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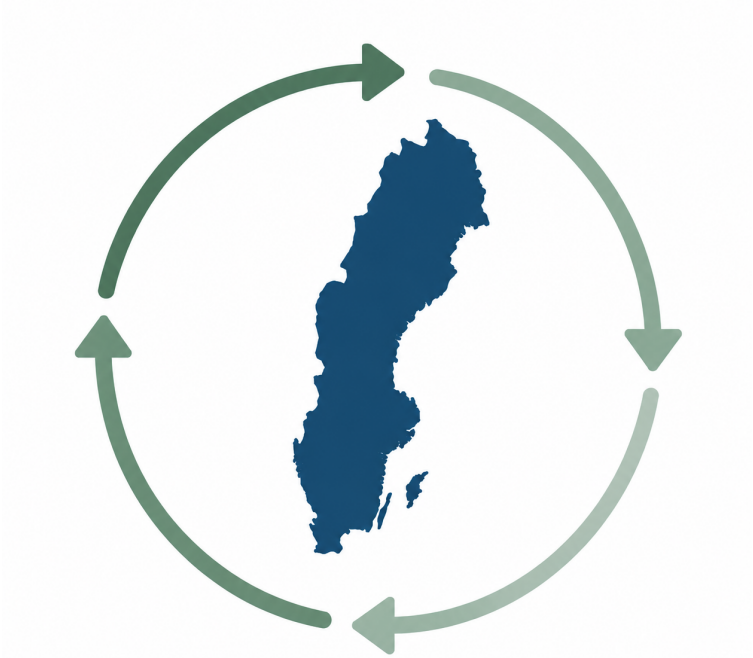

Sweden towards a Measurable Circular Economy

An Evaluation of Circular Economy Indicators at the National Level

Master's thesis in Industrial Ecology

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SUMMARY

Current global development patterns heavily rely on resource extraction, driving environmental pressures and planetary crises. To decouple resource use and environmental impacts from socioeconomic welfare, the transition towards a circular economy (CE) has emerged as a sustainability transition. The International Resource Panel (IRP) emphasises that nations should implement monitoring and follow-up systems to identify transition priorities. The Delegation for Circular Economy recommends Sweden to develop an updated CE strategy, containing new CE objectives with associated indicators that are followed up regularly. Therefore, this study examines international initiatives with the aim to identify, map, and analyse macro-level CE indicators that can contribute to Sweden's CE monitoring.

The methodology combined a literature review with a screening of official national strategies, multilateral guidelines, and monitoring frameworks. To capture practical insights, gaps, and challenges, semi-structured interviews were conducted with international statisticians and policymakers. Furthermore, the identified indicators were mapped to assess their distribution across different CE areas and their data availability in Sweden, while a questionnaire evaluated Swedish stakeholder priorities.

The study mapped 82 CE indicators from 8 monitoring frameworks, including Eurostat, the UNECE/OECD, and 5 EU countries. While Belgium and the Netherlands stand out by incorporating strategic, social and environmental indicators, Germany and Austria are actively developing new frameworks. In contrast, Sweden does not have CE indicators connected to its national strategy or continuous financing for CE monitoring. The study finds that indicator selection is a political and strategic choice, influenced by data availability, policy priorities, and differing interpretations of what the CE should encompass.

Three potential pathways are presented for Sweden's future CE monitoring: continuous reporting of existing data to ensure high data availability; expanding the existing data using indicators from international frameworks to capture strategic, social and environmental dimensions; or developing a new national framework tailored specifically to Sweden's conditions and priorities.

Keywords: circular economy, circularity, indicators, monitoring, measuring, macro-level

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Adina Ponzio and Ida Kron, Gothenburg, June 2026

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

CE	Circular economy
CEAP	Circular Economy Action Plan
CGR	Circularity Gap Report
CM	Circularity metric
CMUR	Circular material use rate
CO_2	Carbon dioxide
DIERec	Direct and Indirect Effects of Recovery
DMC	Domestic Material Consumption
DMI	Direct Material Input
DPSIR	Driving forces-Pressure-State-Impacts-Response
EEA	European Environment Agency
EOL-RIR	End-of-live recycling input rates
EQO	Environmental Quality Objective
EU	European Union
EUR	Euro
FTE	Full-time equivalent
GDP	Gross Domestic Product
GHG	Greenhouse gases
IMP	Imports
ISO	International Organization for Standardization
MIS	Mission-Driven Innovation System
NGO	Non-governmental organisation
NSS	Needs Satisfier System
NPSIR	Need satisfaction-Pressure-State- Impacts-Response
OECD	Organisation for Economic Co-operation and Development

Continued on next page

RECE-XG	OECD Expert Group on a new generation of information for a resource efficient and circular economy
RACER	Relevant-Accepted-Credible-Easy to monitor-Robust
RMC	Raw Material Consumption
RME	Raw materials equivalent
RMI	Raw Material Input
RUT	Cleaning, Maintenance and Laundry
SCB	Statistics Sweden
SIS	Swedish Institute for Standards
UNECE	United Nations Economic Commission For Europe
UNECE-TF	UNECE Task Force on Measuring Circular Economy
WEEE	Waste of Electrical and Electronic Equipment

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Introduction

1.1 Background

The current reliance on natural resources is essential to reach the basic needs of a prosperous population and ensuring human well-being (United Nations Environment Programme, 2024b). From 1970 to 2024, the global material extraction has increased from 30 billion tonnes to 107 billion tonnes, indicating an average annual growth of 2.3% (United Nations Environment Programme, 2024a). The rate at which natural resources are extracted, processed, exchanged, used, and managed over their life cycle impacts the progress of all 17 of the UN Sustainable Development Goals (SDGs), and is a key driving force behind the three planetary crises (climate change, biodiversity loss and pollution). Circular economy (CE) is an economic model characterised by circular resource flows where processes such as reusing, repairing, and recycling extends the life cycle of materials and products (Ellen MacArthur Foundation, n.d.). CE can therefore be a powerful tool in the transition towards a more resource efficient society and play a central role in achieving a sustainable development while reducing anthropogenic environmental impacts.

In Sweden, material consumption amounts to 25 tonnes per person per year, implying that four Earths would be required if the global population consumed resources at the same rate (Swedish Environmental Protection Agency, n.d.-b). With increased CE initiatives, Sweden could significantly reduce its material consumption and contribute to achieve the national environmental and climate objectives. In addition, SEK 600 billion are lost annually due to linear system practices, which is equivalent to nearly 57% of Sweden's state expenditures (Circle Economy, 2025a). These losses come from six sectors; mining and extraction, manufacturing, agrifood, construction, mobility and consumables, where economic value that could be created is either never realised or prematurely lost. Through a transition towards a circular economy, these losses could be lowered.

It is emphasised by the International Resource Panel (IRP) that nations should implement monitoring and follow-up systems to identify priorities and develop ambitious action plans for circular economy (United Nations Environment Programme, 2024a). The European Union (EU)

monitors the CE transition for its member states. In addition, multilateral organisations, research as well as individual countries have suggested and implemented CE monitoring frameworks. These frameworks present data for a number of metrics, or CE indicators. CE indicators are used to measure and understand the performance of the different aspects of the CE. The most effective indicators for circularity depend on how CE is defined and which strategic goals the indicators are aimed to monitor (United Nations Economic Commission for Europe, 2024).

In Sweden, the *Delegation for Circular Economy* serves as an advisory body to the Swedish government with a mandate to enable and accelerate the business sector's transition toward a competitive circular economy (The Delegation for Circular Economy, 2025b). The Delegation currently consist of 11 members chosen by the government, representing the Swedish business sector. Since their establishment in 2018, the Delegation presents annual recommendations to the government. In their recommendations from 2025, the Delegation emphasises that Sweden's national CE strategy and action plan are becoming outdated, with many of the initiatives no longer reflecting current needs (The Delegation for Circular Economy, 2025c). Further, it is stated that the national environmental objectives do not encompass the full width of parameters to define a CE and requires supplementation, along with associated CE indicators that are followed up regularly (The Delegation for Circular Economy, 2025c). The connection between accurate and relevant indicators linking to established targets is currently not sufficiently developed in Sweden (The Delegation for Circular Economy, 2025a). This thesis is initiated by the Delegation for Circular Economy to contribute to their commission in enabling and accelerating the transition to a circular economy in Sweden.

1.2 Aim and Research Questions

The aim of this thesis is to identify, map, and analyse CE indicators to contribute to Sweden's monitoring of the transition to a circular economy. This aim will be addressed by analysing national and multilateral frameworks in the forefront of the CE monitoring in relation to Sweden's current initiatives. By identifying which CE indicators that are currently used internationally, and what data that is available nationally, this research fills a gap regarding what Sweden could do to improve its own monitoring of the circular economy. To address this aim, the following research questions will be answered:

1. How is the circular economy monitored in Sweden?
2. How is the circular economy monitored internationally?
3. Which indicators from international circular economy monitoring frameworks could Sweden consider for national monitoring?

1.3 Scope

The thesis takes a national perspective, meaning that the CE indicators considered are suggested or implemented at a national level. Indicators exist on different spatial levels, where macro-level indicators focus on material exchanges between national economies and the environment and describes the characteristics of a country or larger region, while meso-level indicators rather reflect the performance of a smaller region, industry, or product group (Vercalsteren et al., n.d.). Micro-indicators measure at business or local level, providing more detailed information on individual products. This study thereby focuses on macro-level indicators and excludes micro- and meso-level indicators. Further, the study will focus on countries with established CE monitoring frameworks. The structural boundary for country selection is determined by the extent to which CE indicator frameworks have been developed and implemented.

Whereas the Delegation suggests Sweden to develop a follow-up plan containing quantitative indicators to monitor the national transition towards a circular economy, this study focuses on the selection of such indicators. Consequently, the procedural and operational aspects of developing and implementing such a plan remain outside of the scope. Additionally, national objectives are often connected to relevant indicators. Therefore, existing objectives in studied countries will be presented and discussed in relation to Sweden's.

