has not, however, identified existing EU targets or indicators for measuring or tracking PSS models directly. Though some existing indicators for example: “Resource productivity,” “Circular material use rate,” and “Consumption footprint” (Eurostat / CEMF) may indirectly capture the effects of PSS models within the economy, they do not adequately assess the contribution or progress of these models compared to traditional ownership structures.

Other entities are collecting data on indicators that are similarly (indirectly) relevant such as “Percentage of revenue that comes from circular services” (Ellen MacArthur[36]) and “Product Repairability” (Circular Economy Indicators Coalition[37]). These indicators cover a wide range of, if not all, R-strategies and facets of circularity, which PSS models may utilise or contribute to. Still, the indicators do not directly target the effects of PSS models and, thus, cannot determine the contribution or progress over time of these models compared to traditional ownership models.

The absence of direct indicators means that the effectiveness and impact of PSS models cannot be thoroughly evaluated. The reliance on indirect measurements complicates the assessment of how PSS contributes to circular economy goals, limiting policymakers' ability to gauge their progress effectively. Therefore, developing specific metrics that can adequately capture the nuances of PSS and its potential to foster more sustainable business practices is essential.

Alignment with the CEMF

The CEMF employs various indicators to evaluate resource efficiency and sustainability, focusing on waste generation, material recycling, and resource usage across households and businesses. However, the indicators of the CEMF are not directly relevant for supporting PSS models since each indicator tracks a singular element of the economy or product value chains. Measuring PSS

[34] https://environment.ec.europa.eu/strategy/textiles-strategy_en

[35] https://environment.ec.europa.eu/strategy/chemicals-strategy_en

[36] Data & Insights, Ellen Macarthur Foundation, n.d.: https://www.ellenmacarthurfoundation.org/resources/circulytics/insights

[37] Indicators, Knowledge Hub, n.d.: https://knowledge-hub.circle-economy.com/indicator

requires a different lens, considering the life cycle of such systems compared to linear businesses and ownership models.

In this project, several indicators have been tested which emphasise, for example, the presence of policy references to PSS, measures of the market size of PSS models, and consumer perspectives on PSS. The general conclusion across indicator testing is that much work is needed to facilitate their development and implementation.

PSS models may potentially be linked more explicitly for existing CEMF indicators in their data foundation, if relevant data can be gathered and made appropriate for the measurement. For example, the Consumer Footprint indicator's background data on consumption within the mobility area currently does not comprehensively consider shared mobility services other than public transport[38]. PSS models for shared mobility have the potential to be an important element of a more circular mobility landscape in future and should therefore be considered for this CEMF indicator. However, a lack of comprehensive data and maturity of the PSS models across MS currently limits the opportunities for integrating PSS in the data model.

Another CEMF indicator, "Persons employed" in circular economy sectors, could be adapted to consider sectors specifically related to circular business models. The NACE (Nomenclature of Economic Activities) code system could be developed to provide for better registration of circular business models, such as operational leasing of equipment in different sectors, and would support better data collection and monitoring on an industry level. For example, the tests on the proposed indicator on companies providing PSS solutions in ICT showed that there is a large existing market, which may provide substantial employment opportunities. Therefore, by improving the NACE code system, the CEMF indicator may be based on more relevant data on PSS business models in addition to current data sources. Adding additional NACE codes for PSS models in sectors with no currently relevant code may extend this potential further.

Despite these opportunities, securing data quality and assessing the potential for increased circularity of services by companies in practice presents multiple challenges. There is a trade-off between generalisability and accuracy on circularity and other metrics, which needs further analysis and development.

6.1.2.2. Recommendations

Table 50 provides the 'ideal' suite of indicators has been recommended to adequately assess the policy gaps and subsequent circularity of PSS.

High-level theme	Specific indicator	Source	Justification for inclusion
Consumer preference & awareness of PSS	Consumer perception of the attractiveness of PSS models	Testing	Monitoring consumer experience with and perception of PSS models is a relevant proxy for understanding their penetration and relevance of in the economy. There are interesting opportunities for including CEAP priorities, such as PSS, in the DG EFA's consumer surveys.
	Percentage of citizens who have used PSS models		
Market share and volume of PSS models	Share of electric passenger vehicles (EV) operationally leased by consumers (B2C)	Testing	These indicators hold potential for providing stronger data and insights on the role of PSS across various products groups. There is a strong policy relevance of PSS across

[38] The Consumer Footprint Calculator, Sala Serenella et al., Publications Office of the European Union, 2022: https://publications.jrc.ec.europa.eu/repository/handle/JRC129382

	No. of companies offering PSS solutions for EEE / ICT		product groups, but a need for better data to assess their penetration and impact. By including indicators such as these in monitoring frameworks, and combining it with targeted initiatives, such data generation and the PSS models may be promoted.
Public support and investment in PSS	No. of public procurement contracts for EEE / ICT that incorporate PSS models	Testing	National and EU policies highlight the potential of PSS for promoting sustainability and circularity priorities. Indicators are needed to monitor how this translates to concrete policy support and financial initiatives. These indicators do not provide direct measurements of circularity, but give an indication of what priority is given to PSS on an EU and national level.
	EU funding for R&D in PSS		
	No. of MS that include PSS in national CE strategies		
	No. of public financial incentives directed at PSS providers/models		

Table 50. Summary of the 'ideal' suite of indicators for 'PSS'.

Figure 10**Error! Reference source not found.** presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

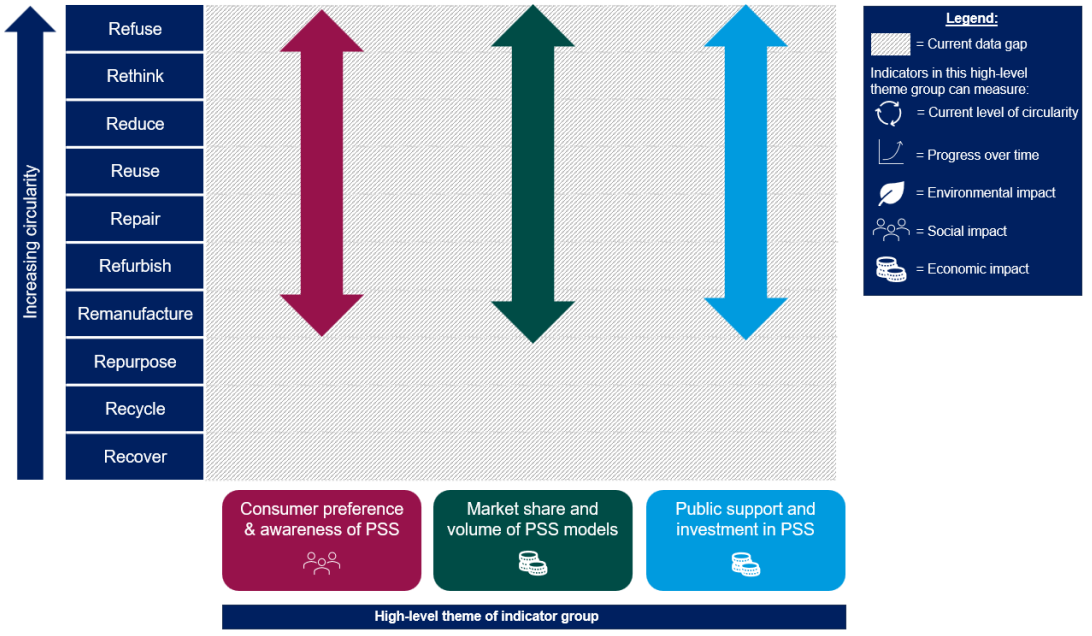

Figure 10. Overview of 'ideal' suite of indicators for 'PSS', mapped against the R-Strategies and three facets.

The recommendations recognise the current lack of research and data to sufficiently document the benefits of PSS models and categorise and systematise the foundations for these benefits to be generalised across products, countries, use cases, etc. These shortcomings greatly reduce the general acceptability and credibility of PSS indicators. Developing indicators on PSS requires, first

and foremost, further research and data on the field and prioritising sectors that hold the most potential. Table 51 summarises the recommendations for further developing these indicators.

Type of recommendation	Recommendation	Timeline
Development of methodology and guidance	Development of the NACE code system to provide for better registration of PSS models and the related economy and employment.	Medium (1.5 – 5 years)
Development of methodology and guidance	Support research investigating the actual benefits of PSS models within the most promising products groups and defining the most relevant metrics for these product groups. The research may enable a prioritisation of monitoring efforts on the availability and benefits of PSS solutions. This may provide the foundation for improved target setting and for creating or developing indicators in the CEMF.	Medium (1.5 – 5 years)
Stakeholder initiative	Promote and potentially fund the creation of national networks on PSS and circular business models within specific sectors, e.g. by creating PSS networks within existing associations, to help foster improved knowledge sharing and facilitate easier data collection on PSS performance in future.	Short (0.5 – 1.5 years)

Table 51. Recommendations for monitoring of 'PSS'.

6.1.3. Cities and regions

6.1.3.1. Current state of play and gap analysis

Introduction

The transition to a CE in cities and regions is crucial for achieving sustainability goals and mitigating the environmental impacts of urbanisation. The current policy framework primarily focuses on waste management regulations, the provision of infrastructure to enable **recycling**, encouraging **re-use**, establishing extended producer responsibility (EPR) and ecodesign regulations. Green Public Procurement (GPP) initiatives are also a vital component of local sustainability efforts, aiming to integrate environmental considerations into public purchasing decisions.

Key directives that shape this landscape include:

- **Waste Framework Directive (WFD)**[39] – This directive establishes minimum recycling targets and promotes the recovery of materials from waste. It outlines a comprehensive approach to waste management, focusing on prevention, **reduction, reuse and recycling**.

[39] https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

- **Directive (EU) 2018/851**[40] – This directive amends the WFD and sets specific targets for reducing household food waste, aiming to promote more sustainable consumption patterns at the local level.
- **Regional Circular Economy Initiatives** – Various regions are implementing CE strategies tailored to their unique economic contexts and resource availability. These initiatives often focus on enhancing local resilience and reducing environmental impact by promoting local circular practices.

Gap analysis

While the current CE policy framework for Cities and Regions addresses concerns regarding the environmental impact of pollution, there are key gaps in terms of the social and economic impact. Despite the CEAP 2020 having an entire chapter dedicated to "Making circularity work for people, regions and cities", there are minimum explicit targets for consumer goods, high-value R-strategies (e.g. Repair, Refurbish), or the delivery of CE job or business creation.

In light of these gaps the Circular Cities and Regions Initiative (CCRI)[41] was established to support cities and regions transition to a CE within their economic sectors, value chains and services. CCRI are actively involved in research and innovation initiatives, development of policy tools and funding instruments, and dissemination of awareness and best practice to achieve this aim. This includes development of the Cities and Regions Self-Assessment Tool, which contains 82 indicators that allow local and regional administrations to measure CE criteria across six key policy domains. However, the effectiveness of these initiatives is often hampered by insufficient data collection and monitoring mechanisms.

Alignment with the CEMF

The CEMF plays a critical role in tracking progress towards CE objectives however it does not collect data at the sub-national level, thereby limiting the ability of the EU to track progress by local and regional public administrations. While it is positive that material consumption rates, private investment, job creation and gross value added related to circularity are monitored by CEMF, it is not possible to assess how local and/or regional policies influence these factors or their relevance to specific R-strategies or sectors such as repair and Industrial Symbiosis (IS). This limits the ability of Cities and Regions to monitor the Triple Bottom line impacts of a CE transition within both the public and private sectors over time.

The tested indicators seek to bridge this gap by providing metrics applicable at the level of Cities and Regions level that directly support the objectives of the CEMF. For example, two indicators were developed to quantify the share and value of public procurement notices containing explicit CE criteria. As the EU moves to make GPP requirements a mandatory requirement of sectoral legislation, these provide administrations with a mechanism to assess the effectiveness of integrating circularity into procurement activities and contributes to R-strategies of reduce, reuse.

Other indicators tested aim to enhance the granularity of data gathered through the CEMF's Production, Consumption, Competitiveness and Innovation indicators, for example by focusing on IS systems, as well as the availability of CE capacity-building programmes, such as business support, training and financing. These additional data points allow Cities and Regions to understand the effectiveness of local policies in stimulating CE industrial activity and empowering businesses to adopt circular practices. As a result, they provide evidence that local and regional administrations can use to illustrate a CE transition across sectors within their jurisdiction.

6.1.3.2. Recommendations

To enhance the assessment of the Cities and Regions, a refined suite of complementary indicators is proposed, focusing on measurable metrics that can be effectively monitored in both the short

[40] https://eur-lex.europa.eu/eli/dir/2018/851/oj
[41] https://circular-cities-and-regions.ec.europa.eu/

and long term. These indicators aim to address identified gaps while aligning with the EU CEAP (see Table 52).

High-level theme	Specific indicator	Source	Justification for inclusion
Circular procurement	Share of public procurement notices that stipulate specific CE aspects	Tested	Public procurement is an essential tool to stimulating the adoption of CE practices within regional supply chains.
	Budget of public procurement notices that stipulate specific CE aspects	Tested	As above.
Circular transition	The number of local and regional entities implementing circular transition agendas aligned with regional targets	Tested	It enables administrations to track the awareness of, and alignment with, local and/or regional CE objectives among public and private entities in the region.
Circular business activity	Number of public and semi-private entities providing regional CE support programmes	Tested	Provides clarity on effectiveness of local policies in stimulating circular job and business generation.
	Persons employed in CE-related sectors	CEMF	As above.
	Private investments in CE related sectors	CEMF	As above.
	Total Quantity of Byproducts Valorised Annually Due to Regional Industrial Symbioses Systems and Partnerships	Tested	Provides IS-specific data on circular material consumption rates.
	CO2 savings through industrial symbiosis	CCRI	IS-specific CO_2e savings data, augments previous metric.
	Number of repair spaces by population size	Tested	It provides insight into availability of infrastructure required to facilitate citizen-led repairs within a city's boundaries.
Waste & resources	GHG-emissions from waste	CCRI	Provides insight into carbon impact of waste streams.
	Waste generated per capita per stream	CEMF	Provides insights into material consumption rates.
	Generation of industrial waste per capita	CCRI	As above.
	Recycling rates of waste by waste stream	CEMF	Data indicates effectiveness of recycling infrastructure.

Table 52. Summary of the 'ideal' suite of indicators for Cities and Regions

Figure 11 presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

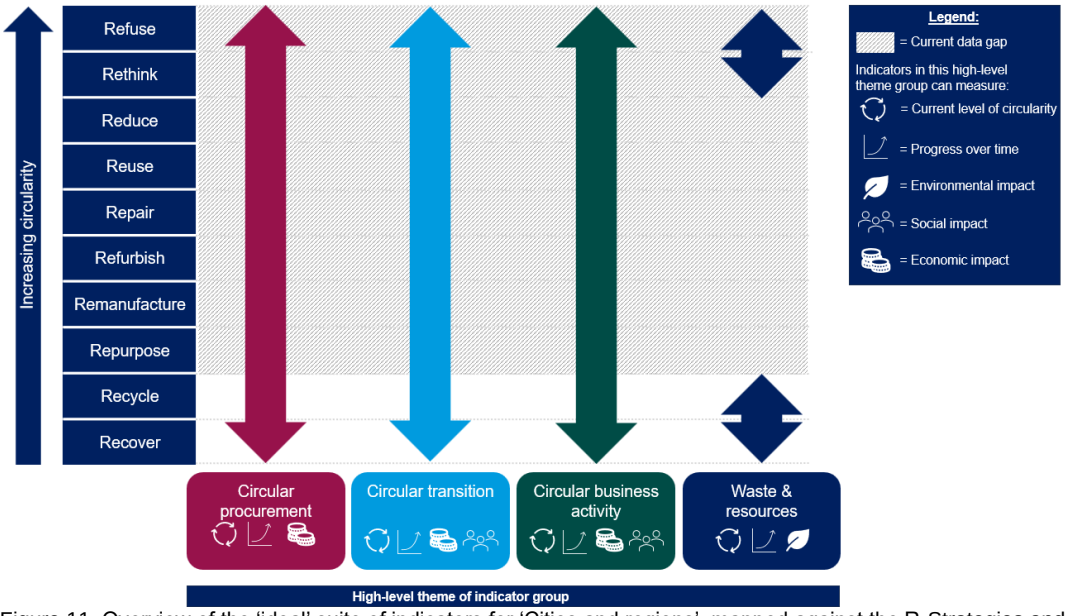

Figure 11. Overview of the 'ideal' suite of indicators for 'Cities and regions', mapped against the R-Strategies and three facets.

Table 53 outlines the actions needed to implement these recommendations effectively.

Type of recommendation	Recommendation	Timeline
Data support	Development of digital reporting platforms for regional administrations to facilitate collection of data regarding CE capacity-building programmes, CE procurement and valorisation of byproducts as a result of IS systems.	Medium (1.5 – 5 years)
Industry & Policymaker engagement	Engagement to gain consensus on standardisation of criteria to monitor CE transition agendas, capacity building programmes, and practices, such as IS, repair and procurement.	Medium (1.5 – 5 years)
Policy	Development of minimum monitoring requirements for circular procurement practices	Medium (1.5 – 5 years)

Table 53. Recommendations for monitoring of 'Cities and Regions'.

6.1.4. Households

6.1.4.1. Current state of play and gap analysis

Introduction

Households play a pivotal role in the transition to a CE, influencing resource consumption patterns and waste generation. Existing EU initiatives and legislation address the efficiency of energy-related products within households (the Ecodesign Directive[42]), support consumers to make more informed choices (such as the EU Ecolabel[43]), reduce food waste and plastic consumption and maximise the recycling and reuse of municipal waste.

The current policy framework for households focuses on the R-strategies of 'Rethink' (through supporting energy efficiency improvements in products), 'Reduce' (through efforts to decrease food waste and plastic consumption), 'Recycle' and 'Recover' (both through the setting of municipal waste targets).

Gap analysis

There is currently no comprehensive set of requirements to ensure that all products placed on the EU market become increasingly sustainable and stand the test of circularity. Limited policies or legislation currently exist which tackle the R-strategies 'Reuse', 'Refurbish', 'Remanufacture' and 'Repurpose'. The proposal for a regulation on Ecodesign Requirements for Sustainable Products will address these gaps through ensuring that products are designed with circularity in mind ensuring they can be reused, repaired or recycled effectively. However to truly assess the impact of these regulations, indicators will need to be developed to monitor the performance improvements of key household products once these requirements are implemented via Delegated Acts.

Existing indicators often lack the necessary granularity to effectively measure progress in household circularity. The absence of clear metrics hampers the ability of local and regional governments to create targeted interventions that foster sustainable practices among consumers. Therefore, the development of robust indicators tailored to household dynamics is essential for driving the circular economy forward.

Alignment with the CEMF

The existing CEMF directly measures circularity within households through quantifying the amount of food waste generated at a national and EU level, which can subsequently be broken down into key sources including activities by households. The 'Recycling rate of municipal waste' also directly measures household circularity, as it measures the level of household waste which is subsequently recycled. 'Generation of municipal waste per capita' is another relevant indicator, as it specifically focuses on the amount of waste collected by municipality authorities and largely waste generated by household, although waste from commerce, offices and public institutions may also be included. This means that the reported data is likely an overestimation of household waste.

The CEMF indicators of 'Food waste', 'Generation of packaging waste per capita', 'Generation of plastic packaging waste per capita', 'Recycling rate of overall packaging', 'Recycling rate of plastic packaging' and 'Recycling rate of WEEE separately collected' are all relevant, however due to not be able to split the proportion of waste generated from household versus commercial sources, their benefits to measuring household circularity are limited. There are also limitations in the granularity of the data provided by the CEMF indicators.

For example, for 'Generation of municipal waste per capita' and 'Recycling rate of municipal waste', the data is presented at a national level but is not broken down per waste stream. This limits its

[42] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, OJ L 285, 31.10.2009

[43] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel, OJ L 27, 30.1.2010, p. 1.

ability to identify waste hotspots and develop targeted interventions to support needed improvements. The current CEMF does not measure the utilisation of products by households, reuse rates of products, behavioural change and perceptions of circular products and services, the uptake/use of circular products and services, and water consumption.

Whilst there are no direct cross overs, all household specific indicators in the testing programme were found to indirectly support the improvements across a number of the macro level indicators in the CEMF, namely: 'Material footprint', 'Total waste generated per capita', 'Generation of municipal waste per capita' and 'Consumption footprint'. The tested indicators within this study provide greater levels of granularity to further understand the problematic products and materials within households. They also provide clarity on what happens to household products during their use phase, through monitoring the number of items being repaired, household spending on maintenance and repair activities, level of unused household goods and amount of consumer goods reused through reuse centres. Water was one area identified as a current gap within the existing CEMF which was covered during the testing programme.

6.1.4.2. Recommendations

Table 54 provides the 'ideal' suite of indicators has been recommended to adequately assess the policy gaps and subsequent circularity of households across four key themes.

High-level theme	Specific indicator	Source	Justification for inclusion
Food and water consumption	Water footprint of private consumption.	Tested	Measures the water used to produce goods/services used by households and signals areas of high consumption.
	Impacts of differing food consumption on European biodiversity through potential species lost.	Tested	Investigates how varied diets impact biodiversity and identifies food sources with high biodiversity impacts.
Utilisation of household goods	Unused household goods.	Tested	Provides clarity on the 'use' phase and quantifies the 'lost opportunity'.
	Comparison of life of household furniture as estimated by manufacturers and the actual use time by households	Tested	Quantifies the success of product life extension interventions.
	Level and perception of peer-to-peer use and sharing.	Tested	Explores the current use of these models and monitors circular behaviours/purchases in households.

High-level theme	Specific indicator	Source	Justification for inclusion
Product life extension of household goods	Items of clothing repaired by households[44].	Tested	Supportive of higher value retention activities and will gain understanding of the current adoption of repair.
	Household spending on maintenance and repair.	Tested	As above.
Waste generation and management	Generation of municipal waste per capita.	CEMF	Measures the waste collected by municipal authorities and generated by households.
	Recycling rate of municipal waste.	CEMF	Measures the waste collected by municipal authorities and generated by households which is subsequently recycled.

Table 54. Summary of the 'ideal' suite of indicators for 'Households'.

Figure 12 presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

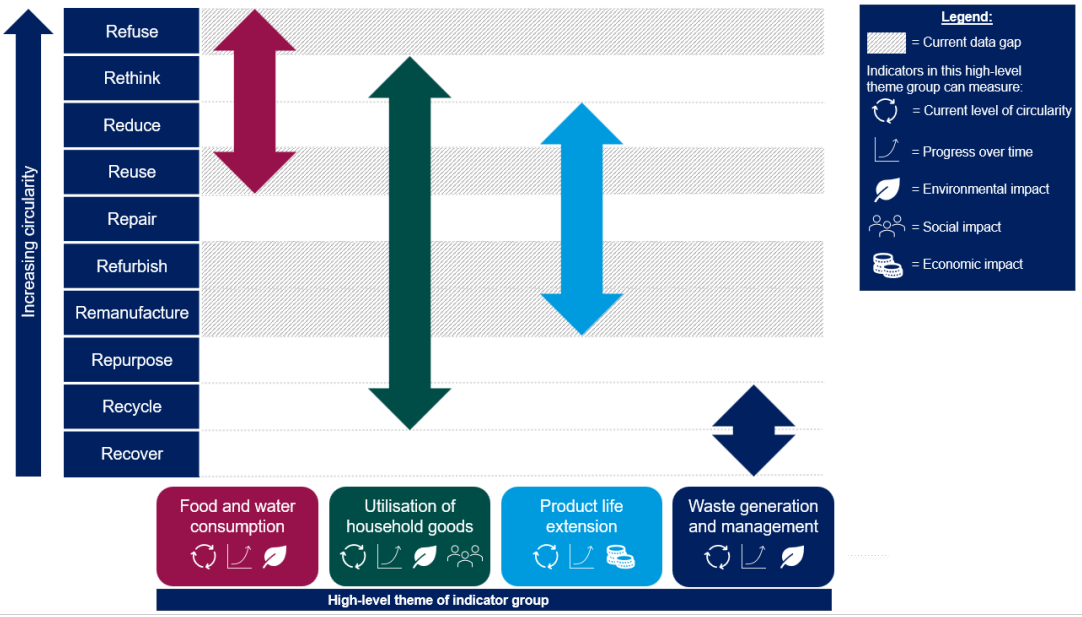

Figure 12. Overview of the 'ideal' suite of indicators for 'Households', mapped against the R-Strategies and three facets.

The main actions needed to support the eventual implementation of this suite of indicators are summarised in Table 55.

[44] For the nature of this testing programme, the scope of these indicators were reduced to cover only one household good. There inclusion in the monitoring framework assumes these indicators are rolled out to other high priority CEAP products.

Type of recommendation	Recommendation	Timeline
R&D	Development of classification systems across key household products (such as textiles and furniture) to support harmonisation across the EU and EU Member States.	Short (0.5 – 1.5 years)
Policy	Development of a new target to monitor the repair rate of priority products within the CEAP.	Medium (1.5 – 5 years)
Legislation	Provide economic and commercial incentives to encourage the implementation of household water meters and support the collection of usage data.	Medium (1.5 – 5 years)

Table 55. Recommendations for monitoring of 'Households'.

6.1.5. Electronics and ICT

6.1.5.1. Current state of play and gap analysis

Introduction

The EU's policy landscape for the Electronics & ICT sector is shaped by directives promoting circularity and sustainability, including the Waste Electrical and Electronic Equipment (WEEE) Directive[45], the Restriction of Hazardous Substances (RoHS) Directive[46], and the Ecodesign Directive. These set targets for recycling, reducing hazardous substances, and improving product design for easier dismantling and recycling. The Chemicals Strategy for Sustainability and the Critical Raw Materials Act[47] further support reducing harmful substances and securing access to key materials.

Current indicators mainly track recycling rates and product weight at end-of-life, due to Extended Producer Responsibility (EPR) reporting. However, they focus heavily on recycling, with limited attention given to higher-order R-strategies like refuse, rethink and repair. This oversight highlights a crucial area for improvement, as these strategies aim to prevent waste generation and enhance product lifecycles. Additionally, policies prioritise waste management but provide less support for evaluating current circularity levels, transition progress, or the triple-bottom-line impacts of sectoral innovations.

Gap analysis

Despite the existing framework, there are notable gaps in the policy support for the Electronics and ICT sector:

- **Focus on waste management:** Current policies prioritise waste management but provide limited support for evaluating current circularity levels, monitoring transition progress or assessing the triple-bottom-line impacts of sectoral innovations. This lack of comprehensive monitoring may result in missed opportunities for meaningful improvements in circularity.
- **Higher-order R-strategies:** Key gaps include insufficient focus on higher-order R-strategies such as refuse, rethink, and reduce, which aim to prevent waste generation. Additionally, there is a lack of emphasis on repair, refurbishment and remanufacturing to extend product lifecycles.

[45] https://environment.ec.europa.eu/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en
[46] https://environment.ec.europa.eu/topics/waste-and-recycling/rohs-directive_en
[47] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en

- **Need for improved indicators:** There is a pressing need for enhanced indicators that measure circularity levels, facilitate product comparisons, track transition progress and assess the environmental, economic, and social impacts of circularity efforts.

Overall, the Electronics & ICT sector's existing framework needs to integrate a broader range of strategies and indicators to foster a more comprehensive approach to circularity.

Alignment with the CEMF

The CEMF advances circularity in the Electronics & ICT sector by offering detailed metrics on resource efficiency and sustainability. It tracks key indicators like material consumption, waste generation, and recycling rates specific to electronic equipment. This data helps policymakers and businesses pinpoint areas for improvement, such as boosting e-waste recycling, designing products for durability and repairability, and promoting extended producer responsibility (EPR) schemes. By aligning these indicators with the EU's CEAP, the CEMF drives innovation and reduces environmental impact in the sector.