1.4 Organisation of Report

The report begins with an introduction giving a background of the subject's importance and a presentation of the research gap, the aim and research questions, and the scope of the study. Chapter 2 provides a theoretical background on sustainability transitions theory and the concepts of circular economy, with emphasis on CE monitoring and CE indicators. Chapter 3 presents the methodology, covering the screening of national and multilateral monitoring frameworks, the interview processes, and how CE indicators were identified, mapped and evaluated.

The results are presented in Chapter 4, where the CE initiatives by Sweden, the selected countries, and multilateral organisations are explained. Further, the identified CE indicators from the investigated frameworks are mapped through categorising them into a large table. The mapped indicators are then evaluated based on their data availability in Sweden and their relevance according to the members of the Delegation. Chapter 5 analyses the results and discusses future pathways for CE monitoring in Sweden. Limitations of the study and suggested areas for future research are also addressed. Lastly, Chapter 6 summarises the thesis and its key findings.

2

Background and Theory

This chapter presents the theoretical background relevant to the study. It begins with an introduction to sustainability transitions theory, followed by a presentation of the concept of circular economy, circular economy monitoring and the use of indicators to assess progress.

2.1 Sustainability Transitions

Environmental problems such as climate change, biodiversity loss, and resource scarcity are continuing to worsen, putting increasing pressure and causing negative impacts on natural ecosystems and society (Geels, 2024). This has resulted in a pressing need to reduce resource use and the emissions of waste, pollutants and GHGs, and calling for rapid sustainability transitions in systems such as energy, food, mobility, and industry. Achieving a circular economy is one example of such a sustainability transition (Lehtimäki et al., 2023).

A sustainability transition consists of multidimensional processes where elements such as technology, user practices, public policies, cultural and scientific meanings, and supply chains, co-evolve and together create significant changes in production-consumption systems (Geels, 2024). These transitions are multi-actor and long-term processes, meaning that they evolve through interactions between different actors, unfolding over decades. Radical innovations are viewed as the driving force of transition through their interactions with other elements and processes during their lifecycle phases: embryonic, growth and diffusion, maturity, and decline. This typically takes the shape of an S-curve, with slow emergence, accelerated growth, and saturation.

That is to say, the transition from a linear to a circular economy is a long-term process that requires systemic changes across technological, economic, social, and institutional dimensions, as well as among the actors involved (Lehtimäki et al., 2023).

2.2 Circular Economy

Circular economy (CE) has been recognised as an important field of research in recent years, distinguished through increasing numbers of articles and journals tackling the subject, as well as it being embedded as a guiding framework in policy strategies and industry roadmaps (van der Werf et al., 2025; dos Santos Gonçalves and Campos, 2022). This rise in interest is based on the need to move away from the current unsustainable linear economic structure, which contributes significantly to natural resource depletion and other critical environmental problems (van der Werf et al., 2025). Despite the large inventory of CE research, goals, visions, values, and definitions of tools, criteria, and analysis methods widely differentiate among authors (van der Werf et al., 2025; Vulsteke et al., 2026; dos Santos Gonçalves and Campos, 2022). Likewise, there is no single agreed upon definition among countries, international institutions and NGOs, although all definitions used have many common elements (United Nations Economic Commission for Europe, 2024). The definitions all include the concept of material circularity through reducing the demand for certain natural resources, as well as the materials and products produced from them.

The conducted literature review, following the methodology outlined in Chapter 3, present different definitions of CE. Vulsteke et al. (2026) defines CE as a systemic pathway for responsible resource management through the reconfiguration of current production and consumption practices. Multiple definitions views CE as a mean for decoupling, meaning the concept of coordinated sustainability actions and targets decreasing resource use, waste generation, and related environmental impacts, and at the same time allowing for continued socioeconomic welfare (Vulsteke et al., 2026; United Nations Environment Programme, 2024a). van der Werf et al. (2025) presents alternative definitions, including one claiming decoupling to be illusory, and that the aim of CE is to return to the ecological footprint of one planet. According to Haupt and Hellweg (2019), CE does not usually explicitly assess the environmental perspective, meaning that navigating among CE strategies in different contexts can result in misguided decisions or weakened environmental performance. Xijie et al. (2023) also examines multiple definitions of CE and concludes that the concept mainly focuses on the progress itself, through strategies such as reduce, reuse, and recycle, often viewed as an alternative pathway to sustainable development. Further, it is expressed that the examined definitions are incomplete and do not fully address all dimensions of the broader CE system.

The United Nations Economic Commission for Europe (2024) (UNECE) defines CE as an economy where the value of materials is maximised and maintained for as long as possible. In addition, the consumption of materials and the generation of waste is minimized, as well as the negative environmental impacts along the entire life-cycle. One of the initial and leading parts in the field of CE, Ellen MacArthur Foundation (n.d.), defines CE as a regenerative

systemic economic model where resources and materials circulate instead of becoming waste. The system involves processes, such as maintenance, reusing, refurbishing, repairing, sharing, leasing, recycling, and composting, with the aim of extending the life cycle of materials and moving away from the conventional linear economic model (European Parliament, 2023; Ellen MacArthur Foundation, n.d.). Figure 2.1 presents the *Circular Economy Butterfly Diagram*, differentiating the technical cycle from the biological cycle in a CE illustrated as wings (Ellen MacArthur Foundation, 2021). The diagram presents the circular material flows of the technological cycle through processes such as *reuse*, *repair*, *remanufacture*, and *recycling*, while the biological cycle includes natural regeneration where the nutrients from biodegradable materials are returned to the Earth. *Primary raw materials* includes both finite materials and renewables (Ellen McArthur Foundation, n.d.). *Secondary materials* are materials that have been previously used, which include: materials in products that have been reused, refurbished or repaired; components that have been remanufactured; and materials that have been recycled.

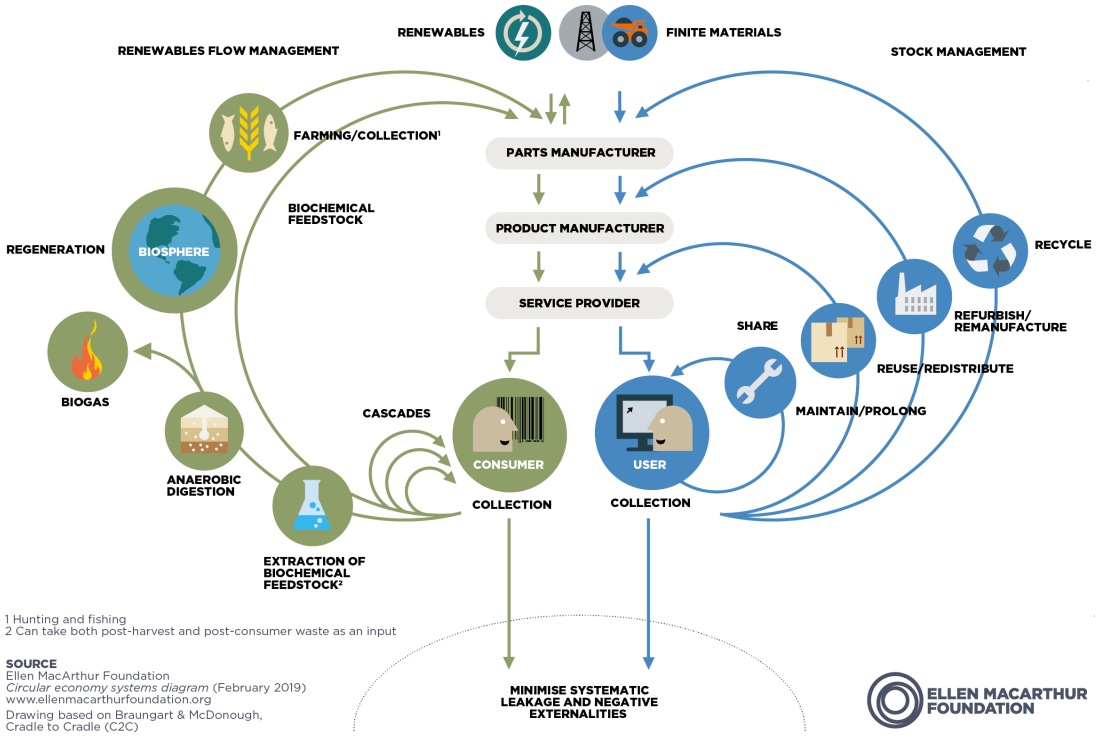

Figure 2.1: Circular economy butterfly diagram (Ellen MacArthur Foundation, 2021).

According to Ellen MachArthur Foundation (2024), CE includes three core principles; (i) eliminate waste and pollution, (ii) circulate products and materials, and (iii) regenerate nature. Additionally, the concept of CE is often described through a hierarchy of strategies, so called *CE strategies* or *R-strategies* (Circular Flanders, n.d.-b). One example of an hierarchy is presented in Figure 2.2, where the strategies are ordered so that the higher up in the hierarchy, the more circular the strategy. *Recover* and *recycle* are the furthest down in the hierarchy and represent more linear strategies where materials are processed and the outcome is applied in a useful

way. *Repurpose*, *remanufacture*, *refurbish*, *repair*, and *reuse* are strategies located in the middle of the scale, and support the extension of the lifespan of products, components or materials. Highest in the hierarchy are *reduce*, *rethink*, and *refuse*, strategies that rather focus on using materials and producing products less and/or more effective. These strategies are related to the idea of slowing loops (using longer), closing loops (using again), and narrowing loops (using less) (Böckin et al., 2020). Different constellations of R-hierarchies exist including different strategies in varying orders (Kurilova-Palisaitiene et al., 2023). This implies that the structure may not be representative for all situations, where preferred, or more circular, strategies can vary depending on material, product, or industry.