Key gaps in the CEMF for the Electronics & ICT sector include insufficient tracking of R-strategies, resource use, product lifecycle, and waste management. The framework lacks robust indicators for reducing critical raw material consumption and promoting reuse through refurbishment or repair. While recycling rates are measured, the efficiency of recycling processes, particularly for rare earth metals, is not well captured. Data on product durability, reparability, and lifecycle improvements is also limited. Moreover, the focus on waste management neglects higher-level strategies like prevention and reuse, and does not sufficiently address illegal e-waste exports, which hinders recycling efforts. These gaps highlight the need for more comprehensive metrics to support circularity.

These gaps highlight the need for more comprehensive metrics to support circularity in the sector. The tested indicators can enhance the CEMF and address these gaps. The following indicators have been identified to strengthen the framework:

- **Percentage of citizens opting for sustainable alternatives:** This indicator measures consumer behaviour regarding the choice of refurbished or second-hand electronics, thereby addressing the CEMF’s gap in reuse strategies.
- **Real recycling rate of electronic and ICT equipment:** This metric evaluates the quality of recycling processes, focusing on the recovery of valuable materials rather than just overall recycling volumes.
- **Public sector purchases of second-hand or leased ICT equipment:** This indicator promotes circular procurement, encouraging large-scale reductions in resource use.
- **Share of consumer electronics fulfilling ecodesign criteria:** This metric addresses product durability and repairability, ensuring longer lifecycles and improved end-of-life recycling.

These indicators strengthen the CEMF's role in advancing circularity in the Electronics & ICT sector.

6.1.5.2. Recommendations

To enhance the assessment of the electronics & ICT sector, a refined suite of complementary indicators is proposed, focusing on measurable metrics that can be effectively monitored in both the short and long term. These indicators aim to address identified gaps while aligning with the EU CEAP. Table 56 provides an overview of the ideal indicators for electronics and ICT.

High-level theme	Specific indicator	Source	Justification for inclusion
Percentage of citizens opting for sustainable alternatives	Percentage of consumers choosing to repair electronic and ICT products.	Tested	Shows how consumers engage with circularity by repairing products rather than discarding.
	Percentage of electronic and ICT products sold through second-hand markets.	Tested	Provides insight into transition progress in consumer choices towards circular business models.
	Rate of borrowing or leasing electronic and ICT products.	Tested	Tracks alternative consumption models, helping to understand how these models are contributing to progress in reducing material consumption.
Material Circularity Index	Proportion of recycled content in products.	CEMF	Provides insights into resource efficiency and use of virgin materials.
	Proportion of reused components in manufacturing.	CEMF	Helps with understanding how the supply chain relies on virgin materials.
Percentage of public sector ICT equipment purchased second-hand or leased	Percentage of public sector procurement that includes circular criteria.	Tested	Measures how circular principles are integrated in public sector procurement.
	Proportion of electronic and ICT products purchased by the public sector that are refurbished or second-hand.	Tested	Provides a benchmark for transition progress and promotes circular procurement practices.
Real recycling rate of electronic and ICT equipment	Mass of critical raw materials recovered from e-waste.	Tested	Ensure recycling rates go further than just overall volume, instead also focussing on critical raw materials.
	Percentage of collected WEEE prepared for reuse, repair, and refurbishment.	Tested	Shifts focus from waste collection to waste preparation, supporting higher R-strategies.

Table 56. Summary of the 'ideal' suite of indicators for 'Electronics & ICT'.

Figure 13 presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

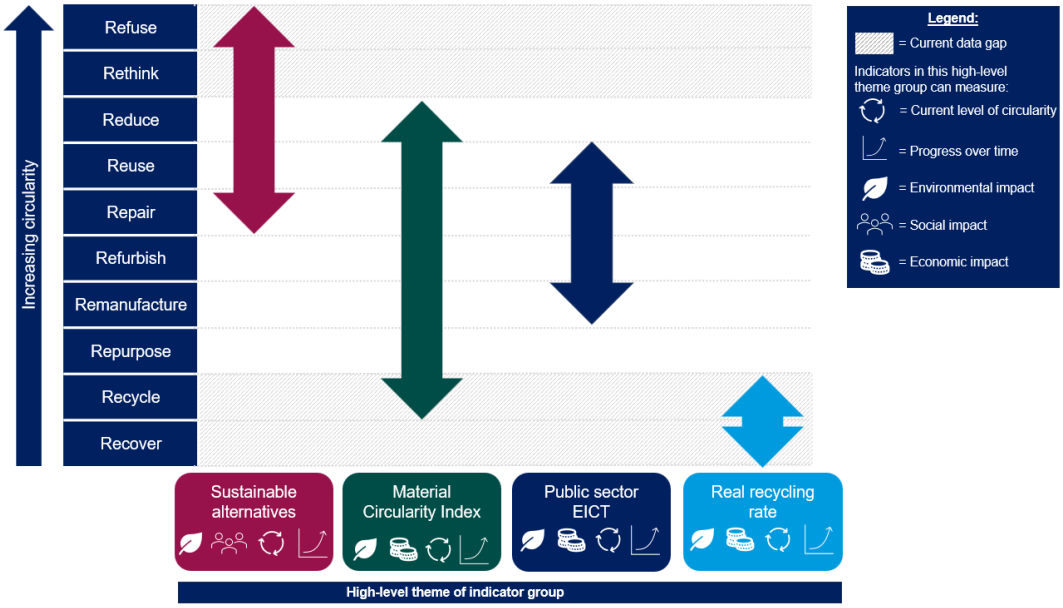

Figure 13. Overview of 'ideal' suite of indicators for 'Electronics & ICT', mapped against the R-Strategies and three facets.

Table 57 outlines the actions needed to implement these recommendations effectively.

Type of recommendation	Recommendation	Timeline
Ecodesign Criteria Compliance	Ensure a high share of consumer electronics fulfil ecodesign criteria, focusing on factors such as repairability and recyclability	Medium (1.5 – 5 years)
Public engagement	Develop guidance and run awareness campaigns to encourage consumer and industry uptake of repair, reuse, and sustainable purchasing behaviours.	Short (0.5 – 1.5 years)
Incentivising circular business models	Introduce incentives encouraging alternatives to purchasing new household electrical items and communications equipment. This aims to minimise the number of new products purchased.	Medium (1.5 – 5 years)
Data collection integration	Integrate data collection into existing EU-wide surveys to improve the quality and quantity of data related to electronics and ICT usage patterns, including repair and reuse behaviours.	Short (0.5 – 1.5 years)
Public sector procurement	Increase public sector purchases of second-hand/refurbished ICT equipment or those acquired through renting/leasing models to promote circular procurement practices.	Medium (1.5 – 5 years)
Real recycling rate improvements	Improve methodologies for calculating real recycling rates to ensure reliable tracking of material recovery.	Medium (1.5 – 5 years)
Policy	Extend Ecodesign Directive to include circular criteria like disassembly and repairability.	Medium (1.5 – 5 years)

Table 57. Recommendations for monitoring of ‘Electronics and ICT’.

6.1.6. Batteries and vehicles

6.1.6.1. Current state of play and Gap analysis

Introduction

The current policy landscape for batteries and vehicles is critical for achieving sustainability goals and transitioning to a circular economy. As the demand for EVs rises due to their lower carbon footprint compared to traditional internal combustion engine vehicles, the importance of effective battery management cannot be overstated. Batteries, particularly lithium-ion types used in EVs, are central to this shift, but they pose unique challenges regarding recycling, resource consumption, and end-of-life management.

The current policy landscape for batteries and vehicles includes the following:

- The **WFD** establishes guidelines to promote consistency and clarity in determining when substances become waste.
- **Directive 2005/64/EC**[48] on the type-approval of motor vehicles regarding their reusability, recyclability and recoverability. This directive incentivises manufacturers to design vehicles that can be more easily dismantled and recycled at end-of-life.
- **Regulation (EU) 493/2012**[49] outlines detailed rules regarding the calculation of recycling efficiencies of the recycling processes of waste batteries and accumulators. These regulations are essential for tracking recycling performance and ensuring that waste batteries are managed properly.
- **Proposed regulations/directives** particularly the EC's new "End of Life Vehicles Directive" proposed in 2023 (expected to be implemented in the next 1-2 years). A key focus of this directive is establishing minimum recycled content targets for specific material groups expected to increase over time. This directive aims to further embed sustainability into the automotive sector by incentivising the use of recycled materials in new vehicles.

Considering the R-Strategies, the predominant focus of these policy instruments, is on recycling and recyclability, but there is a consideration of reusability and rethinking – through the encouragement of using recycled content. However, as discussed below, there is room for improvement.

Gap analysis

The current policy framework for batteries and vehicles exhibits significant gaps in addressing higher-priority R-strategies such as refuse, rethink and reuse. These strategies are crucial for reducing material consumption and promoting sustainability. Existing policies predominantly focus on recycling at the end-of-life stage, neglecting initiatives that encourage manufacturers to enhance product design for durability and recyclability from the outset.

The lack of emphasis on the 'refuse' strategy limits consumer alternatives to car ownership, preventing a shift toward shared mobility solutions. Furthermore, the 'rethink' strategy is underutilised; manufacturers often prioritise performance over sustainability, missing opportunities to adopt circular design principles that extend vehicle lifecycles. The 'reuse' strategy is also inadequately addressed, as many vehicles are discarded rather than refurbished, resulting in valuable material loss and increased waste.

Material consumption remains a pressing issue, particularly concerning critical raw materials used in batteries and vehicle components. The extraction of these materials leads to environmental degradation, highlighting the necessity for policies that incentivise recycling and closed-loop systems. Additionally, the current focus on plastic use in vehicles requires enhancement; policies

[48] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32005L0064

[49] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32012R0493

mandating a minimum percentage of recycled plastic in new vehicles can promote a circular economy.

Consumer behaviour plays a pivotal role in achieving circularity. There is a need for more detailed metrics to gauge public acceptance of car-sharing initiatives and the use of recycled materials. By understanding consumer preferences, policymakers can better design programs that encourage sustainable behaviours and facilitate the transition to a circular economy within the batteries and vehicles sector.

This was a key focus for the indicators developed throughout this project and is reflected in those selected in Figure 14 below.

Alignment with the CEMF

The CEMF currently has a limited number of indicators which are related more generally to the "Batteries and vehicles" theme under the 5 high-level themes of the "Monitoring Framework". However, the CEMF does not list any indicators that are sector specific to the automotive and/or batteries sectors. The most relevant indicators from the monitoring framework have been identified as the following:

- **Circular material use rate** (%) – This monitors the percentage of raw material which is recycled and then reused in manufacturing processes. Consequently, this saves on the quantity of primary raw material which needs to be extracted. This is also referred to as circularity rate and is calculated through the ratio of the circular use of materials to the overall material use.
- **End-of-life recycling input rates (EOL-RIR), aluminium** (%) – This measures, for each respective raw material, the percentage input material used in manufacturing that is sourced from the recycling of "old scrap" from the product's end of life. This does not consider scrap material that originates from the manufacturing process. This can also be referred to as the "recycled content" used in a material as a percentage – specifically for aluminium.
- **Patents related to waste management and recycling** (number) – This monitors the number of patents which have been filed for recycling and secondary raw materials (e.g. the development of novel recycling technologies or vehicle dismantling technologies which support a circular economy).

Several gaps are apparent in the CEMF which are related to the batteries and vehicles theme. There is a lack of indicators which specifically focus on the automotive sector itself, insufficient tracking of recycled plastic content used in new vehicles (which is a target material as part of the EC's proposed "End of Life Vehicles Directive") and a lack of emphasis on the three highest priority R-strategies (Refuse, Rethink and Reuse) related specifically to automotive manufacturing.

6.1.6.2. Recommendations

Table 58 provides the 'ideal' suite of indicators has been recommended to adequately assess the policy gaps and subsequent circularity of households across four key themes.

High-level theme	Specific indicator	Source	Justification for inclusion
Ease of dismantling	Ease of disassembly of vehicles	Tested	This indicator presents a quantitative method of measuring the "progress over time" across the higher-priority R-strategies reflecting the benefits of circular design in vehicles. By making vehicles easier to dismantle, we can facilitate more efficient recycling processes and enhance the recovery of valuable materials.

Circular design initiatives	Virgin versus recycled raw material (e.g. plastics) in vehicles	Tested	Focuses on the facet of "measuring progress over time" for the recycled content targets set for 2030 and beyond, as part of the EC's proposed "End of Life Vehicle Directive". This will provide insights into the effectiveness of policies aimed at increasing the use of recycled materials in vehicle manufacturing.
Batteries recovered at EoL	Automotive batteries reused at vehicle EoL	Tested	Provides further focus on the automotive sector and prioritises the "reuse" R-strategy specifically, which is not currently part of the CEMF. The reuse of batteries can significantly extend their lifecycle and reduce waste, supporting a more sustainable approach to battery management.
Car Sharing	Car sharing frequency	Tested	Measures the three highest priority R-strategies and the by presenting a way to measure current and future reduction in the requirement for future car manufacturing and associated material consumption at source through journey sharing.

Table 58. Summary of the 'ideal' suite of indicators for 'Batteries and vehicles'.

Figure 14 presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

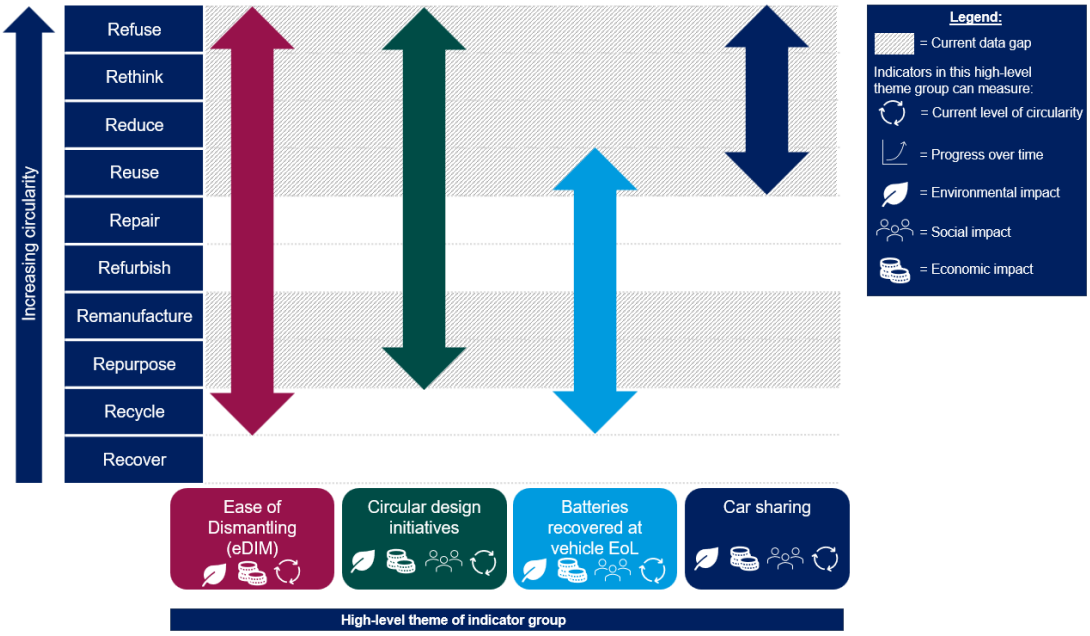

Figure 14. Overview of the 'ideal' suite of indicators for 'Batteries and vehicles', mapped against the R-Strategies and three facets.

Table 59 below summarises some of the key recommendations for progressing the above indicator themes to address the policy area gaps previously identified.

Type of recommendation	Recommendation	Timeline
Legislation/Policy	It is essential that appropriate legislation and policy is proposed and passed where it is identified as the only way to ensure a certain indicator can be successfully implemented. This could include tax incentives, outreach initiatives or raw material requirements in manufacturing (e.g. recycled plastic content).	Medium (1.5 – 5 years) and Long (> 5 years)
Technology	It is important to ensure the appropriate technology is in place to ensure indicators can be delivered. This could include technology to support circularity in the manufacturing itself (e.g. remanufacturing technologies) and/or technologies to support the data recording/reporting.	Medium (1.5 – 5 years) and Long (> 5 years)
Training, guidance and education	Several of the indicators require new data collection, recording and calculation methodologies to be applied to industry stakeholders to ensure successful delivery. To gain endorsement from key industry stakeholders it is important that they feel supported in applying these new methods. The development of appropriate training, guidance and education will be critical to ensuring stakeholder "buy-in" and the collection of reliable data e.g. guidance documents/training on the recording of dismantling time of vehicles.	Short (0.5 – 1.5 years)

Table 59. Recommendations for monitoring of 'Batteries and vehicles'.

6.1.7. Packaging

6.1.7.1. Current state of play and Gap analysis

Introduction

The EU has implemented several legislative measures, such as Directive (EU) 2018/852 (amending Directive 94/62/EC on Packaging and Packaging Waste)[50], to mitigate the environmental impact of packaging. These policies are designed to reduce packaging waste at its source, promote the reuse of materials, increase recycling rates, and improve overall resource recovery. The legislation is a crucial component of the EU's broader transition to a CE, where resources are kept in use for as long as possible, minimising waste and resource extraction.

This directive outlines specific recycling targets for various packaging materials, including plastics, paper, cardboard, glass, wood and metals. By 2025 and 2030, increasingly ambitious recycling quotas are set, aiming to create a closed-loop system for packaging materials. Similarly, the Proposal for a Regulation (2022)[51] (on packaging and packaging waste) introduces reuse targets and measures focused on optimising packaging size, increasing the production of reusable packaging and encouraging refill systems.

The existing policy framework reflects the EU's focus on the "R-strategies" that guide circular economy practices:

- **Reduce:** Efficiency in packaging design, weight and sizing is critical for reducing the overall volume of materials used. By creating more efficient packaging, the legislation aims to minimise resource consumption and waste generation at the outset.
- **Reuse:** This strategy is promoted through legislative requirements that encourage the production and use of reusable packaging and the establishment of refill systems for a variety of products.
- **Recycle and Recover:** Extensive targets for municipal waste and material-specific recycling rates ensure that packaging waste is not just diverted from landfills but also reintegrated into production cycles.

Gap analysis

Despite the progress made with these 'R-strategies', certain other strategies remain underutilised within the current legislative framework. The strategies of 'Rethink', 'Refurbish', 'Remanufacture', and 'Repurpose'—which would entail redesigning packaging systems entirely, repairing or renewing materials, or finding alternative uses for discarded products—are not yet comprehensively addressed in existing packaging legislation. This gap highlights a crucial oversight in the regulatory framework, as these strategies are vital for achieving a circular economy.

The current legislative measures primarily emphasise the **Reduce, Reuse** and **Recycle** strategies, aiming to minimise packaging waste and enhance recycling rates. However, without robust support for the underutilised strategies, the potential for innovation in packaging design and functionality is limited. The absence of requirements to promote these strategies limits opportunities for systemic change within the packaging sector.

The **Proposal for a Regulation (2022)[43]** seeks to address these gaps by promoting design principles and material choices aligned with circular economy goals. By creating an environment where packaging is not only designed for immediate use but also for future repurposing, repair and remanufacturing, the proposal could significantly enhance the sustainability of packaging systems. Nonetheless, effective implementation of these principles will require clear indicators and

[50] https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en
[51] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0677

regulatory support to ensure that all aspects of packaging sustainability are addressed comprehensively.

Alignment with the CEMF

The CEMF utilises various indicators to measure resource efficiency and sustainability, particularly regarding waste generation, material recycling and resource use in households and businesses. In the context of packaging, the CEMF uses specific indicators to monitor circularity, including:

- Packaging waste generated per capita.
- Plastic packaging waste generated per capita.
- Recycling rate of overall packaging.
- Recycling rate of plastic packaging.

However, these indicators present several limitations. First, they do not differentiate between household and commercial waste streams, making it difficult to assess the effectiveness of packaging legislation targeted at either sector specifically. Packaging waste management differs significantly between households and businesses, yet the aggregated data obscures the potential for more precise interventions based on sector-specific dynamics. Second, while the CEMF tracks overall packaging waste and plastic packaging, it does not provide data on different types of packaging materials in more granular detail. For example, plastic packaging waste is measured as a whole, without breaking it down by individual plastic polymers (such as PET, HDPE, etc.), which is important because different polymers have varying recyclability and environmental impacts. This lack of specificity limits the ability to measure the success of legislation targeting particular materials (e.g. HDPE or PET bottles).

Moreover, the CEMF focuses predominantly on the end-of-life phase of packaging, overlooking key stages of the packaging life cycle such as the use phase. Current indicators do not measure the uptake of reusable packaging or the implementation of reuse systems, which are essential to reducing packaging waste through extended use and refill systems. Without such indicators, it is challenging to assess the impact of legislative efforts to encourage reusable packaging and the adoption of refill infrastructure.

The indicators tested in the present study offer a potential solution to some of the existing gaps in the CEMF. For example, one indicator proposes measuring the amount of packaging placed on the market designed with the principle of ‘Reuse’. This indicator indirectly supports the CEMF’s goal of reducing the total amount of packaging waste generated per capita by extending the lifecycle of packaging materials and reducing the need for single-use items. These tested indicators also offer greater granularity, allowing for a more detailed assessment of packaging circularity. By focusing on packaging designed for reuse and tracking the integration of reusable systems, these indicators provide insights that extend beyond what is currently measured by the CEMF. Additionally, they help measure the impact of strategies like ‘Rethink’ (encouraging systemic changes in packaging design and functionality) and ‘Reuse’ in ways that are not fully captured by existing CEMF metrics.

These improvements are essential for driving the EU's circular economy objectives forward, as they promote comprehensive understanding and effective actions across the packaging lifecycle.

6.1.7.2. Recommendations

In order to address the gaps in current legislation and indicators measured by the CEMF, it is proposed that the indicators detailed in Table 60 are introduced:

High-level theme	Specific indicator	Source	Justification for inclusion
Legislation	Number of legislative incentives created to encourage circularity in the European Union packaging industry	Tested	To fully understand the current legislative landscape that regulates the packaging industry.
Circular design (reuse)	Percentage, by weight of packaging placed on the market, designed by circular principles	Tested	To measure and understand the packaging quantities currently designed with principles such as 'reuse' in mind
	Share of takeaway meals and drinks provided in reusable packaging	Tested	To measure the quantity of takeaway food and drink packaging that is reusable, as this industry produces some of the greatest packaging waste quantities.
Packaging waste and recycling	Packaging waste generated per capita	CEMF	To measure the amount of overall packaging waste generated in each member state.
	Recycling rate of overall packaging	CEMF	To measure the amount of overall packaging that is being recycled in each member state, and to understand the recycling rate in comparison to packaging waste generated

Table 60. Summary of 'ideal' suite of indicators for 'Packaging'.

Figure 15 presents how the recommended indicators address the identified policy gaps and align with the R-strategies and 3 facets.

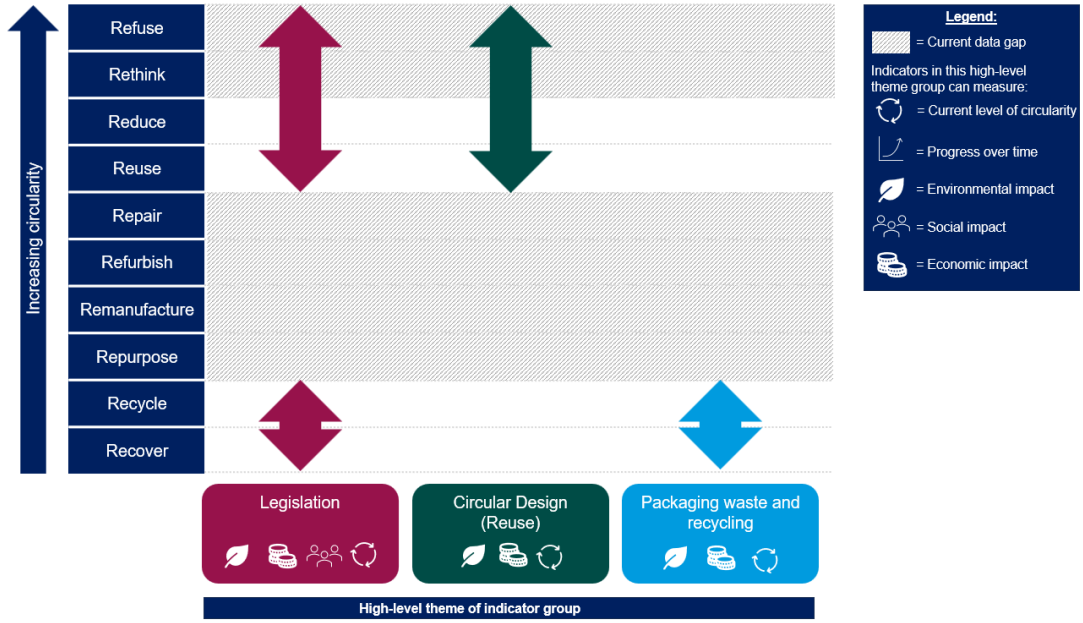

Figure 15. Overview of 'ideal' indicators for 'Packaging', mapped against the R-Strategies and three facets.

The main actions needed to support the eventual implementation of this suite of indicators are summarised in Table 61**Error! Reference source not found.**.

Type of recommendation	Recommendation	Timeline
Legislation	Incentives encouraging the use of reusable packaging	Medium (1.5 – 5 years)
R&D	Further testing and development of the indicators	Medium (1.5 – 5 years)
R&D	Stakeholder engagement to support the development and measurement of the indicators	Medium (1.5 – 5 years)

Table 61. Recommendations for 'Packaging'

6.1.8. Plastics

6.1.8.1. Current state of play and gap analysis

Introduction

The EU has enacted several legislative measures focused on integrating plastics into its broader circular economy goals, aiming to reduce plastic waste, improve recyclability, and address environmental impacts. Current legislation aims to redesign the way plastics are produced, used, and recycled within the EU. It sets out actions to reduce plastic waste, promote recycling, and tackle marine litter. Key initiatives include increasing the recyclability of plastic packaging and encouraging the use of recycled plastics in new products. Legislation such as the Single-Use Plastics Directive (2019)[52] target common single-use plastic items (that are often found on

[52] https://environment.ec.europa.eu/topics/plastics/single-use-plastics_en

European beaches) such as straws, cutlery, and cotton bud sticks, and either bans or restricts them. Other legislation, such as the Packaging and Packaging Waste Directive sets recycling targets for plastic packaging and focuses on reducing packaging waste while promoting reusable and recyclable alternatives. New regulations also target and work to prevent pellet losses in plastic production, encouraging the use of alternative materials.

The existing policy framework reflects the EU's focus on the "R-strategies" that guide circular economy practices:

- **Reduce:** Limiting the use of single-use plastics, like straws and cutlery, to lower plastic waste.
- **Reuse:** Promoting the design and use of reusable packaging and products.
- **Recycle:** Setting ambitious recycling targets for plastic packaging and increasing the use of recycled plastic in new products.
- **Rethink:** Redesigning products to improve recyclability and reduce environmental impact.
- **Refuse:** Banning certain harmful single-use plastic items.

Gap analysis

The EU has implemented numerous legislative measures aimed at integrating plastics into a circular economy, focusing on reducing waste and enhancing recyclability. Despite these efforts, significant gaps remain in the policy framework. There is an overemphasis on recycling rather than adequately supporting upstream R-strategies such as Reduce, Rethink, Reuse, Repair, Refurbish, and Remanufacture. Additionally, there is a lack of incentives for packaging redesign, insufficient tracking of product durability and reusability, and limited innovation in alternative materials.

Alignment with the CEMF

The CEMF supports circularity improvements in the plastics industry by providing key indicators that track progress in the transition to a circular economy. These indicators help measure and guide improvements in various areas:

- **Recycling Rates:** The CEMF tracks the recycling input rate and plastic waste recycling rates, assessing how much plastic waste is being recycled and reused as raw materials. This helps monitor the industry's shift from linear to circular practices.
- **Circular Material Use:** The framework measures the circular material use rate, which reflects the percentage of recycled plastics used in production. This encourages the industry to increase the use of secondary raw materials, reducing reliance on virgin plastics.
- **Waste Generation:** By tracking plastic waste generation, the CEMF helps identify areas where waste can be reduced, supporting better design and production processes that lead to less waste.