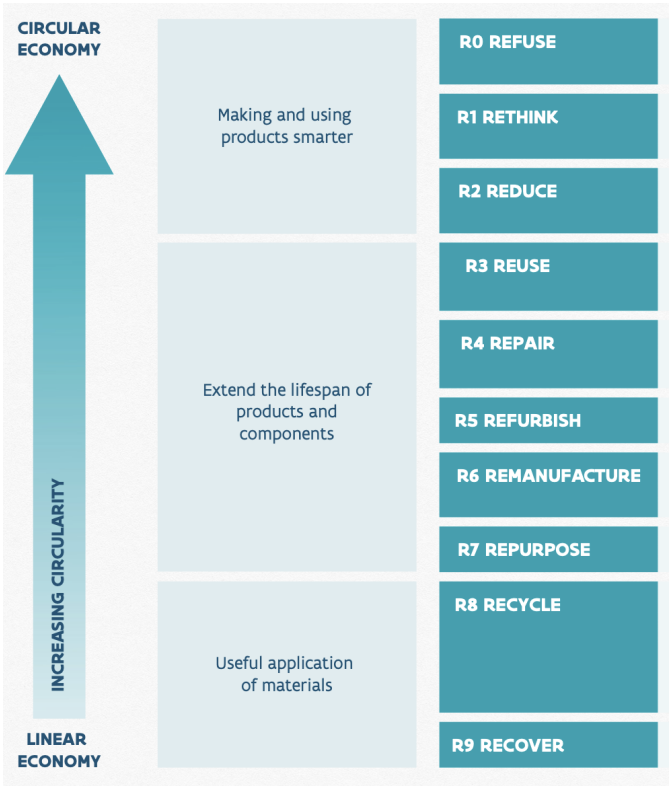

Figure 2.2: R-strategies (Circular Flanders, n.d.-b).

2.3 Monitoring the CE

The information and data required to support circular economy policy initiatives depend on how the CE is defined and what goals the information is intended to serve (United Nations Economic Commission for Europe, 2024). How to actually track progress of the CE is a core question due to its inherent complexity and the lack of an agreed definition of what the CE is (Saidani et al., 2019; Figueirinhas et al., 2026). Consequently, questions have been raised regarding whether current statistics and indicators are adequate to guide national policies and international work for CE (United Nations Economic Commission for Europe, 2024). The UNECE highlights that while waste management is a core element, CE policies now cut across a much broader

scope, including material extraction, product design, supply security, environmental issues and socio-economic opportunities. This shift has created a strong demand for more reliable and harmonised information that moves beyond traditional waste statistics to capture the complexity of the entire CE.

2.3.1 Indicators

Indicators are defined as information which have a wider significance beyond the parameter itself, and is relevant to a particular issue of concern (Braat, 1991). An indicator serves a purpose, like providing context to a topic, explaining a complex issue further than just raw data. Presented in Figure 2.3 the indicator pyramid illustrates, above *raw data*, a *set of indicators* which is a group of metrics, keeping the details from single data points and showing the different dimensions. *Core indicators* are a smaller set of indicators that represent the main issues, which are useful to decrease information overload. At the top of the pyramid is the *index*, which is a single value that has been consolidated from multiple data points. If an indicator relates to an objective or target, it may be referred to as a *performance indicator*.

An indicator can be useful in decision-making, when simplifying or summarising important properties, when visualising phenomena of interest, and when quantifying, measuring and communicating relevant information (Lundin, 2003). Other functions are to assess conditions and trends, to provide information for spatial comparisons, to provide early warnings, and to anticipate future conditions and trends. Different indicators may be tailored for the different groups (experts and scientists, policymakers, the public), and this choice should be based on the purpose of the use of the information and the needs of the target groups, see Figure 2.3. For example, policymakers prefer data that are related to policy objectives and reference values (Braat, 1991).

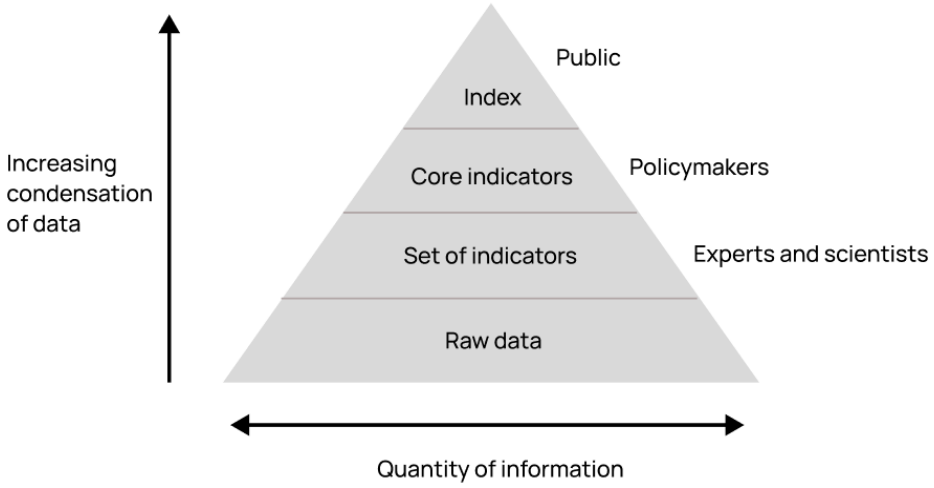

Figure 2.3: The indicator pyramid, illustrating the relationship between data condensation, information quantity, and the intended target groups (Lundin, 2003; Braat, 1991).

In a monitoring system, indicators are an important part (European Commission, 2025). They provide an indication of how close an initiative is to achieve targets that have been set. In this way, it is a variable used to measure and understand aspects of strategy progress. Therefore it is necessary to select an indicator set carefully while being aware of their limitations and the burden the data collection will imply. During selection, any unintended negative impact on the initiative that the indicators are supposed to report on should be considered. Numerical targets should not be achieved at the expense of quality, as this is counterproductive if the pressure to improve a number degrades the actual outcome. When indicators are defined they should include a description of what they are measuring exactly, its metadata and a qualitative analysis if appropriate.

The European Commission concludes that all indicators should be RACER, that means Relevant, Accepted, Credible, Easy to monitor and Robust (European Commission, 2025). This ensures that the indicators are closely linked to goals and that stakeholders accept and approve of them. For non-experts, indicators should be credible and easy to understand, leaving no room for confusion. In addition, they should be able to be monitored at a low cost with an administrative process that is acceptable, as well as them being robust to not create a false sense of progress.

The Pressure-State-Response (PSR) framework is an environmental assessment tool developed by the Organisation for Economic Co-operation and Development (OECD) (Lundin, 2003). The tool presents a template of the three types of indicators that should be included in a comprehensive monitoring framework: Pressure, State and Response indicators. Pressure indicators measure environmental pressures from human activities, state indicators reflect the state of the environment and the availability of natural resources, and response indicators monitor society's response to environmental changes and concerns. The framework does not include a set of predefined indicators, these should be decided based on the application context and demands. The European Environmental Agency (EEA) modified the PSR framework to include two additional categories of indicators: Driving forces and Impacts, resulting in the DPSIR framework. Driving forces reflect economic development, population, education and life style, and impact indicators measure health and biological effects.

2.3.2 CE indicators

As a response to the need of monitoring the CE transition, an increasing number of attempts to develop CE indicators have been noticed in the last few years by different international organisations, institutions, countries, and regions, covering different levels and aspects (Jerome et al., 2022; Saidani et al., 2019; Xijie et al., 2023). Following the methodology outlined in Chapter 3, this section presents the key findings from recent literature regarding CE indicators.

A number of research studies have reviewed existing indicators at the national level for measuring CE, for instance Barahmand et al. (2026) studies 2701 indicators, Saidani et al. (2019) identifies 55 indicators, Parchomenko et al. (2019) assesses 63 indicators, van der Werf et al. (2025) organises 379 indicators, and the European Commission et al. (2025) studies over 700 indicators. To navigate among the vast number of CE indicators, the literature sort them into different categories. Additionally, attempts on weighting indicators to achieve a circularity score or index have been done in several studies (D'Adamo et al., 2024; Alfaro Navarro and Andrés Martínez, 2024).

Structural categories from the literature include: micro (products, companies, consumers), meso (eco-industrial parks, industrial symbiosis), and macro (cities, regions, nations) (Nika et al., 2021; Figueirinhas et al., 2026; Saidani et al., 2019), unit, availability of data, (European Commission et al., 2025), composite and analytical (Barahmand et al., 2026). Saidani et al. (2019) categorised CE indicators based on dimension (single, multiple), the units (quantitative, qualitative), the format (web-based, Excel, formulas), and sources (academics, companies, agencies).

Further, categories based more on the functionality of the indicators can be identified in the literature. Smol (2023) categorises indicators into main indicators focusing on the retention of economic value in the economy, auxiliary indicators designed to supplement the basic criteria set for the main indicators, and contextual indicators that provide insight into systemic changes in the structure of the economy. On the contrary, Nika et al. (2021) sorts indicators based on their driving and dependence power, where the first is how much the indicator affects other ones and the latter how much the indicator is being affected by other indicators. Accordingly, the indicators are either autonomous, dependent, linkaging, or driving. Moreover, Nowaczek et al. (2023) proposes three categories: Indicators related directly to specific strategies or materials; Direct indicators embracing more than one strategy; Indirect indicators containing information about the CE but not referring directly to CE goals. Saidani et al. (2019) also categorised CE indicators according to the perspective of circularity: actual or potential, and the degree of transversality: generic or sector-specific.

Finally, the literature also includes categorisations that describe what the indicators measure in relation to CE. Several of the reviewed articles classifies CE indicators based on the sustainability dimensions: economic, environmental and social sustainability (European Commission et al., 2025; van der Werf et al., 2025; Barahmand et al., 2026; Nowaczek et al., 2023). Barahmand et al. (2026) extends the domains by adding circularity, technological, and legislation, and van der Werf et al. (2025) adds socio-economy, technic, matter and energy flow. Another prominent category is to sort the indicators according to the CE strategies (European Commission et al., 2025; van der Werf et al., 2025; Saidani et al., 2019). Other themes are life cycle phases (European Commission et al., 2025; Nowaczek et al., 2023), the SDGs (Nowaczek et al., 2023), and the CE principles (Nika et al., 2021).