These indicators guide policy and industry efforts toward more sustainable plastic production, consumption, and waste management. However, there are some key gaps in the CEMF relating to the plastics industry, including:

- Limited focus on upstream strategies like **Rethink** and **Refuse** (product redesign and avoiding plastic use), with an overemphasis on recycling.
- Inadequate tracking of product durability and reusability, which is essential for promoting the **Reuse, Repair**, and **Refurbish** and **Remanufacture** strategies.
- Insufficient focus on innovation in alternative materials limiting the potential for more sustainable solutions.
- Lack of waste prevention measures, particularly in reducing plastic consumption at the source.
- Insufficient granularity of data. The CEMF provides overall recycling rates without a breakdown into individual materials, hindering targeted improvements.

- Lack of measurement of progress over time and benchmarking which are vital for assessing advancements in circular economy initiatives.

The tested indicators would help to augment the existing CEMF indicators and fill gaps in existing indicators and legislation in various ways, including:

- Showcasing successful models of circular economy principles for wider adoption across the industry, helping to bridge the gap in the **Rethink** and **Reuse** strategies.
- Providing more data on current levels of circularity in the industry.
- Enhancing the measurement of progress over time. Tracking the number of projects over time provides a metric for assessing the progress in the transition towards a circular economy, allowing advances in plastic waste reduction to be quantified.
- Providing policymakers with data on the effectiveness and scalability of circular practices, informing legislation and adjusting existing legislation to better support circularity.

6.1.8.2. Recommendations

The 'ideal' suite of indicators in Table 62 has been recommended to adequately assess the policy gaps and subsequent circularity of households across four key themes:

High-level theme	Specific indicator	Source	Justification for inclusion
Circular production	Number of pilot/demonstration projects on the circular production and treatment of plastics	Tested	Explores the implementation of circular principles in the production and the post-use phase of plastics.
Legislation	Number of legislative incentives created to encourage circularity in the plastics industry	Tested	Provides an understanding of the current legislative landscape for the plastics industry.
Waste generation and management	Generation of plastic packaging waste per capita	CEMF	Measures the plastic packaging waste collected by municipal authorities and generated by households.
	Recycling rate of plastic packaging	CEMF	Measures the plastic packaging waste collected by municipal authorities and generated by households which is subsequently recycled.

Table 62. Overview of 'ideal' indicators for 'Plastics'.

The overarching themes of the indicators tested in this project are illustrated in Figure 16 below in relation to the R-Strategies and which of the three-facets they cover.

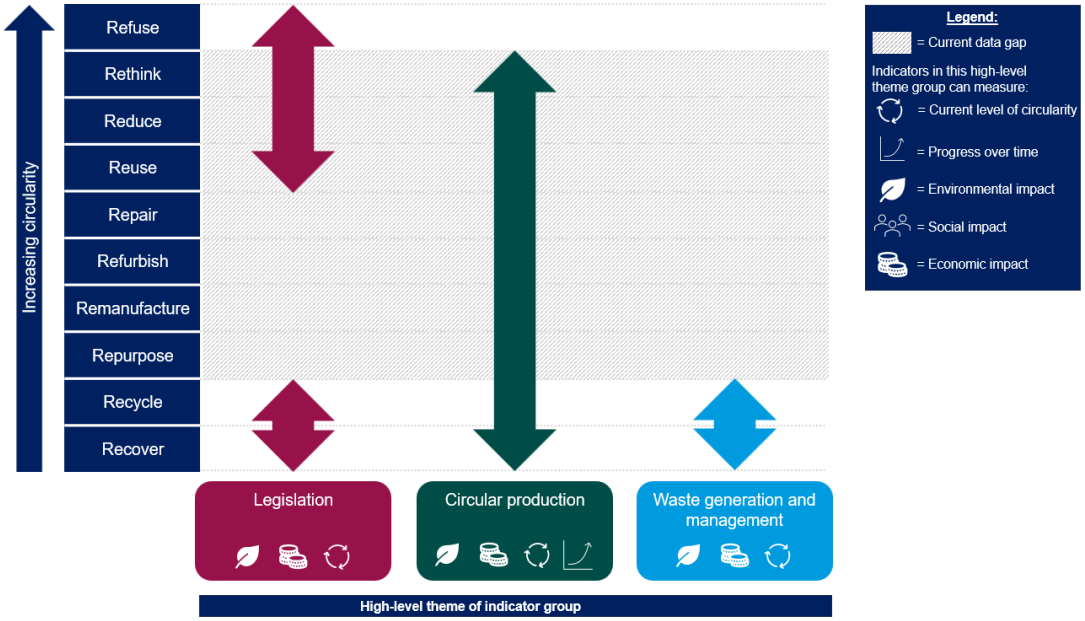

Figure 16. Overview of 'ideal' suite of indicators for 'Plastics', mapped against the R-Strategies and three facets.

The main actions needed to support the eventual implementation of this suite of indicators are summarised in Table 63.

Type of recommendation	Recommendation	Timeline
R&D	Improvement of Eurostat indicators	Medium (1.5 years – 5 years)
R&D	Consider tracking indicators over multi-year period to increase statistical significance of results	Medium (1.5 – 5 years)
Policy	Develop a digital portal where Member States can directly report information on legislative incentives to European Commission	Medium (1.5 – 5 years)

Table 63. Recommendations for 'Plastics'.

6.1.9. Textiles

6.1.9.1. Current state of play and Gap analysis

Introduction

The textiles value chain is increasingly recognised for its potential to foster sustainable consumption and production, with an emphasis on creating a more circular textile industry. The CEAP highlights textiles as a resource-intensive sector with a high potential for circularity. In response, the EU Strategy for Sustainable and Circular Textiles, adopted in 2022, aims to create a greener, more competitive, and resilient textile sector. This strategy sets ambitious objectives to ensure that, by 2030, all textiles on the EU market are durable, repairable, and recyclable, largely made from recycled fibres, free of hazardous substances, and produced in accordance with social and environmental standards. The strategy also envisions a shift away from fast fashion, encouraging longer-lasting, high-quality textiles and expanding profitable re-use and repair services.

To achieve these goals, the strategy promotes several R-strategies, including reuse**,** repair, and recycling. The emphasis on R-strategies reflects a shift away from fast fashion towards a more sustainable model that values longer-lasting, high-quality textiles. Producers are expected to be responsible along the entire value chain, ensuring sufficient recycling capacity and minimising incineration and landfilling.

Gap analysis

Despite these positive developments, significant gaps persist in the existing policy framework for textiles. One major gap is the lack of EU-wide targets specifically focused on textile circularity and waste management. The European Parliament has called for specific targets for the prevention, collection, reuse and fibre-to-fibre recycling of textile waste. Key legislative measures currently in process include the mandatory separate collection of textiles by 2025, the introduction of Extended Producer Responsibility (EPR) schemes for textiles, and the establishment of ecodesign criteria under the European Sustainable Product Regulation (ESPR)[53].

Alignment with the CEMF

The CEMF does not include any textile-specific indicators, although it does include several indicators that could be applied to textiles:

- **Waste generation:** This monitors the waste generated per capita for different waste streams, such as municipal waste, food waste, and packaging waste. Textile waste has not been systematically monitored; the separate collection of textile waste will become mandatory in 2025.
- **End-of-life recycling input rates (EOL-RIR):** This monitors, for each respective raw material, the percentage of input material used in manufacturing that is sourced from the recycling of “old scrap” from the product’s end-of-life. This can also be referred to as the “recycled content share” used in a material. No metrics are introduced assessing the share of recycled content in textile products put on the EU market.
- **Persons employed in circular economy sectors:** This monitors the percentage of total employment employed in the recycling, repair and reuse, and rental and leasing sectors. However, there is a lack of more granular data on these activities, broken down by product type or material, including textiles.

The CEMF does not include indicators for value retention strategies, such as increased repair or reuse, which are critical for enhancing textile circularity. Given that the CEMF relies largely on national statistics, these gaps reflect current data collection limitations at the national level. It may

[53] https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en

also reflect a lack of political will to pursue value retention, resulting in no national-level monitoring on this topic.

This project has identified potential indicators to address the gaps in textile-specific data within the CEMF, focusing on areas where data collection is feasible. For instance, jobs in textile repair could serve as a proxy indicator for increased repair activity. However, further indicators on reuse and extended product lifetimes are still needed to capture these strategies comprehensively.

6.1.9.2. Recommendations

Table 64 provides the 'ideal' suite of indicators has been recommended to adequately assess the policy gaps and subsequent circularity of textiles.

High-level theme	Specific indicator	Source	Justification for inclusion
Product use/consumption	Jobs in textile repair	Tested	Serves as a proxy for textile repair activity, highlighting repair services as a key component of product life extension.
	Apparent consumption	ETC/CE (2022)[54]	Tracks the consumption volumes of textiles, which are a key driver of environmental and climate pressures stemming from the textile value chain.
	Reused textiles	ETC/CE (2025, forthcoming)[55]	Captures the volume of reused items, as a critical strategy to extend product lifetimes and reduce waste generation.
Product design	Shared of recycled content put on the market	Tested	Reflects the substitution of virgin raw materials with recycled ones, promoting circular design and sourcing practices.
Disposal	Separate collection of textiles	Tested	Indicates the volumes of separate collection, which are a prerequisite for sorting for reuse and recycling.
	Capture rate	ETC/CE (2025, forthcoming)[56]	Measures the effectiveness of the collection systems, representing the share of separately collected textiles.

[54] https://www.researchgate.net/publication/358493746_Textiles_and_the_Environment_-_The_role_of_design_in_Europe's_circular_economy

[55] Unpublished report by the ETC/CE to which the Consortium team members had been provided access.

[56] *ibid*

High-level theme	Specific indicator	Source	Justification for inclusion
End-of-life	Textile waste treatment	ETC/CE (2024)[57]	Assesses the share of separately collected textile waste going to incineration or landfill.
	Output from textile recycling	Tested	Reflects the amount of secondary raw materials available for fibre production, derived from recycled textiles.

Table 64. Overview of 'ideal' indicators for 'Textiles'.

The overarching themes of the indicators tested in this project are illustrated in Figure 17 below in relation to the R-Strategies and the environmental, economic, and social aspects they cover.

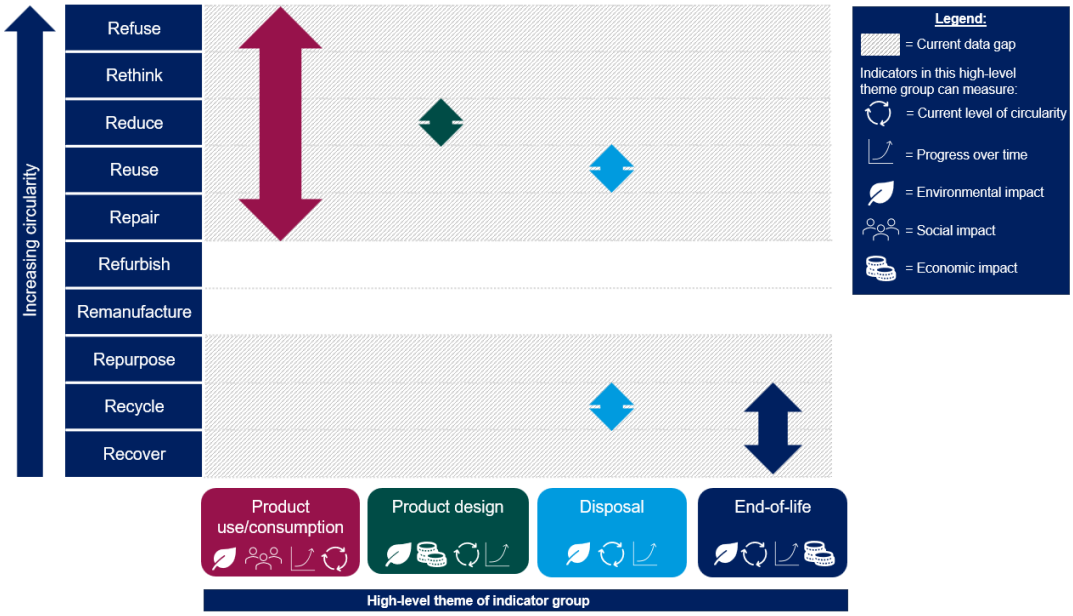

Figure 17. Overview of the 'ideal' indicators for 'Textiles', mapped against the R-Strategies and three facets.

The recommendations presented in Table 65 below address the significant lack of transparency in tracking materials and the fate of textiles in the European market, along with inconsistencies in the classification of used textiles and textile waste and the absence of clear circularity targets at both EU and national levels.

Developing effective indicators for textile circularity, as explored in this project, first requires enhanced reporting requirements for EU textile brands to increase transparency regarding the products placed on the European market. Implementing EPR schemes for textiles could further support transparency and data availability by requiring brands to report the share of secondary materials used in their products. To close current monitoring gaps in the post-consumer textile value chain, it is necessary to establish standardised definitions at the EU level—particularly for

[57] https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-5-textile-waste-management-in-europes-circular-economy

textile waste and used textiles—and to implement a harmonised reporting methodology for textile collection and processing.

Leveraging existing initiatives, such as the Right-to-Repair, the ESPR, and EPR schemes, can enhance transparency and data collection in the textile sector. In the longer term, revising economic activity classifications, such as the NACE system, will help better reflect textile-specific categories, although this will be a complex and resource-intensive process.

Type of recommendation	Recommendation	Timeline
Legislation	Introduction of mandatory reporting requirements for brands and retailers putting textile products on the European market regarding fulfilment of ecodesign criteria, such as share of recycled content / post-consumer textile waste.	Medium (1.5 – 5 years)
Legislation	Harmonisation of the collection approaches, reporting standards and definitions on textile waste / reused textiles across EU Member States.	Medium (1.5 – 5 years)
Revision of economic activity classifications	Revision of the NACE classifications to provide for better registration of textile repair and recycling activities.	Long (> 5 years)

Table 65. Recommendations for Monitoring of Circularity in 'Textiles'.

6.1.10. Construction and buildings

6.1.10.1. Current state of play and Gap analysis

Introduction

Existing EU initiatives and legislation on circular construction include the application of circularity principles to building renovation (the Renovation Wave Strategy, October 2020)[58], which will 'reduce' materials-related greenhouse gas emissions from buildings. At the same time, it will expand the market for sustainable construction products and services, including integrating new materials and nature-based solutions and revised legislation on marketing construction products and material 'reuse' and 'recovery' targets.

The EU Taxonomy Environment Delegated Act (June 2023)[59] addresses construction and real estate activities that can substantially contribute to the transition to a circular economy for buildings and infrastructure works[60]. For example, it requires conducting pre-demolition audits and 're-using' and 'recycling' construction materials.

Regulation on reducing GHG emissions and requiring pre-demolition audits for all construction projects through 'reduce', 'reuse', and 'recycling' strategies at the construction product level (e.g., documented through EPDs) and building level (e.g., documented through certification schemes or following the Level(s) indicators framework) can further promote circular construction practices.

Gap analysis

Current policies in the construction sector exhibit significant gaps concerning the R-strategies (Refuse, Rethink, Reuse, Recycle). A significant gap identified is the absence of robust monitoring specifically for the reuse of construction products. While reuse is incorporated into the

[58] COM(2020) 662 final: 'A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives'
[59] https://finance.ec.europa.eu/publications/sustainable-finance-package-2023_en
[60] See Anne II 'Transition to a circular economy': https://finance.ec.europa.eu/system/files/2023-06/taxonomy-regulation-delegated-act-2022-environmental-annex-2_en_0.pdf

recommended indicators of building-level certification schemes, systematic tracking of reused materials is not standardised across projects. The R-strategies 'Refuse' and 'Rethink' are currently not monitored within the context of construction and buildings. This oversight limits the potential for proactive decision-making in reducing material consumption and re-evaluating project designs to favour sustainability.

While existing policies place significant emphasis on recycling and reuse, they overlook the necessity of rethinking project designs to effectively minimise resource use. Addressing these policy gaps is essential for promoting circularity within the construction sector.

Alignment with the CEMF

The CEMF has some indicators comprising the ‘construction and buildings’ theme with the most relevant indicators being:

- **Green public procurement** which includes construction projects.
- **Total waste generation per capita, kg per capita:** Construction and demolition waste management requirements and increasing the use of pre-demolition audits to promote reuse and recycling can decrease the overall amount of waste generation.
- **Recycling rate of all waste, excluding major mineral waste**: The construction material is fed back into the economy at the de-construction phase, where materials are sorted for reuse and recycling.
- **GHG emissions from production activities, kg per capita:** GHG emissions are monitored through LCAs, EPDs, and certification schemes at the product and building levels.

The ‘reuse’ R-strategy is highly relevant in construction but is not monitored as part of the CEMF. The CEMF includes no construction-specific indicators.

The three indicators tested in this project are:

- The ‘Share of building product EPDs with circular properties’ is linked to the latter CEMF indicator mentioned above, notably with product-specific benchmarks incorporating circular principles to reduce GHG emissions.
- The indicator ‘Number of building projects that are certified’ potentially supports all the abovementioned indicators because the criteria included in certification schemes positively impact all indicators (green public procurement in the case of public authority construction projects).
- The ‘Utilisation rate of existing building stock’ refers to better utilisation of existing buildings, potentially contributing to all the above indicators. It is significantly linked to green public procurement as it can impact choices to renovate or repurpose instead of constructing new buildings.

6.1.10.2. Recommendations

Table 66 provides the ‘ideal’ suite of indicators has been recommended to adequately assess the policy gaps and subsequent circularity of construction and buildings.

High-level theme	Specific indicator	Source	Justification for inclusion
Circular documentation	Share of EPDs with circular properties	Tested	It offers the opportunity to document development over time at product level.
	Number of certified buildings with schemes including circularity requirements	Tested	It offers the opportunity to document development over time at building level.
Maintain building stock	Utilisation of existing building stock	Tested	Documentation on the vacancy of existing building stock to identify potential for better utilisation rather than constructing new buildings.
	Total renovations vs. demolition and new buildings: • Total m2 of building permissions per year. • Total m2 of demolitions projects per year. • Total m2 of renovation/ rehabilitation projects per year.	Bauer et al. (2024)[61]	Documentation on the development in construction of new buildings.
Construction and demolition waste	Total amount of construction and demolition waste	Bauer et al. (2024)[62]	The CEMF currently does not include an indicator for construction and demolition waste.
	Construction and demolition waste per capita, in relation to turnover for the sector, or per new m2 built.	Bauer et al. (2024)[63]	Same as above.

Table 66. Summary of the 'ideal' suite of indicators of 'Construction and buildings'

[61] https://pub.norden.org/nord2024-024/index.html
[62] *ibid*
[63] *ibid*

The overarching themes of the indicators tested in this project are illustrated in Figure 18 below in relation to the R-Strategies and the environmental, economic, and social aspects they cover.

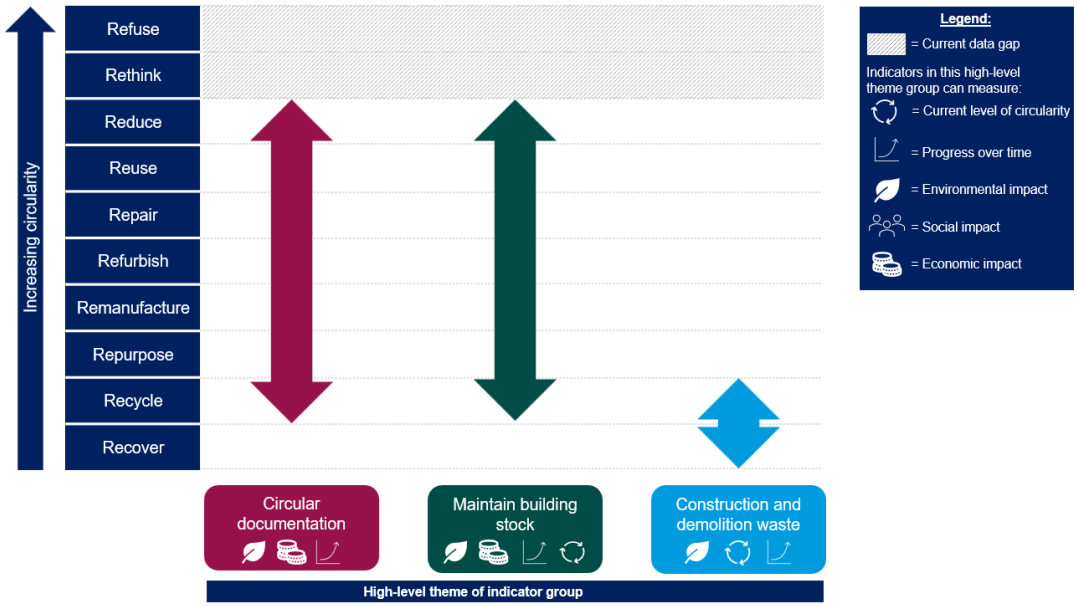

Figure 18. Overview of the 'ideal' suite of indicators for 'Construction and buildings', mapped against the R-strategies and three facets.

The main actions needed to support the eventual implementation of this suite of indicators are summarised in Table 67.

Type of recommendation	Recommendation	Timeline
Development of methodology and guidance	Pursue implementation of more circular criteria in certification schemes and monitor the share of certified buildings.	Medium (1.5 – 5 years)
Development of methodology and guidance	Monitor total renovations vs. demolition and new buildings via local authorities.	Medium (1.5 – 5 years)
Development of methodology and guidance	Develop more detailed reporting requirements for waste management companies to be able to monitor the share of waste derived from construction and demolition.	Medium (1.5 – 5 years)

Table 67. Recommendations for the monitoring of 'Construction and buildings'.

6.1.11. Food, water and nutrients

6.1.11.1. Current state of play and gap analysis

Introduction

The indicators selected for analysis in the context of food, water, and nutrients primarily concentrate on the food aspect of this theme. The current EU policy framework in relation to food includes several key strategies and action plans designed to promote sustainability and circularity within the food system. The Farm to Fork Strategy[64] aims to accelerate the transition to a sustainable food system and includes targets for 2030 for at least 10% of agricultural areas to be brought back under high-diversity landscape features, for 25% of EU agricultural land to be organically farmed, and to reduce by 50% the use of (and risk from) chemical pesticides, and the use of more hazardous pesticides.

The European Biodiversity Strategy[65] aims to put biodiversity on the path to recovery by 2030, and to build society's resilience to threats including climate change, forest fires, food insecurity and disease. As well as sharing the Farm to Fork Strategy's high-diversity landscape feature and organic farming targets, it includes targets to restore 25,000km of free-flowing rivers and significantly increase agro-ecological practices.

The EU Soil Strategy for 2030 aims to bring soil ecosystems into healthy conditions by 2050. In addition to sharing the Farm to Fork Strategy's pesticides targets, it includes targets to achieve net GHG removal of 310 mt CO2e per year for the land use change and forestry sector by 2030, and to reach no net land take by 2050.

The Action Plan for the development of organic production[66] and the Food 2030 Pathways for Action initiative[67], whilst not containing specific targets, aim to support organic farming and demand and trust from consumers, and to contribute to the UN SDG targets, respectively. The existing indicators mapped (from the EU, EEA, Member States and research organisations) relate to: ecolabels, food waste, biological, household and total waste treatment, water consumption, climate impacts/GHG emissions, land use preservation, and material and consumption footprints/circularity. The existing policy landscape and indicators have potential to contribute in particular to the R-strategies of Refuse (e.g. limiting pesticide use), Reduce (e.g. consuming fewer resources and addressing food waste), and Recycle (e.g. organic waste treatment).

Gap analysis

Several of the R-strategies are less relevant to food than to other key product value chains (e.g. Reuse, Repair, Refurbish, Remanufacture and Repurpose), therefore even though they are not really dealt with in the relevant policy framework, this should not necessarily be seen as a gap to be addressed.

In terms of the 3-facets of circularity, some of the existing indicators contribute to understanding current levels of circularity (e.g. food waste, organic waste treatment, material circularity), most indicators can contribute to assessing progress over time, and some of the policies have potential to contribute to the triple bottom line impacts (e.g. by tackling the environmental impacts of food production and supporting the development and uptake of organic farming).

[64] https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

[65] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

[66] https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-action-plan-for-the-development-of-organic-production

[67] www.research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/new-report-food-2030-research-and-innovation-pathways-action-20-2023-12-04_en

Alignment with the CEMF[68]

Some of the existing indicators in the CEMF have potential to support circularity improvements in relation to food and food production. The GHG emissions from production activities (kg CO2e per capita) indicator presents GHG emissions of all production activities undertaken in the EU economy, including agriculture.

The Green Public Procurement indicator measures the share of public procurement procedures above the EU thresholds (in number and value) that include environmental elements that may contribute to circularity.

The Food Waste Generation (kg per capita) indicator measures waste throughout the food value chain, including production, processing, manufacture, retail, distribution, restaurants, food services and households, with the potential to inform EU targets to reduce food waste.

The Consumption Footprint (Index 2010=100) indicator estimates the environmental impacts of EU and Member States' consumption by combining data on the consumption intensity and environmental impacts of specific products, including food.

These indicators go some way to better understanding circularity in relation to food and food production, offering potential to contribute in particular to the R-strategies of Refuse (green public procurement indicator) and Reduce (food waste generation indicator). They can also support the 3-facets by contributing to understanding current levels of circularity (food waste generation and green public procurement indicators), to assessing progress over time (all indicators), and to understanding the triple bottom line impacts (indicator on GHG emissions from agriculture, food waste generation and consumption footprint indicators).

The tested indicators related to food can complement the existing CEMF in several ways. They offer potential to complement the GHG emissions from production activities indicator, by highlighting CO2e emissions related to food (climate labelling indicator). They also have clear synergies with the Green Public Procurement indicator, by adding granularity on procurement requirements related to organic food; there is also already guidance in place to support this indicator, through the EU GPP criteria for food, catering services and vending machines (organic procurement requirements indicator). They can also complement the information gathered under the food waste indicator by providing a complementary perspective (sustainable calorie intake indicator); for example if the food waste metric decreases over time but the sustainable calorie intake is shown to be persistent, this may hint at overconsumption stemming from unhealthy diets, rather than (just) from food waste. Finally, the consumption footprint indicator would be complemented by a better understanding of the progress on achieving healthy, sustainable diets (sustainable calorie intake indicator).

6.1.11.2. Recommendations

As discussed above, several of the R-strategies are less relevant to food than to other key product value chains (e.g. Reuse, Repair, Refurbish, Remanufacture and Repurpose), therefore although they are not particularly addressed in the relevant policy framework, this should not necessarily be seen as a gap to be addressed. Nevertheless, a suite of indicators to more adequately assess the circularity of food and food production than the current CEMF could include those presented in Table 68.

[68] Please note that the EU Bioeconomy Monitoring System was not similarly assessed at this stage of this project to ensure the methodology was consistent across all the key policy areas under consideration.

High-level theme	Specific indicator	Source	Justification for inclusion
Climate and food	Presence of guidance (labelling) on climate impact of food product categories	Tested	To highlight CO2e emissions related to food and encourage consumption of less climate-impactful foods.
	GHG emissions from production activities (kg CO_2e per capita)	CEMF	To measure GHG emissions from agricultural production.
Sustainable public procurement	Presence of requirements for organic products in public procurement of food	Tested	To add granularity on procurement requirements for organic food.
	Green public procurement	CEMF	To measure the share of public procurement procedures above the EU thresholds that include environmental elements contributing to circularity.
Waste generation and management	Food waste treatment	EU EEA Swedish waste management association[69]	To better understand how treatment of generated food waste contributes to circularity
	Food waste generation/consumer food waste	CEMF	To measure food waste generation and inform EU targets to reduce food waste.
Food consumption	Sustainable Calorie intake per capita gap of animal-based food consumption	Tested	To complement the food waste and consumption footprint indicators by giving a better understanding of the impact of healthy, sustainable diets.