Beyond these more commonly applied categorisations, the literature also presents alternative thematic groupings for organising CE indicators. For instance, Kahandawa et al. (2025) presents the framework CirDEF consisting of five main thematic clusters: re-consumption, resource optimisation, production LCA, social well-being, and environmental impact. Using a different approach, Xijie et al. (2023) assesses indicators characterising the efficiency of the CE based on the following categories: Indicators reflecting the efficiency of a CE; Indicators reflecting the use of renewable energy and eco-friendly products; Indicators reflecting the recovery of waste, recycling, and reuse of materials, parts, and products; Indicators reflecting the possibility of a guarantee for the implementation of the CE. Furthermore, the analysis by Parchomenko et al. (2019) identified three main clusters of metrics: a resource-efficiency cluster, a materials stocks and flows cluster, and a product-centric cluster.

The continuous search for metrics indicates that current measurements cannot capture the complexities of the CE (Parchomenko et al., 2019). Xijie et al. (2023) states that few methodologies exist that comprehensively evaluate and compare CE performance at an international level. A significant limitation of existing CE indicators is their limited focus on products, waste, and recycling, which results in the higher R-strategies being overlooked or missing (Reich et al., 2023). Hence, there is a need to develop indicators that prioritise value retention (Parchomenko et al., 2019; Vulsteke et al., 2026; European Commission et al., 2025) by assessing for instance longevity and maintenance of quality, including issues like contamination, degradation and purity reduction. Furthermore, Pitkänen et al. (2023) points out that the monitoring of the CE leaves out social aspects by mainly focusing on the environmental and economic impacts of sustainability.

The CE indicators are further limited by their inability to identify specific opportunities and barriers necessary for accelerating systemic transitions (Smol, 2023). Relying solely on favourable indicators can be misleading, since strong policies or education can exist alongside weak practical implementation (Smol, 2023). The information provided by CE indicators must be effectively translated into actionable strategies to manage the transition (Saidani et al., 2019). In addition, Kahandawa et al. (2025) stresses that differing terminologies for similar metrics creates confusion. The data sharing required for CE indicators is often restricted because of time, cost and confidentiality concerns. Inconsistencies, overlaps, and misinterpretations of the variations in CE indicators creates challenges and hinders effective circularity assessment (Kahandawa et al., 2025).

In summary, the literature demonstrates a wide variety of approaches to categorising indicators, reflecting the diverse perspectives on which aspects and themes that can be prioritised when measuring the CE. While a standardised method or framework is not present, the reviewed research highlights gaps in current monitoring frameworks. Indicators for higher-order R-strategies and social dimensions are missing, and current frameworks remain focused on

waste and recycling primarily. Furthermore, actionable strategies based on the statistics must be implemented for actual systemic change. Challenges regarding terminology, data availability, and potential misinterpretations complicates development and usage of CE indicators.

3

Methodology

The methodology of the study includes three steps: (i) identifying existing CE indicators, (ii) mapping the CE indicators, and (iii) evaluating the CE indicators to determine their applicability in the Swedish context. Figure 3.1 illustrates the methodology.

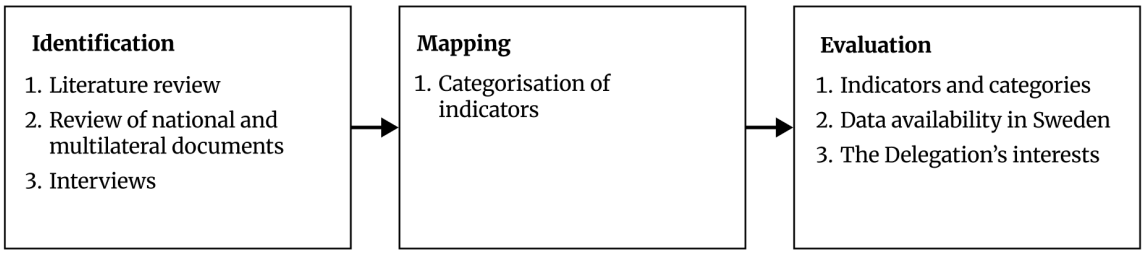

Figure 3.1: Methodology of the study.

3.1 Identification

The identification was conducted in three steps: (1) Literature review, (2) Review of national and multilateral documents, and (3) Interviews. The aim of the identification was to gain an understanding of and identify CE indicators used in research, and national and multilateral monitoring frameworks. Table 3.1 presents the identified components used in the study and their sources. where *CE indicators from national frameworks* and *CE indicators from multilateral frameworks* will be further categorised in Section 3.2. All the components will contribute to the analysis and discussion of the results.

Table 3.1: Overview of components and their data sources. *Abbreviations: NF=National frameworks, MF=Multilateral frameworks, I=Interview.*

	Component	Source		
		NF	MF	I
Quantitative	National objectives for CE	x		
	CE indicators from national frameworks	x		
	CE indicators from multilateral frameworks		x	
Qualitative	National development of CE monitoring			x
	National gaps and challenges			x

Literature review

A review of existing scientific literature on the definition of CE and CE indicators at macro-level was conducted. The review served to give theory of the field, presented in Section 2.2, and to determine if there was existing CE indicator frameworks relevant for the study, which is presented in Section 2.3.2.

The search was made on the 18th of February 2026 on *Scopus* database with the following key words: *indicator* and *circular economy*. Entries that were not articles and not in English were removed. The search resulted in 603 entries, which were screened through reading title and sometimes abstract to exclude articles limited to meso- or micro-level indicators. In addition, the reviewed literature's references added one entry, resulting in 24 entries.

Review of national and multilateral monitoring frameworks

To identify suitable countries for the study, it was essential that they had established indicator frameworks in place. A consultation with Ida Björkefall (Swedish Environmental Protection Agency) guided the identification of suitable countries with established national monitoring frameworks. In addition, the selection was based on discussions with the Delegation for Circular Economy and their secretariat, and reflected their interests of investigating countries in the forefront of the transition towards a circular economy.

Furthermore, five guiding interviews were conducted in the early stages of the study which helped steer the projects' direction and provided necessary insights that contributed to the study's results. Consultations with Emma Snölilja and Malin Andersson (Statistics Sweden), and Louise Sörme (formerly Statistics Sweden) provided a foundational understanding of Sweden's previous CE monitoring. Additionally, consultations with Malin Bergmark (Swedish Environmental Protection Agency) and Annica Carlsson (Linköping University) helped navigate in the connection between CE and the environmental objectives system in Sweden. Laura Linnala (Swedish Institute for Standards) was consulted to gain a deeper understanding for the Interna-

tional Organization for Standardization (ISO) standards for CE, their usage and applicability on a national level, as well as future developments of the standards.

The multilateral frameworks considered in the study all represent globally recognized systems with the intention of guiding how to measure and monitor CE. These frameworks were identified through a general examination of existing international initiatives or collaborations for CE monitoring, and based on discussions with the secretariat of the Delegation for Circular Economy.

After the screening process, the documents and websites of the identified countries, including Sweden, and multilateral organisations were examined. The reviewed information were limited to national official CE strategies and monitoring documents, statistical websites, and multilateral guidelines and frameworks. The national CE objectives of the countries and CE indicators from both national and multilateral frameworks were synthesised. A few of these documents and websites were only available in the countries' native languages, resulting in the usage of the translation tools Google Translate and Google Gemini 3.5 Flash (see Appendix A.4 for details on the usage of AI).

All CE indicators identified in the national and multilateral frameworks were compiled into tables, see Chapter 4. To ensure that the CE indicators were relevant at the national level, only indicators linked to ongoing strategic national work were included in the tables. Consequently, indicators that remained in a proposed state were excluded. The tables were structured including three columns: the indicator name and its unit, the description of the indicator, and the agency or organisation responsible for producing the data. For material flows, e.g. tonnes or kilograms of waste, the unit label *mass* or *mass per capita* was used. For indicators reflecting a quantity e.g. number of CE companies or jobs, the unit label *qty* was used. For monetary values, the unit label € was used, and for indicators monitoring relative values, e.g. the share of secondary materials in relation to total material use, % was used. The indicator descriptions represent the authors' interpretation of the reviewed documentation, since explicit definitions rarely were available in the source material. In the cases where the description was the same for all indicators, the source was placed in the table caption. When the responsible authority for the data were not available or if it was a single one for all indicators, the data-column was removed and an explanation was added in the text connecting to that table.

Interviews

Semi-structured interviews with experts from ministries and agencies across the selected countries were conducted (Esaiasson et al., 2024). The ministry or governmental agency responsible for developing the country's CE strategy or monitoring framework was contacted either through the email address provided on their website or via an online contact form. The interview request included a brief description of the project and the purpose of the interview. In most cases, the

contacted organisation referred the request to the person considered knowledgeable and available to participate. To the suitable respondent, proposed interview times and the interview guide (see Table A.1 in Appendix A) were sent to schedule and prepare for the interview. One or two interviews were conducted per nation, depending on their CE monitoring structures.

The interviews were a central part of the methodology in order to gain a deeper understanding for national CE monitoring frameworks and CE indicators, and how they were developed and are applied. Furthermore they provided the experts' professional views on existing gaps and challenges in their national monitoring frameworks. For this reason, the interviews were of both informant and respondent character (Esaiasson et al., 2024). The interviews provided information that was not publicly documented and helped in confirming that gathered data and information were correct, as well as helped understand the content of documents or reports in more detail.

To facilitate the transcription process, the interviewees were asked about permission to record the interviews that were conducted via *Teams*, in line with the GDPR regulation (Regulation (EU) 2016/679). The recordings were then transcribed manually. Both the interview transcriptions and the notes taken during the interview were thoroughly read and synthesised into summaries. These were sent out to the interviewees for approval.

3.2 Mapping

The mapping consisted of categorising the identified CE indicators from the national and multilateral frameworks.

Categorisation of indicators
The European Commission is consistently presenting CE indicators through Eurostat's Circular Economy Monitoring framework for the EU and the individual member states. Sweden and the examined countries in this study are EU member states, and are obliged to report national CE data to Eurostat. Because of this, it was considered sufficient to map and sort the identified indicators of this study based on the categorisation used in the Eurostat framework. The categorisation is presented in Table 3.2, which classifies the indicators based on what area of the CE that they monitor. The *Others* category was added for the indicators not suited among the predefined Eurostat categories. An indicator was assigned to a Eurostat category if it was similar to or strongly related to the data already in that group. If no direct data match existed, the indicator was still placed in that category if the category title was a clear fit. In cases where neither the data nor the title provided a good match, the indicator was placed in the *Others* category.

Table 3.2: CE monitoring categories (Eurostat, n.d.).

CE Monitoring Categories
Production and consumption
Waste management
Secondary raw materials
Competitiveness and innovation
Global sustainability and resilience
Others

To ensure the mapping in Table 4.19 was clear and easy to read, indicators with identical or very similar functions were combined under a single name. This consolidation was based on a review of the Eurostat metadata, as well as the descriptions from the national frameworks and the resulting interpretations. In cases where descriptions were limited and the similarity between indicators remained unclear, they were kept separate. While some names were modified for clarity, the original Eurostat names were retained for reference. The specific details of these changes are provided in Table A.2 in Appendix A.

3.3 Evaluation

The evaluation of the mapping was based on three aspects: (1) Indicators and categories, (2) Data availability in Sweden, and (3) The Delegation's interests.

Indicators and categories
The evaluation first focused on the frequency and total number of identified CE indicators. This provided an overview of which metrics that are most commonly used by the studied countries. Furthermore, the extent to which national indicators diverge from the Eurostat framework was analysed. This also identified unique indicators that were used solely by one country. The categorisation was addressed by examining the types of indicators assigned to the different categories. The indicators placed in the *Others* category were evaluated to determine which aspects of the CE that were captured within this grouping.

Data availability in Sweden
Based on the mapping of indicators currently used in CE monitoring frameworks by the studied countries, their applicability within a Swedish context was evaluated. This was achieved by categorising the indicators based on their data availability into the following four groups:

1. Open-access data available
2. Data exists but is not public
3. Data is currently not available
4. Status cannot be determined

This information was provided by Emma Snölilja at Statistics Sweden (SCB) the 20th of May 2026. An Excel sheet (Appendix A.3) with all the identified indicators was created for Snölilja to classify each indicator into one of the four groups.

The Delegation's interests
To narrow down the identified set of CE indicators, it was necessary to assess the relative priority of them within a potential Swedish monitoring framework. Given that the thesis was conducted at the request of the Delegation for Circular Economy, and because they intend to utilise the results of this study in the future, it was considered important to understand the Delegation's interests and priorities in the evaluation. Therefore, a questionnaire was distributed to the current 11 members of the Delegation. The questionnaire was structured according to the categories detailed in Section 3.2. Respondents anonymously rated individual or grouped indicators on a five-point scale, ranging from "low priority" (1) to "high priority" (5) for monitoring CE in Sweden. This serves as an evaluation of the indicators' 'Relevance', included in the RACER criteria. In addition to individual member responses, the Secretariat was also given the opportunity to provide one collective response. Respondents were also given the option to leave a question blank if they found an indicator difficult to interpret or had no specific opinion. There was a possibility to write final comments in a free-text format at the end of the questionnaire.

The average rating for each indicator was taken in order to determine their relative relevance in a potential future national monitoring system. The indicators with an average rating of 4 or higher were compiled into an indicator set reflecting the interests of the members of the Delegation. The set was evaluated based on the representation of indicators from the different categories and on the data availability in Sweden. These averages were also used to determine the average rating for each category, which reflected the relative relevance of different areas of CE according to the Delegation.

4

Results

This chapter presents the results from the study. It begins by introducing the specific countries and organisations that were selected through the screening process. Following this, the multilateral frameworks are presented to provide a general understanding of the global monitoring landscape. Since these frameworks are referred to throughout the chapter, it is necessary to present them first. Subsequently, Sweden's circular economy work and monitoring initiatives are presented. This serves as a reference to the other national monitoring strategies and indicators. Thereafter, the chapter maps the CE indicators identified from the national and multilateral frameworks into one comprehensive table. The table categorises the indicators based on monitored CE area in accordance with Eurostat, specifies the frameworks in which they are included, and indicates the data availability in Sweden. This is followed by an evaluation of the indicators' applicability and relevance in a Swedish context.

The countries and multilateral organisations listed in Table 4.1 were selected from the screening process. These form the focus of the study and will be explored in greater depth throughout this chapter.

Table 4.1: Overview of selected countries and multilateral organisations.

	Country/ Organisation	**Sources**
National	The Netherlands	(Waterstaat, 2025; PBL, 2025c; PBL, n.d.-e)
	Finland	(Finnish Government, 2021; Finnish Government, 2023)
	Germany	(BMUKN, 2024; UBA, n.d.-b)
	Austria	(BMK, 2022; BMK, 2024)
	Belgium	(Circular Flanders, n.d.-a; Circular Wallonia, 2024)
Multilateral	Eurostat	(Eurostat, n.d.)
	UNECE/OECD	(UNECE Statistical Division, 2025)
	ISO	(Swedish Institute for Standards, 2024)
	Circle Economy	(Circle Economy, 2025b)

The countries selected for the study were the Netherlands, Finland, Germany, Austria, and Belgium. While Poland was also considered, it was eventually excluded. Following email contact with Polish governmental representatives, it was clarified that although a previous project had developed a system of indicators, these have not been fully implemented at the national level. Furthermore, an interview could not be confirmed, which resulted in Poland being removed from the final selection. Additionally, Canada and the United Kingdom (UK) were also countries of interest to the Delegation for Circular Economy. While both were contacted for consultation, the UK was unable to share its ongoing work prior to publication, and Canada did not respond within the study's time frame. As both Canada and the UK are currently developing their monitoring frameworks, publicly available information was insufficient for a comprehensive analysis and therefore they were excluded from the study.

Four multilateral frameworks were identified for further analysis: the Eurostat framework, the UNECE/OECD framework, the ISO standards for circular economy, and the Circularity Gap Report framework. However, the indicators from the latter two were not included in the final mapping for the following reasons. Since the study's objective is to understand what governments are doing at a national level, the scope naturally focuses on the EU and UN levels where nations are officially represented. Furthermore, Eurostat reports at country-level for their indicators, and the UNECE/OECD framework is targeted at implementation by governments and national statistical offices. The interviews confirmed that both the Eurostat and UNECE/OECD framework have been used in the development of national monitoring frameworks, or that national statistical offices have been directly involved in the development of these.

In contrast, the ISO standards are designed for organisations, such as smaller or larger companies, rather than for the national level. In addition, their indicators are not publicly available for use unless the standard is purchased, and the information within cannot be freely distributed. The Circularity Gap Report by the non-profit organisation Circle Economy has gained a lot of recognition, however it remains a non-governmental initiative and does not represent formal national work. These two frameworks are still described for informational purposes in the following section.

4.1 Multilateral CE Monitoring

This section presents a selection of multilateral frameworks that have gained global recognition for their role in guiding CE monitoring. For the frameworks identified as suitable for integration into a national monitoring system, their specific CE indicators are presented. These CE indicators are used for the mapping presented in Section 4.4.

4.1.1 The Eurostat Framework

In 2026, the European Commission plans to adopt the new *Circular Economy Act*, aiming to create a single market for secondary raw materials, as well as increase the supply and demand of high-quality recycled materials in the EU (European Commission, 2026). The act will be based on the *EU Circular Economy Action Plan* (CEAP) from 2020, which aims to extend the efforts to scale up CE, and ultimately double EU's circularity rate from 12% to 24%. The CEAP is one of the central pillars of the *European Green Deal*, the EU's overarching plan for sustainable growth (European Commission, n.d.). The deal aims to half GHG emissions by 2030 through implementing the *European Climate Law*, binding the 2050 neutrality goal. The CEAP thereby combines legislation, economic incentives, and different initiatives to increase sustainable product design and resource efficiency, as well as reduce waste streams. In addition, the plan expresses the need for a strengthened and harmonised monitoring framework to follow up the transition (European Commission, 2026), which has resulted in the *Eurostat Circular Economy Monitoring Framework* (Eurostat, n.d.).

The European Commission delivers data for the EU and its member states within the Eurostat framework to keep track on the progress of the transition towards a CE (Eurostat, n.d.). It was originally set up in 2018 as a set of 10 CE indicators, and has since then been revised with an additional 17 indicators (Commission & for Environment, 2023). They are categorised according to the following groups: *Production and consumption*, *Waste management*, *Secondary raw materials*, *Competitiveness and innovation*, and *Global sustainability and resilience*. The framework is presented in Table 4.2.

Table 4.2: Eurostat's circular economy indicators (Eurostat, n.d.).

Indicator [unit]	**Description**
Production and consumption	
Material footprint [mass per capita]	The worldwide demand for material extractions (biomass, metal ores, non-metallic minerals and fossil energy materials/carriers) triggered by consumption and investment by households, governments and businesses in the EU (in tonnes per capita). Raw material consumption indicator (RMC) is a measure of material footprints, calculated as Raw material input (RMI) minus exports in Raw materials equivalent (RME) (calculated at the aggregate product level, by material).

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Table 4.2 – continued from previous page

Indicator [unit]	Description
Resource productivity [index 2000=100]	Gross domestic product (GDP) divided by domestic material consumption (DMC). DMC measures the total amount of materials directly used by an economy, defined as the annual quantity of raw materials extracted from the domestic territory of the local economy, plus all physical imports minus all physical exports. DMC does not include upstream flows related to imports and exports originating outside of the local economy.
Green Public Procurement [%]	The share of public procurement procedures above the EU thresholds (in number and value), which include environmental elements. This is a new indicator with no available data yet.
Total waste generation per capita [mass per capita]	The total waste generated in a country including major mineral wastes in kg per capita, divided by the average population of the country.
Generation of waste excluding major mineral wastes per GDP unit [mass per €]	The waste generated in a country, excluding major mineral wastes, per GDP unit. The ratio is expressed in kg per thousand EUR.
Generation of municipal waste per capita [mass per capita]	The waste collected by or on behalf of municipal authorities and disposed of through the waste management system, in kg per capita.
Food waste [mass per capita]	The amount of food waste generated per year divided by the average population of the country (kg per capita). It is measured as fresh mass all along the food value chain, including production sites, processing and manufacture, retail and distribution, restaurants and food services and households.
Generation of packaging waste per capita [mass per capita]	The amount of packaging waste generated per year divided by the average population of the country (kg per capita). 'Packaging' in this context means all products made of any materials of any nature to be used for the containment, protection, handling, delivery and presentation of goods, from raw materials to processed goods, from the producer to the user or the consumer. 'Non-returnable' items used for the same purposes shall also be considered to constitute packaging.