[69] https://www.avfallsverige.se/

High-level theme	Specific indicator	Source	Justification for inclusion
	Land-use footprint of production or consumption	PBL Netherlands Environmental Assessment Agency[70]	To understand the land-use impacts of food production and/or consumption
	Consumption footprint	CEMF	To estimate the environmental impacts of EU and Member States' food consumption.

Table 68. Overview of 'ideal' indicators for 'Food, water and nutrients'.

Figure 19 presents how the recommended indicators and how they align with the R-strategies and 3 facets.

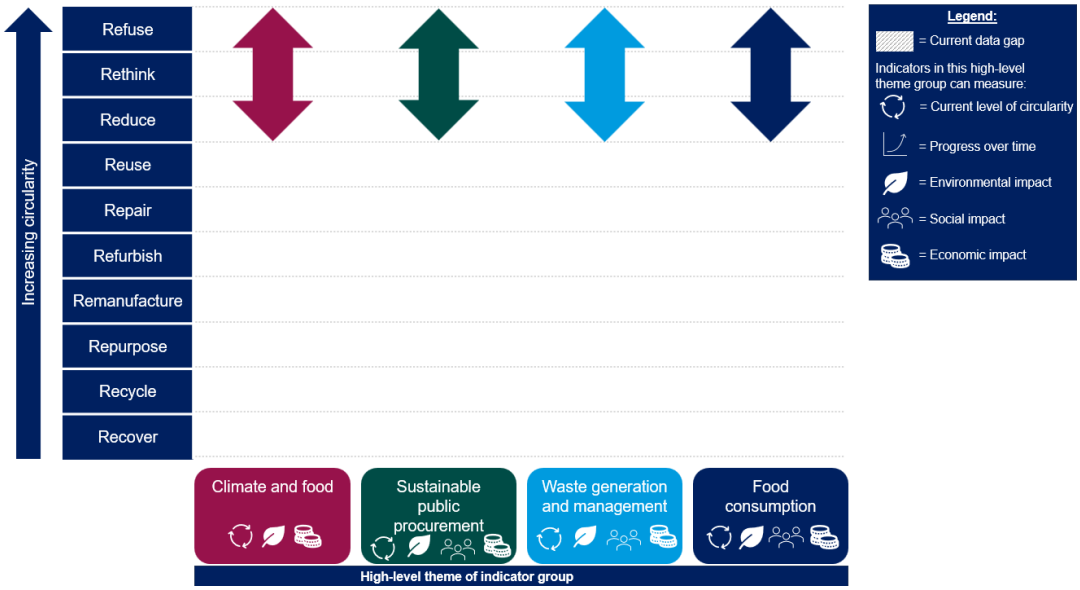

Figure 19. The 'ideal' indicators for 'Food, water and nutrients'.

The main actions needed to support the eventual implementation of this suite of indicators are summarised in Table 69 below. Additional scoping of the tested indicators would help to create sound definitions of the indicators to ensure they fit with and complement the existing CEMF indicators. The development and application of robust data collection, calculation and sharing methods, including through stakeholder engagement, would contribute to the successful implementation of the tested indicators. An update to the EU organic label would ensure it is in line with recent developments in circularity for food, contributing to the rollout of the tested indicators. Finally, the tested indicators would be introduced and implemented, to complement the existing CEMF and ensure that the circularity of food and food production can be more adequately assessed.

[70] https://www.pbl.nl/en/publications/the-price-of-protein-review-of-land-use-and-carbon-footprints-from-life-cycle-assessments-of-animal-food-products

Type of recommendation	Recommendation	Timeline
R&D, info/guidance provision	Further scoping of the tested indicators, e.g. to create sound indicator definitions	Short (0.5 – 1.5 years)
Data support, industry/public engagement	Develop and apply data collection/calculation/sharing methods to implement the tested indicators	Medium (1.5 – 5 years)
Policy, info/guidance provision	Update the EU organic label to be more in line with recent developments in circularity for food	Medium (1.5 – 5 years)
Policy	Test and introduce the tested indicators, to complement existing CEMF	Medium (1.5 – 5 years)

Table 69. Recommendations for 'Food, water and nutrients'

6.2. Cross-cutting learnings

6.2.1. Data availability

As discussed in detail in Section 4.3, data gaps were present in a large proportion of the 60 indicators investigated.

The primary reasons for the data gaps were:

- Lack of engagement from key data-holding stakeholders, comprising:
  - Simply no response to repeated engagement attempts.
  - Lack of time/resource to engage with and fulfil data requests.
- Restricted access due to commercial sensitivity.
- Methodological inconsistencies in data recording practices, meaning data that was available was not always easily comparable.
- Insufficient granularity of existing datasets preventing accurate analysis of the intended indicators. The severity of the impact of these data gaps varied.

Some of the indicators had to be treated in a more narrative fashion for their case studies, with simply no data available to conduct any level of quantitative assessment.

For the majority though, alternative sources or proxy and extrapolation methods were able to be identified and deployed. These sometimes led to slight shifts in the wording of the indicator, or the focus of the research, but always allowed for a level of analysis sufficient to provide some insight on the value and usefulness of the indicator going forward. This in turn lead to the recommendations made for further development or not, and suggested actions. The actions suggested to mitigate against specific data availability issues are presented in Section 5.2, and are summarised in Section 6.3.

6.2.2. Emerging themes in key recommendations

Several key themes and trends emerge from the recommendations made for both aspects of the roadmap for key indicators.

6.2.2.1. Regulatory and policy recommendations

Across the 21 key recommended indicators, the policy or regulatory related recommendations suggested fall into three main categories:

- Data reporting

Both the introduction of mandatory reporting, and regulatory support to formalise and therefore increase the availability and quality of reported data, across all themes. Cross-sectoral alignment in data collection is crucial, ensuring that data is harmonised across different sectors such as construction, ICT and bioeconomy, enabling more holistic tracking of circularity.

- Incentivisation and financial support

Predominantly aimed at incentivising citizens to choose more circular practices in everyday life, such as modal transport shift, and considering repair or re-use options rather than new purchases for common goods.

- Legislative changes for sustainable practices

Alongside the encouragement of the citizenry to shift towards circularity, recommendations here also include commercial, company-targeting aspects. These include the incentivisation of reuse of automotive batteries within the automotive sector, and stipulations to ensure that primary forestry material outputs are not used for lower-value energy recovery.

6.2.2.2. Technical recommendations

The technical action plan provided 62 recommendations from the 21 key indicators. These can be grouped into four key areas:

- Data collection and support

Recommendations covering the actual collection of relevant data, and technical support options to facilitate that, such as the adoption and roll-out of standardised formats and tools, and investigation into granularity improvements of existing datasets.

- Provision of guidance and information

A mix of recommendations for public-facing guidance to educate around and encourage more circular personal choices, and more technical guidance ideas such as how cities can improve infrastructure to incentivise alternatives to private vehicle use, and circular design guidance for ease of repair and recoverability of priority materials or products. This should include supporting innovation platforms that foster collaboration between research institutions, governments and industries to develop new circular business models and indicators.

- Stakeholder / sector engagement

  Aligned with the above two themes, recommendations covering further engagement with key sector players to understand perceptions and attitudes towards the indicators and the principles of circularity they aim to measure, any gaps in relevant data, knowledge, capacity and resource, and potential routes to support the filling of those gaps. Cross-border data collaboration is also recommended, allowing regions and countries to share best practices and build more robust, consistent datasets.

- Further R&D into the indicator itself

  Continued research to build on that done as part of this study, developing understanding and working towards defining aspects such as scopes, criteria and monitoring strategies. Research should also focus on refining indicators for underrepresented R-strategies such as Refurbish, Remanufacture and Refuse to ensure a balanced and comprehensive coverage of circular practices.

6.2.2.3. Target setting recommendations

The final stage of the project focused on reviewing outputs from the earlier tasks to propose and define SMART targets. The following key areas were highlighted in Section 5.3:

- Integration of circularity with climate goals

CE targets should be aligned with environmental and climate objectives, ensuring that circular practices not only focus on resource recovery but also contribute to reducing GHG emissions. This will allow circular economy initiatives to support broader climate action and ensure that circularity contributes meaningfully to net-zero.

- SMART targets for underrepresented R-strategies

There is a need to develop SMART targets for underrepresented circular strategies such as Refurbish, Remanufacture and Refuse. Expanding the focus to these areas will close the gap in circularity practices and provide more comprehensive metrics for target setting and monitoring.

- LCAs for holistic impact

    In addition to setting resource-focused targets, the use of LCAs should be encouraged to ensure that circular practices deliver overall environmental benefits. LCAs provide a full view of the environmental impacts of circular actions, helping to prevent unintended consequences like resource depletion.

6.2.2.4. Support requirements for implementation of actions

The focus on recommendations related to data collection, quality and mandatory reporting is not surprising. Data is key to any monitoring strategy and the innovative nature of the indicators studied during this project meant that the ideal data was not always readily available in existing storage and reporting regimes. The work highlighted what is possible through initial investigations, stakeholder engagement and creative analysis, leading to a set of recommendations aiming to overcome the data-related challenges encountered. The potential increase in administrative burden from new reporting requirements is clearly a concern, but to be able to robustly monitor and therefore support the circular transition in Europe, new data *is* needed. The recommendations for regulatory support in data requirements should serve to alleviate this potential burden by simplifying the content and format of requirements through harmonisation and the deployment of digital capabilities for collection and analysis.

The themes in recommendations proposing both further R&D into the indicator contexts and formation themselves, and development of related guidance and materials, are complementary to the overarching data focussed recommendations. The R&D informs the best balance of data requirements, and the guidance efforts should communicate them alongside the rationale and aspirations of the indicator in such a way to engender the highest level of support possible from all key stakeholders. Where legislative or incentivisation recommendations exist, these then underpin and facilitate all other efforts.

Thus, no one link in this chain of indicator development can ensure success without the contribution of the others, and support requirements for all connected recommendations need to be considered holistically. To develop these indicators correctly, with maximum chance of sustainable execution, is not a cheap or quick process, and a full assessment of funding, human time resource and delivery timelines should be developed and mapped onto the key stakeholders for various elements and at various levels of implementation. This has been started in Section 5 for the 21 indicators deemed as priority possibilities for prompt successful development but should be built upon further and potentially replicated for indicators of specific interest in the 34 recommended for longer-term attention.

6.2.3. Methodological approaches for indicator testing

6.2.3.1. Indicator performance

As discussed in Section 4.4, the RACER scores for each indicator were reassessed after the testing process was complete, to reflect the learnings gained during the study. The average variation in RACER scores across all 60 indicators is shown in Figure 20, and shows that Relevance scores remained stable, confirming the indicators suitability for the task of measuring circularity. However all other scores, including Credibility, Ease and Robustness, showed a slightly decrease, reflecting the challenges associated with testing innovative indicators in areas where data is scare or inconsistent.

RACER assessment variations after testing					
Relevance	Acceptability	Credibility	Ease	Robustness	**Total score**
0.07	-0.26	-0.69	-0.39	-0.36	-0.83

Figure 20: Average variations between pre- and post-testing RACER scores

These average variations highlight two key principles of the overall project. The shortlisting process followed for the 60 indicators to be tested incorporated extensive sector- and policy theme-specific stakeholder engagement in tasks 3 and 4 which, combined with the research team's own CE experience, aimed to favour indicators with potential to assess progress towards 'true' circularity for the relevant areas. This is reflected in the stability between pre- and post-testing assessment of the Relevance scores, suggesting that the indicators tested were indeed relevant for the aspirational task at hand.

Secondly, the average decrease in scores for the other criteria, and overall, could be reflective of the study's desire to test indicators deemed to be innovative. By embracing the challenge to investigate indicators that were either not currently accurately monitored at any level, or at least not in the sector or level of implementation examined for this work, the research team inevitably encountered and were able to elucidate challenges to their Credibility, Ease and Robustness. The Acceptability score could be seen as a sector-internal output of the combination of all the other criteria, where key stakeholders recognise the value of the indicators in progressing the aims of CE, but also being intimately familiar with the limitations and demand on already restricted resources which their effective monitoring would necessitate.

In the large part, these challenges are not insurmountable, with recommendations made for all 60 indicators to begin addressing them.

6.2.3.2. Learnings for methodologies

The actual data analysis required for most of the indicators studied is not particularly complex, with the main challenge being the availability and access to the required data itself. While data challenges, and routes to overcoming them, are discussed extensively throughout this report, there are a few key general learnings to be drawn about some of the main methodologies adopted.

6.2.3.2.1. Stakeholder engagement

The majority of the 60 indicators were in early or nascent stages, making stakeholder engagement essential across all themes and sub-themes. Detailed, on-the-ground knowledge of data availability and access routes is needed to facilitate the development of smooth and robust collection, collation and reporting approaches. In an exploratory testing process like this project,

early engagement with relevant public officials, private sector industry bodies, and individual organisations allows for verification or otherwise of the initially proposed approach. If initial plans are simply not feasible, alternative options need to be identified and explored.

Once the approach has been fully verified, continued collaborative work is often required to collect and quality assess the data to be analysed. Strong relationship building and communication is necessary to allay any potential concerns about confidentially or the resource time needed for fulfil data requests.

To reduce the 'pain' of data provision on the stakeholder as much as possible, the research team provided standardised data collection templates where relevant, or offered to take whatever was available and collate, or reformat it internally to prepare it for the planned analysis. This was deemed suitable to obtain as much information as possible for the testing process but is resource demanding and not the ideal situation going forward for indicators to be further developed. This project had a nominal time budget of roughly 10 'testing' days per indicator which covered planning and refinement, all required methods of data collection and analysis, and the drafting and finalisation of reports. In some instances, this was ample time for the testing process to be completed broadly in line with aspirations. For others, however, the awareness of budgetary constraints and the temporal restrictions of the overall study meant that some stakeholder engagement 'dead-ends' had to be accepted, and alternative approaches deployed. This meant that, for example, extra time could not be given to supporting stakeholders in accessing and collating the required data where they were already time-constrained, or broader engagement discussions / workshop sessions could not be held to fully convey the rationale and value of the work, to foster increased buy-in.