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Table 4.2 – continued from previous page

Indicator [unit]	Description
Generation of plastic packaging waste per capita [mass per capita]	The amount of plastic packaging waste generated per year divided by the average population of the country (kg per capita).
Waste management	
Recycling rate of municipal waste [%]	The share of recycled municipal waste in the total municipal waste generation. Recycling includes material recycling, composting and anaerobic digestion.
Recycling rate of all waste excluding major mineral waste [%]	The share of recycled waste in the total waste treated excluding major mineral wastes. Recycled waste is waste treated, which was sent to recovery operation other than energy recovery and backfilling.
Recycling rate of overall packaging [%]	The share of recycled packaging waste in all generated packaging waste. The packaging waste is broken down into 'paper and cardboard packaging', 'plastic packaging', 'wooden packaging', 'metallic packaging' and 'glass packaging'.
Recycling rate of plastic packaging [%]	The share of recycled plastic packaging waste in all generated plastic packaging waste.
Recycling rate of WEEE separately collected [%]	The share of waste of electrical and electronic equipment (WEEE) that enters the recycling/preparing for re-use facility in all separately collected WEEE.
Secondary raw materials	
Circular material use rate (CMUR) [%]	The share of material recycled and fed back into the economy in overall material use. The overall material use is measured by summing up the domestic material consumption (DMC) and the circular use of materials. The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants minus imported waste destined for recovery plus exported waste destined for recovery abroad.
End-of-live recycling input rates (EOL-RIR), aluminium [%]	The share of aluminium input into the production system that comes from recycling of scrap from end-of-life products. The EOL-RIR does not take into account scrap that originates from manufacturing processes.

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Table 4.2 – continued from previous page

Indicator [unit]	Description
Imports from non-EU countries [mass]	The quantities of selected waste categories and by-products, in thousand tonnes, imported by EU Member States from third countries.
Exports to non-EU countries [mass]	The quantities of selected waste categories and by-products, in thousand tonnes, exported by EU Member States to third countries.
Intra EU trade [mass]	The quantities of selected waste categories and by-products, in thousand tonnes, imported by EU Member States from another Member State.
Competitiveness and innovation	
Private investments [%]	The gross investment in tangible goods in the recycling sector; repair and reuse sector, in percentage of gross domestic product (GDP) at current prices. Gross investment in tangible goods is defined as investment during the reference year in all tangible goods.
Persons employed [%]	The share of persons employed in the recycling sector, repair and reuse sector and rental and leasing sector, as percentage of total employment.
Gross value added [%]	The value added at factor costs in the recycling sector, repair and reuse sector and rental and leasing sector, as percentage of gross domestic product (GDP) at current prices.
Patents related to waste management and recycling [qty]	The number of patents related to recycling and secondary raw materials.
Global sustainability and resilience	
Consumption footprint [index 2010=100]	The environmental impacts of EU's and Member States' consumption by combining data on consumption intensity and environmental impacts of representative products. The indicator covers consumption of food, mobility, housing, appliances, and household goods.
GHG emissions from production activities [mass per capita]	The greenhouse gas emissions of all production activities undertaken in the EU economy, in kilograms of CO_2-eq equivalents per capita. The indicator includes emissions from international air transport undertaken by EU resident airlines and excludes emissions by private households.
Material import dependency [%]	The ratio of imports (IMP) over direct material inputs (DMI) in percentage. The term 'material import dependency' shows the extent to which an economy relies upon imports in order to meet its material needs.

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Table 4.2 – continued from previous page

Indicator [unit]	Description
EU self-sufficiency for raw materials, aluminium [%]	Indicates how much the EU is independent from the rest of the world for aluminium. The indicator has been calculated based on yearly quantity data for domestic production, exports and imports.

4.1.2 The UNECE/OECD Framework

The Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE) and the UNECE Task Force on Measuring Circular Economy (UNECE-TF), which they established in 2021, are together developing guidance for measuring progress towards a circular economy (UNECE, n.d.). The report *Guidelines for Measuring Circular Economy*, consists of two parts; *Part A: Conceptual Framework, Statistical Framework and Indicators* (United Nations Economic Commission for Europe, 2024) was presented in 2024 and *Part B: Practical guide for measuring progress towards a circular economy* is currently under development. The guidelines are directed at national statistical offices and governmental agencies specifically, as well as policymakers involved in the transition towards a CE and the application of CE indicators.

Part A (United Nations Economic Commission for Europe, 2024) outlines circular economy concepts and provides a statistical measurement framework with four different components: *Material life cycle and value chain*, *Interactions with the environment*, *Socio-economic opportunities*, and *Responses and actions*. The framework contains a total of 19 core indicators, 72 complementary indicators, and 13 contextual indicators. Several indicators are placeholders that are yet to be defined.

Each indicator is rated based on its relevance and usefulness, and its current measurability. This was done in cooperation between the informal OECD Expert Group on a new generation of information for a resource efficient and circular economy (RECE-XG) and the UNECE-TF. High, medium or low relevance is assessed with respect to the following criteria: *ability to provide a representative picture of the material life-cycle*; *its interactions with the environment, and society's responses*; *simplicity, ease of interpretation*; *ability to show trends over time, and responsiveness to changes*; *ability to provide a basis for international comparisons*; *existence of a threshold or reference value against which to compare it*.

Furthermore, high, medium or low measurability indicates the current availability of data and if there are agreed methodologies. For example, an indicator with high measurability have basic data available for a majority of OECD members and a few non-members. The methodology for producing the indicator is well defined and there is consensus about its validity. On the

contrary, an indicator with low measurability have major methodological or data gaps where data collection and conceptual efforts are needed.

The framework is extensive and to give clearer guidance for national statistical offices, Part B will provide information on for example, how to use statistics to produce the indicators, guidance on the required institutional collaboration, and how to understand which of the proposed indicators fall under their responsibility. It is suggested that the core indicators should be limited to a set of 20–25 metrics, while a set of complementary indicators can be used to provide details on specific sectors or materials. Several international organisations, such as the European Environment Agency (EEA), Eurostat, International Monetary Fund (IMF) and United Nations Environmental Programme (UNEP) are taking part in conducting Part B (UNECE, 2026). The national statistical offices of Austria, Belgium, Finland, and the Netherlands, among others, are also participating. In contrast, Sweden has not been involved (UNECE, 2026).

The core indicators are further explained in Part B (UNECE, 2026). Notably, the Part B report is currently a draft. The final version is planned to be published later in 2026 and it may offer further descriptions and details for the indicators. In the current version, 4 of the 19 core indicators are still placeholders: Impacts on human health, Education and training, Behaviour, and Distributional aspects & socio-economic inequality of CE policies. The remaining 15 core indicators are presented in table 4.3. Three indicators are not defined (n/a) and were therefore excluded from further analysis. Because multiple potential units are suggested for each indicator, the has not been defined here and readers are referred to the Part B report's (UNECE, 2026) metadata for further details.

Table 4.3: UNECE/OECD circular economy indicators (UNECE, 2026).

Indicator [unit]	**Description**
Material consumption and productivity [n/a]	Domestic Material Consumption (DMC) is calculated as the sum of domestic extraction of raw materials plus all physical imports minus all physical exports. Raw Material Consumption (RMC) extends DMC by including the "hidden" flows of raw materials embodied in trade. It represents the global extraction of primary materials required to produce the goods and services consumed by a country's residents, regardless of where those extractions occur.
Total waste generation [n/a]	Total mass of all primary waste generated by all economic activities and households in a country.
Circular Material Use Rate (CMUR) [n/a]	The volume of secondary materials recovered from waste and used again.
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Table 4.3 – continued from previous page

Indicator [unit]	Description
National Recycling Rate [n/a]	The quantity of waste entering recycling processes (including exports destined for recycling and excluding imports for recycling) divided by the total waste generated.
Waste going to final disposal [n/a]	Waste that is finally disposed of, rather than recovered or recycled. It reflects the amount of material leaving the economic cycle.
Natural resource index: energy & mineral resources [n/a]	n/a
Intensity of use of renewable freshwater resources (abstraction over available renewable stocks) (water stress) [n/a]	n/a
GHG emissions from production activities [n/a]	Total greenhouse gas emissions from production activities of industries, including services, of a national economy per unit of real gross domestic product for the same set of industries.
Pollutant discharges from material extraction and processing to water bodies & proportion safely treated [n/a]	Proportion of industrial wastewater safely treated is calculated as the volume of industrial wastewater safely treated divided by total industrial wastewater generated, expressed as a percentage. Pollutant discharges to water measures the annual mass load of selected pollutants released into water bodies from specific industrial activities.
Taxes and government support for circular business models [n/a]	n/a
Investments in waste management infrastructure, waste collection and sorting [n/a]	The total amount invested by government and corporations to manage waste, i.e. to collect, transport and treat (disposal, sorting and recovery activities are included) waste.
Government and business R&D expenditure on CE technologies [n/a]	The amount of research and development (R&D) spending by governments and businesses that is dedicated to CE activities (recycling processes, use of secondary raw materials, product design for circularity, new circular business models).

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Table 4.3 – continued from previous page

Indicator [unit]	Description
Business investment in CE activities [n/a]	Measures the scale of private-sector financial commitment to circular practices. The total gross investment in tangible goods by enterprises engaged in circular economy sectors.
Gross value added of circular economy sectors [n/a]	Measures how much of a country's economic output is generated by industries that keep resources in use and minimise waste (e.g., recycling, repair, reuse).
Jobs in CE sectors [n/a]	The number of persons employed in economic activities that are considered part of the circular economy, expressed in full-time equivalent (FTE) units for comparability. This number can be divided by total national employment.

4.1.3 The ISO Standards for Circular Economy

The *ISO 59020 Circular economy — Measuring and assessing circularity performance* was published in 2024 by the International Organization for Standardization (ISO) (Swedish Institute for Standards, 2024). The standard serves the role of guiding how measuring should be developed, such as boundary setting, data acquisition, calculations and aggregation. In addition, there are two other standards in the CE package, ISO 59004 and ISO 59010, where the idea is that these should be used together (L. Linnala, personal communication, 13th of April, 2026). The standard is not directly aimed for implementation at national level, but primarily at organisational micro and meso-levels. However, this does not exclude that it can be used at national level, e.g. through the use of definitions or setting system boundaries.

Standards are typically revised every five years (L. Linnala, personal communication, 13th of April, 2026). However, the current CE standards are already undergoing revision as of 2026 due to significant developments in the field. The updated versions are expected to be published within approximately two years. In parallel, work has begun on a management system standard for CE, and it is anticipated to be completed around 2028–2029. The CE-standards are classified as Swedish standards by the Swedish Institute for Standards (SIS), and the package is in the ongoing process of becoming a European standard as well, resulting in all EU member states having to implement the standards on a national level. In Sweden, the current CE-standards are not certifiable, meaning that there is no process that ensures and monitors that those who purchase and claim to operate based on the standards are actually doing so correctly. However, the new management system standard under development will be certifiable and actors will be certified by the Swedish Certification body.

4.1.4 The Circularity Gap Report Framework

The organisation Circle Economy has, since 2018, published global, multinational, national, and regional reports on the current state of circularity, with the aim of accelerating the transition (CGR, n.d.). The organisation is based in the Netherlands, and they collaborate with national research institutes to produce the *Circularity Gap Reports* (CGR). These reports are based around the *Circularity Metric* (CM), an indicator quantifying the share of secondary materials out of total material consumption. The latest global CGR was published in 2025 and analyses the circularity gap by examining other material flows to add onto the CM, hence expanding the dashboard of indicators (Circle Economy, 2025b). These indicators are presented at a global level using global data. The set has not been identified as being used or implemented by governments.

4.2 CE Monitoring in Sweden

This section outlines Sweden's previous national CE initiatives, including the national CE strategy and action plan, their linked environmental objectives, and national monitoring of the CE. It provides the necessary context for understanding Sweden's monitoring approach in relation to the other national CE strategies presented in Section 4.3.

4.2.1 The Swedish CE Strategy and Action Plan

In Sweden, a national CE strategy was released in 2020 (R. o. Regeringskansliet, 2020). The strategy presents the overarching vision and goal for a national transition towards a CE:

> Vision: A society in which resources are used efficiently in toxin-free circular flows, replacing the use of virgin materials.
>
> Goal: The transition to a circular economy should contribute to achieving the national environmental objectives, as well as the UN Sustainable Development Goals (SDGs) in the 2030 Agenda (R. o. Regeringskansliet, 2020, p. 6).

The following year, in 2021, the action plan for Sweden's transition towards a CE was published (R. o. Regeringskansliet, 2021). The action plan concretises the national strategy through the presentation of decided or intended measures to meet the vision and goal in practice. The strategy and action plan are both structured around four areas of focus; *Sustainable production and design*, *Sustainable consumption and use*, *Toxic-free and circular cycles*, and *Circular economy as a driving force for innovation and industry*. Additionally, selected material value chains are prioritised including plastics, textiles, food, renewable and biobased resources, buildings and building materials, and critical metals and minerals. No report following up on the strategy or

action plan has been published.

4.2.2 CE Objectives in Sweden

The UN Sustainable Development Goals

The Swedish CE strategy links each area of focus to SDGs and targets (R. o. Regeringskansliet, 2020). The following SDGs and targets are linked to in the national strategy (United Nations, 2015):

- **SDG 3: Good health and well-being**
  - Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- **SDG 6: Clean water and sanitation**
- **SDG 7: Affordable and clean energy**
- **SDG 8: Decent work and economic growth**
  - Target 8.2: Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors.
  - Target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead.
- **SDG 9: Industry, innovation and infrastructure**
  - Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
- **SDG 11: Sustainable cities and communities**
  - Target 11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
- **SDG 12: Responsible production and consumption**
  - Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources.
  - Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.
  - Target 12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international

frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
  - Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.
  - Target 12.7: Promote public procurement practices that are sustainable, in accordance with national policies and priorities.
- **SDG 13: Climate action**
- **SDG 14: Life below water**
  - Target 14.1: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.
- **SDG 15: Life on land**

Further, Table 4.4 presents the links between the areas of focus from the Swedish national CE strategy and the SDGs and targets.

Table 4.4: SDGs and targets linked to the national CE strategy's focus areas.

Focus area	**Linked SDGs**	**Linked targets**
Sustainable production and design	3, 6, 7, 8, 9 12, 13, 14, 15	3.9, 8.4, 9.4, 12.2
Sustainable consumption and use	3, 6, 8, 9, 12, 13, 14	8.4, 12.3, 12.7
Toxic-free and circular cycles	3, 6, 7, 9, 11, 12, 13, 14, 15	11.6, 12.4, 12.5, 14.1
Circular economy as a driving force for innovation and industry	8, 9, 11, 12, 13, 15	8.2, 9.4

The Swedish Environmental Objectives

The goal of the Swedish national CE strategy and action plan also emphasises that the transition should contribute to achieving the national environmental objectives (R. o. Regeringskansliet, 2020). The Swedish environmental objectives system constitutes the national framework for implementing the environmental dimension of the global UN SDGs (Sveriges miljömål, n.d.). The system consists of one overarching generational goal (*generationsmålet*), 16 environmental quality objectives (EQO) (*miljökvalitetsmålen*), and 19 active milestone targets (*etappmålen*) (R. o. Regeringskansliet, 2021). The objective of the generational goal is to ensure that major environmental problems are solved within one generation without causing increased environmental or health impacts outside of Sweden's borders. Furthermore, the EQOs define the de-

sired quality of the Swedish environment that the national environmental work is intended to achieve (Sveriges miljömål, n.d.).

The milestone targets are time-bounded sub-targets reflecting prioritised areas, implemented in order to reach the generational goal and the EQOs (R. o. Regeringskansliet, 2021). The Swedish national CE action plan is linked to specific milestone targets relevant for the transition, including; *Reduced GHG emissions*, *Reusing of packaging*, *Reduced food waste*, *Municipal waste*, *Building and demolition waste*, and *Food waste* (R. o. Regeringskansliet, 2021). However, since the milestone targets are time-bounded, they are continuously updated, and half of the targets referred to in the action plan have surpassed their time boundary (M. Bergmark, personal communication, 6th of March, 2026; R. o. Regeringskansliet, 2021). The action plan can therefore be considered outdated, and there are likely new or updated milestone targets that are more relevant, both in time and content, for the transition towards a CE. After the national CE action plan was published, the milestone targets have been categorised into different subjects, where circular economy is one of them. One milestone target is categorised within this subject: *Reuse of packaging*, where the reusable proportion of packaging placed on the market should increase by at least 20 percent from 2022 to 2026 and by at least 30 percent from 2022 to 2030.

In contrast, the generational goal and the EQOs do not explicitly reference to CE, making it challenging to identify a direct connection. However, based on insights from the guiding interviews (see Section 3.1), it can be argued that both the generational goal and selected EQOs are linked to CE. These goals have associated indicators used for monitoring progress, e.g. the generational goal has indicators from *Material flow accounting*, *Treated waste*, *Fossil-free energy*, and *Consumption-based GHG emissions per area* that can be considered to measure certain areas of the CE (Swedish Environmental Protection Agency, n.d.-a).

Every year, the Swedish Government follows up on the national CE action plan and the national environmental objectives in the budget proposal (R. o. Regeringskansliet, 2021). The segment presents the governmental work with the environmental objectives done through the year, which is based on the yearly follow-up report of the environmental objectives produced by the Swedish Environmental Protection Agency. The budget proposal does however not quantitatively follow up on CE indicators (Regeringskansliet, 2025).

In summary, the goal of the Swedish national CE strategy and action plan is broad and part of other already established political objectives, rather than existing as its own policy area. It refers to the SDGs and the Swedish national environmental objectives, where both systems consist of multiple types and levels of goals and targets. Circular economy is not explicitly referenced to in these objectives, with the exception of one about the reuse of packaging. Although work on the circular economy in Sweden is addressed annually in the government's budget proposal, no independent follow-up report has been conducted, nor has there been any quantitative evaluation

on any associated CE indicators.

4.2.3 Monitoring Initiatives in Sweden

As a member of the European Union (EU), Sweden is obliged to follow EU directives and implement them through national legislation in line with EU law (European Commission, 2023). Although reporting data specifically for the Eurostat CE indicators is not currently EU regulated, the data is based on primary and secondary statistics governed by EU regulations (SCB, 2025c). In line with this, the national statistical government agency Statistics Sweden (SCB), as well as the Swedish Environmental Protection Agency, provide the European Commission with national data, which are used by Eurostat to calculate and present their CE indicators for Sweden (E. Snölilja & M. Andersson, personal communication, 5th of March, 2026).

In addition, national CE indicators were developed for the period 2020-2023 through a collaborative project between SCB and other agencies, financed by the Swedish Governmental Agency for Innovation Systems (Vinnova) (Miljö & Avfallsbyrån, 2023). With one exception, the indicators presented were entirely based on the Eurostat framework. Although the indicators already are presented by Eurostat, the data behind the results are complex, requiring comprehensive knowledge and understanding in order to communicate the results (L. Sörme, personal communication, 11th of March, 2026). The project thereby supplied national agencies with this knowledge, leading to the ability for involved actors to participate in multilateral developmental work of CE indicators. It also provided increased and easier access to the indicators for Swedish actors, as well as facilitated national work to follow and understand circularity. The indicator *Tax deductions for appliance repairs* was unique to Sweden in this project and specifically refers to the Swedish RUT (Cleaning, Maintenance and Laundry) tax deduction for repair services (SCB, 2025d). This indicator also measures a higher-level R-strategy compared to the majority of CE indicators used by Eurostat (Miljö & Avfallsbyrån, 2023).