For indicators to be taken forward, full consideration should be given on a case-by-case basis to the level of detail, time and materials needed to the stakeholder engagement required to develop a smooth and sustainable monitoring process.

6.2.3.2.2. Citizen surveys

The use of citizen surveys for 13 of the tested indicators was highly effective in gathering tailored data to analyse specific aspects of the indicators. The limitation of such data is a propensity for self-reporting bias where true values may not actually be obtained. This can be mitigated to a certain degree however by using such surveys to focus on some of the softer, social aspects of CE, such as sentiment and behavioural attitudes. That being said, it is still important for any formal communication of the related indicators, and progress towards their targets, that the figures are clearly declared as self-reported. This in itself will, over time, reveal any trends in individuals' awareness and perception of CE and its related activities, with insight from such being a valuable tool in developing and delivering public facing communication campaigns and other initiatives.

The study used an external survey provider, YouGov, for the surveys delivered, which had an obvious expense to the overall budget but saved staff team time and allowed for large survey samples to be collected in a relatively short period. The surveys conducted were of sufficient sample size to be scaled to nationally representative figures, greatly aiding the scope of the analysis completed.

Moving forward, indicators deemed to relevant for citizen surveys should be considered for inclusion in the twice-annual Eurobarometer surveys of the EC. This would allow for the building on the snapshot analyses conducted in this study, developing them into a systematic and consistent monitoring system to robustly track progress over time.

6.2.3.2.3. Web-scraping

The innovative digital approach of web-scraping was deployed on four of the indicators tested in task 5, utilising the research team's specific data-science expert colleagues. The process involved developing and deploying web-scripts to deliver a systematic, automated scan and data extraction procedure, with outputs being ready for the required analysis.

There is definitely a place for such approaches, but their major benefit is in large-scale applications where the effort involved in developing the script and defining the key search terms is outweighed

by the efficiency savings from their deployment. It is fair to say that this balance was not ideal for the indicators involved in this study. Elements such as organic food or CE requirements in public procurement are not yet prevalent or prominent enough to capitalise on the benefit of the at-scale power of this type of approach. Indeed, for the relevant indicators, alternative approaches were suggested in the recommendations, in developing and encouraging the better use of existing digital procurement platforms.

In these instances, the web-scraping approach proved to be efficient but needlessly complex for the size of the task. There is value in using such methods for CE indicator monitoring as the associated scales of deployment grow in the future, but their value would need to be considered on a case-by-case basis.

6.3. Final considerations

Alongside the emergent trends in recommendations and overall learnings on approaches taken, there are several additional considerations to build into any next-steps plans.

6.3.1. Data gaps and limitations

A key limitation of this study is the inconsistency and lack of availability of comprehensive data across the indicators analysed. Despite the considerable progress made in identifying and assessing CE indicators, the absence of standardised, high-quality data collection mechanisms across Member States remains a significant barrier to robust CE monitoring. This challenge was particularly evident during the testing and validation phases, where some indicators could only be assessed through a narrative approach due to missing or incomplete data.

The fragmentation of data sources at national, regional, and sectoral levels contributes to this issue, making it difficult to draw uniform conclusions or to benchmark performance across different regions or industries. In the absence of comparable datasets, many of the indicators, especially those related to innovative or emerging circular practices, remain limited in their potential for reliable assessment.

Addressing these data gaps will be critical for the successful operationalisation of the proposed CE indicators. Future efforts must prioritise establishing clear and uniform data reporting requirements for businesses and governments. This will ensure that future iterations of this monitoring framework are built on a foundation of reliable, granular data, enabling more accurate benchmarking, progress tracking and policy interventions. It may also be worthwhile for future studies to develop more automated data collection methods, using digital platforms or integrating with existing datasets, to streamline the process. Without this step, the usefulness of many indicators, particularly those assessing new areas such as PSS, will be limited. In conclusion, the harmonisation of data collection processes across all levels of governance should be seen as an urgent priority to enable accurate, actionable insights on CE progress.

6.3.2. Holistic environmental impact awareness

While this study has made substantial progress in developing indicators for measuring CE activities, an emerging theme is the recognition that circularity alone does not guarantee environmental sustainability. There is growing awareness that circular actions, such as recycling or reuse, must be evaluated not only for their material recovery rates but also for their overall environmental impacts, particularly regarding GHG emissions and resource extraction.

Indicators focusing on material flows and waste reduction are undoubtedly important, but they must be contextualised within broader environmental metrics to ensure that circular practices lead to meaningful sustainability outcomes. It is important, therefore, to include a systemic perspective with consideration of the conditions under which CE strategies could *contribute* to overall greenhouse gas emissions. For example, Indicator B1 which in essence looks at overall growth in

the bioeconomy sector, and indicators such as CR8, EICT3 and FWN2 which look at aspects of public procurement, could all be seen as agnostic to the actual *need* for the material use they are indirectly measuring.

Priority should always be given to the highest level R-strategies of Refuse, Rethink and Reduce, before progressing with initiatives to develop and monitor circular substitutions for true demand levels. The integration of LCAs into CE monitoring frameworks should also be considered. LCAs provide a comprehensive analysis of the environmental impacts of products and processes from cradle to grave, offering a more holistic view of circular actions. By incorporating LCAs into CE indicators, policymakers can better understand the trade-offs and synergies between circularity and environmental sustainability.

6.3.3. Combined consideration of individual indicators

One of the key findings from this study is the value of considering interactions between multiple indicators, rather than treating each one as an isolated measure. While individual indicators provide valuable insights into specific facets of the circular economy, using them in conjunction can offer a more holistic understanding of the systemic nature of circularity.

Some of the indicators studied will benefit from consideration in combination with each other, and other potential measurements. For example, PSS1 and PSS2 which consider both the self-reported perception and uptake of PSS models, could be seen as general monitors of the diffusion of PSS models in society over time, but not necessarily as measures or even proxies of actual circularity. Whilst still valuable in an overall assessment framework, they should be combined with other measurements that look at the actual circularity and environmental metrics of specific PSS-models.

The same could be said for indicators H2 – H7 which look at varying aspects of the perception and implementation of circular approaches to household life, allowing them to constitute the kernel of a package of indicators for which consideration in the round would give an extra layer of insight.

Similarly, Indicator PL1 – the number of pilot/demonstration projects on circular production and treatment of plastics, could be said to be directly influenced by PL2 – The number of legislative incentives created to encourage circularity in the plastics industry. As such the overall combination of them should be considered and analysed to allow for direction and shaping of further legislative approaches.

This cross-indicator approach is especially important when assessing the impacts of circular economy initiatives on broader sustainability outcomes. For example, while an increase in recycling rates may indicate progress towards circularity, it may not always correlate with a reduction in overall resource extraction. A combination of indicators is necessary to ensure that circular actions are delivering the desired environmental and economic outcomes.

Therefore, the integration of cross-indicator analysis into future CE monitoring frameworks is crucial. Policymakers should be encouraged to look beyond single indicators and adopt a more systemic approach to understanding the interactions between different circularity metrics. This will enable more informed decision-making, leading to better alignment of circular economy policies with broader sustainability goals.

6.3.4. The role of innovation

Innovation plays a critical role in advancing CE practices and the indicators needed to measure them. This study has shown that the development of novel, innovative indicators is essential for capturing emerging circular practices that were previously overlooked. However, innovation must be coupled with effective stakeholder engagement to ensure these indicators are relevant, feasible and widely adopted.

The implementation of CE approaches to reduce material usage is indispensable in achieving net-zero ambitions, particularly in hitherto relatively neglected Scope 3 emissions profiles. Policy makers, and key industry players in the 11 policy focus themes and sub-themes included in this study, recognise this, and a huge amount of work is ongoing to drive towards a CE. However, the overall concepts and principles of CE are still 'new' to many and require a degree of mainstreaming to engender full consumer and public acceptance, and the associated commercial and political viability. For this to happen in a maintainable way, current approaches need to be consistently monitored and candidly assessed, and potential new approaches and means of communicating their benefits need to be developed. The systematic development and deployment of indicators such as those investigated in this study, and the relationship building and communication inherently required therein, can aid both that monitoring and assessment, and the identification of opportunities for innovation in general.

The tested indicators were selected for their inherent innovativeness as measurement tools, but many also measure innovative aspects of CE themselves, or could be used to analyse the need and appetite for new areas of innovative development. For example, Indicators B6, CR6 and PL3 look explicitly at measures of circularity success of industrial symbioses systems. Continued monitoring of elements such as these would by necessity include engagement and relationship building with the relevant delivery cohorts, a relationship which could be leveraged to facilitate collaboration on potential ways to improve and enhance the effectiveness of current activities or build new ones.

Looking ahead, the importance of continuous stakeholder engagement cannot be overstated. New ideas can come from any part of the overall stakeholder ecosystem, from EU level policy makers and monitoring teams, right down to the individuals involved in on-the-ground delivery of the CE activities being monitored. The key to fostering an inspiring and encouraging atmosphere of innovation is clear and open communication in all directions. Everyone involved should know both the high-level and theme-specific circular aspirations of what they are involved in, and how their roles contribute to them. Secondly, they should know what routes exist to provide feedback on current delivery and suggestions for amended or new approaches. These routes could be as simple as on-site suggestion boxes, or through more formal programmes of meetings, workshops or engagement surveys, working all the back up through the system to the EU policy maker level. All suggestions should be considered fairly and assessed on their merit, and those deemed suitable for further investigation escalated to the relevant level for such. Feedback and the rationale behind any decisions should be provided to the original suggester(s), who should also be invited to contribute to any continued development activities where appropriate.

Only following a holistic, open and collaborative charter such as this will allow for the creative innovation necessary to make the strides needed to develop a full, sustainable CE across Europe, and unlocking its potential to tack the climate emergency.

6.3.5. The role regulatory support

The successful implementation of CE indicators and the broader transition to circularity will rely heavily on the regulatory and policy frameworks that underpin them. While this report has identified numerous innovative indicators for measuring CE progress, their adoption and effectiveness will depend largely on the extent to which they are supported by regulatory mechanisms and policy interventions.

At present, there is a strong need for more comprehensive policy frameworks at both the EU and national levels to enforce data collection and reporting requirements for CE indicators. Regulatory support will be crucial in ensuring that businesses and other stakeholders are incentivised, or even mandated, to adopt circular practices and report on their performance. In particular, sectors such as construction, textiles, and electronics, which have high material flows and environmental impacts, would benefit from targeted regulations that promote circular design, recycling and reuse.

The EU's Political Guidelines for 2024 – 2029[71] have an emphasis on strategic autonomy, competitiveness and reducing administrative burden on Member States and stakeholders across the economy. The desire for less 'red tape' may seem counterintuitive when recommending the strengthening of policy frameworks and data requirements, but the guidelines also commit to driving towards the emission reduction target of 90% by 2040, and to ambitions such as improving food security, supporting mass mobility and ensuring a just transition for citizens across the region. Circularity has a significant role to play in all of these ambitions, and for it to truly take hold, a holistic, joined-up thinking set of policy-focus-area-specific regulatory frameworks is needed.

CE indicators can be used as a tool to guide policy development by providing evidence-based insights into the effectiveness of current regulations and identifying areas where further intervention is needed. For example, the inclusion of indicators that track the uptake of PSS and their impact on material consumption could help policymakers design more effective incentives for businesses to transition to circular business models.

Looking ahead, it will be important for the EU and Member States to align CE policies with broader environmental and sustainability goals, such as climate change mitigation and biodiversity conservation. CE indicators should be integrated into existing regulatory frameworks for environmental protection, ensuring that circular practices contribute to these wider objectives. Finally, continuous collaboration between policymakers and businesses will be key to refining and updating the regulatory frameworks to keep pace with technological advancements and evolving market conditions.

6.3.6. Scalability and broader application

Scalability is a key consideration for the future of CE monitoring frameworks. While this study has made significant progress in developing and testing indicators, the challenge remains to scale up these efforts and apply them across a wide range of sectors, regions and governance levels. The ability to scale these indicators will be essential for achieving a broad and systemic transition to a circular economy across the EU.

One of the primary recommendations emerging from this study is the need to develop scalable data collection methods. Innovative techniques such as web-scraping, which was tested for procurement indicators in this study, offer significant potential for scaling up data collection across different sectors. By automating the extraction of relevant data from public databases and procurement platforms, web-scraping can reduce the time and resources required for manual data collection, making it more feasible for widespread use.

However, scaling up CE indicators will also require a broader application of digital tools and platforms that can standardise data collection processes. Tools and platforms need to be developed that can be used to aggregate data from multiple sources, enabling real-time monitoring of CE activities across different regions and industries. This will also help to harmonise data collection processes across EU Member States, ensuring that indicators are comparable and that progress can be tracked consistently at the EU level.

Scalability and the broader application of CE indicators will be critical to ensuring that the EU's circular economy ambitions are realised. Policymakers should prioritise the development of digital tools and platforms that can facilitate the scaling up of CE monitoring efforts. Moreover, businesses and other stakeholders should be encouraged to adopt these technologies to improve the efficiency and accuracy of their data collection processes. By scaling up these efforts, the EU can create a more robust and comprehensive framework for measuring and promoting circularity.

[71] https://commission.europa.eu/towards-new-european-commission-2024-2029_en

7. Appendices

7.1. Task 1 Policy framework report

See separate file on https://www.ricardo.com/ce-indicators.

7.2. CE Indicators Tool

See separate document *Circular Economy Indicators Tool* on https://research-and-innovation.ec.europa.eu/research-area/environment/circular-economy_en

7.3. Indicator Case Studies

See separate files on https://www.ricardo.com/ce-indicators.

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This document is the full final report of a 2-year project to identify and investigate opportunities for innovation in the monitoring of circularity across the EU. The project provides a comprehensive baseline of current policy and funding frameworks, and monitoring efforts across 11 priority policy themes. A multi-faceted taxonomy of over 700 indicators was developed by Ricardo plc and partners into a multi criteria assessment tool, made available for bespoke use by any policy makers or interested parties, allowing for shortlisting of indicators based a range of priority options. 60 indicators were tested as part of the project, leading to conclusions and recommendations for each of the individual policy areas.

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