In 2025, the national CE indicators were updated (SCB, 2025a) as a part of a commission to SCB by the Swedish Agency for Economic and Regional Growth (Tillväxtverket) and the Acceleration Office (Accelerationskontoret) (SCB, 2025b; E. Snölilja & M. Andersson, personal communication, 5th of March, 2026). The agencies commissioned SCB to produce statistics for industry competitiveness and the green transition, and CE was one of the four specific areas. The same indicators were used and updated, primarily based on previously published secondary data. This set of indicators will be referred to as the *SCB set* in this report. While still based on the Eurostat framework, all indicators were not included due to the recent update to the framework in 2023 (E. Snölilja & M. Andersson, personal communication, 5th of March, 2026). For example, the category *Global sustainability and resilience* consisting of four CE indicators was not included. Additionally, indicators such as *Patents related to waste management and recycling* and *Generation of packaging waste per capita* were not reported due to e.g. time con-

straints, work load, or large data uncertainties. Currently, SCB has no national commission or financing to measure and monitor the CE in Sweden (SCB, 2025c; E. Snölilja & M. Andersson, personal communication, 5th of March, 2026).

Another effort made for measuring the CE in Sweden was the *Circularity Gap Report*, published by Circle Economy in 2022 (Circle Economy, 2022). The report was a voluntary one-time research initiative, determining the national circularity to 3.4% for the year 2022.

4.3 National CE Monitoring

This section outlines the strategies, objectives, and monitoring frameworks for each of the studied countries. The CE indicators detailed in the following tables are used in the mapping presented in Section 4.4. The interviews supporting this section of the results are presented in Table 4.5.

Table 4.5: Stakeholders interviewed in the study.

Interviewee	Role	Organisation	Country
Kees Schotten	Researcher	Netherlands Environmental Assessment Agency	The Netherlands
Heikki Sorasahi	Specialist	Ministry of the Environment	Finland
Niko Olsson	Statistician	Statistics Finland	Finland
Dr. Wiebke Jander	Researcher	The German Environment Agency	Germany
Milla Nagy	Statistician	Statistics Austria	Austria
Valentin Vassart	Project officer	Ministry of Economy	Belgium (Wallonia)
Michiel Pauwels	Researcher	The applied research institute VITO	Belgium (Flanders)

4.3.1 The Netherlands

In 2016, the Dutch government implemented its first programme for a CE, describing what is required in order to transform the Dutch economy to a CE by 2050 (Ministry of Infrastructure and Water Management, 2019). Since then, the programme has been updated twice, and the *New National Programme on Circular Economy Implementation Programme* (NPCE 2023-2050), published in 2023, is currently undertaken. The programme presents national goals, indicators, and measures aimed at accelerating the CE transition and ultimately to reach the national long-term ambition to be fully circular by 2050. The programme includes three overarching goals on which the measures, policies, and indicators are based on. The goals are presented in Table 4.6.

Table 4.6: The Netherlands' circular economy goals (Government of Netherlands, 2025).

Goal for retaining raw materials in the economy	By 2035, at least 82% of Dutch waste will be recycled and at least 15% will be recycled to high-quality standards.
Goal for replacing primary and abiotic raw materials	The share of sustainable bio-based raw materials and secondary raw materials in our raw material use will be at least 55% by 2035.
Resource conservation goal	By 2035, our resource consumption will be 15% lower than in 2016.

To achieve the national goals, the NPCE expresses focus on concrete effects and environmental impact, and to be able to steer the development in the right direction effectively indicators are used for monitoring (Government of Netherlands, 2025). Two kinds of indicators are used for monitoring in the NPCE: *Impact indicators* and *Resource indicators*. The use of raw materials contributes to environmental effects, indicating the importance to measure and monitor this impact. The impact indicators are aimed at providing understanding of how CE initiatives affect the footprint of Dutch people (K. Schotten, 14th of April, 2026). They are are presented in Table 4.7. In the future, the framework will be expanded with impact indicators measuring the economic effects of resource use and CE (Government of Netherlands, 2025). The resource indicators provide additional information about how the goals are being achieved, and about potential undesirable developments. They are internationally recognised indicators by Eurostat (K. Schotten, 14th of April, 2026), also presented in Table 4.7.

NPCE reports are planned to be published at the end of every other year (PBL, 2025c). At the start of that same year, an *Integral Circular Economy Report* (ICER) will be announced by The Netherlands Environmental Assessment Agency (PBL), presenting the progress of the transition towards a CE as well as recommendations to the policymakers for the upcoming NPCE report. In the ICER, the progress is monitored using a Mission-Driven Innovation System (MIS), which has a similar purpose to develop a comprehensive indicator set as the frameworks presented in Section 2.3.1. MIS consists of eight identified processes central for setting and keeping the transition to a CE in motion: *Entrepreneurship*, *Knowledge development*, *Knowledge exchange*, *Directing the search process*, *Market formation*, *Mobilizing resources*, *Breaking through resistance*, and *Coordination* (PBL, n.d.-h). These processes are monitored using *Transition indicators*, mapping the progress, obstacles, and opportunities for the CE transition through e.g. reflecting employment, scientific publications, and policy instruments for CE. The transition indicators will evolve along with the transition, indicators that are interesting in the beginning of the transition will not contribute in the same way in later phases (K. Schotten, personal communication, 14th of April, 2026). The transition indicators are presented in Table 4.7 as well.

PBL also monitors the impact of the societal developments through *Physical indicators* (PBL, n.d.-h), also presented in Table 4.7. These indicators capture the resulting changes in e.g. resource use, consumption levels, waste generation, and environmental effects (PBL, n.d.-e). Because it is a transition, the societal changes will firstly be reflected in the transition indicators, followed by the impacts showing in the physical indicators (K. Schotten, personal communication, 14th of April, 2026).

Table 4.7: The Netherlands' circular economy indicators.

Indicator [unit]	Description	Data
National CO_2 Emissions [n/a]	Impact indicator presenting the CO_2 emissions occurring within the Netherlands. (Government of Netherlands, 2025)	Planbureau voor de Leefomgeving (PBL) and Centraal Bureau voor de Statistiek (CBS) (K. Schotten, personal communication, 14th of April, 2026)
Security of Supply [n/a]	Impact indicator presenting the extent to which access to raw materials is reliable and secure. (Government of Netherlands, 2025)	PBL and CBS (K. Schotten, personal communication, 14th of April, 2026)
Raw material input (RMI) [mass]	Resource indicator presenting all raw materials used worldwide to support production in the Netherlands. (Government of Netherlands, 2025)	PBL and CBS (K. Schotten, personal communication, 14th of April, 2026)
Direct material input (DMI) [mass]	Resource and physical indicator presenting all materials entering the Dutch economy. Also presented including the fossil fuels burned for energy (DMI+FE). (PBL, 2025d)	CBS (PBL, 2025d)
Domestic material consumption (DMC) [mass]	Resource and physical indicator presenting the raw materials consumed in the Netherlands to monitor consumption trends. (PBL, 2025d)	CBS (PBL, 2025d)

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Table 4.7 – continued from previous page

Indicator [unit]	Description	Data
Direct material input / domestic material consumption (DMI / DMC) [%]	Resource indicator presenting the relocation of production abroad. (PBL, 2025d)	CBS (PBL, 2025d)
DMC substitution [%]	Resource indicator presenting the share of bio-based and secondary raw materials in the DMC, indicating trends in domestic consumption. (Government of Netherlands, 2025)	PBL and CBS (K. Schotten, personal communication, 14th of April, 2026)
Raw material consumption (RMC) [mass]	Resource indicator presenting all raw materials used worldwide to satisfy consumption in the Netherlands. (PBL, 2025b)	PBL and CBS (PBL, 2025b)
Added value of the circular economy [%, and €, and % of GDP]	Transition and physical indicator presenting the added value generated by economic activities that can be linked to one of the R-strategies: rethink, reduce, reuse, repair, or recycle. (PBL, 2024c)	CBS (PBL, 2024c)
Employment in the circular economy [%, and qty]	Transition and physical indicator presenting full-time jobs that can be linked to one of the R-strategies: rethink, reduce, reuse, repair, or recycle.. (PBL, 2024d)	CBS (PBL, 2024d)
Scientific publications on the circular economy [qty]	Transition indicator presenting the number of publications on the subject of CE produced by Dutch knowledge institutions. (PBL, n.d.-i)	Turkey (PBL, n.d.-i)
Policy instruments for knowledge development by companies [qty]	Transition indicator presenting the number of knowledge and innovation projects for and by companies, so-called MIT projects, and the amount of Circular Subsidies (in million euros). (PBL, n.d.-b)	Rijksdienst voor Ondernemend Nederland (RVO) (PBL, n.d.-b)

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Table 4.7 – continued from previous page

Indicator [unit]	Description	Data
Policy instruments for stimulating circular market formation [€ and %]	Transition indicator presenting the Dutch government's financial policy instruments available to help companies bring circular products to market, or to become more circular themselves, through Circular fiscal contribution (million euros) and the Share of circularity in the fiscal contribution (percentage). (PBL, n.d.-c)	RVO (PBL, n.d.-c)
Use and impact of circular public procurement [%]	Transition indicator presenting the effectiveness of their *Socially Responsible Public Procurement* (MVOI) policy instrument, by linking the share of public tenders incorporating circularity criteria to resulting environmental impacts. It is based on a subset of selected high-impact procurement categories, capturing both the implementation intensity of circular procurement and its measurable contribution to the CE transition over time. (PBL, n.d.-f)	Rijksinstituut voor Volksgezondheid en Milieu (RIVM) (PBL, n.d.-f)
Financial resources for supporting circular activities [€ and %]	Transition indicator presenting the amount of government support for circular projects through subsidies and fiscal contributions (in million euros, and the circular share). (PBL, n.d.-d)	RVO (PBL, n.d.-d)

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Table 4.7 – continued from previous page

Indicator [unit]	Description	Data
Consumer openness and circular behaviour and associated environmental benefits [survey]	Transition indicator presenting the self-reported sustainable behaviour of the Dutch population through a survey by the government-funded, independent public information agency Milieu Centraal. Willingness and reporting regarding circular consumption behaviour, and willingness, reporting, and environmental gains of circular consumption behaviour is monitored through circular behaviours being classified. (PBL, n.d.-g)	Milieu Centraal; processed by PBL (PBL, n.d.-g)
Policy instruments and measures in the CE programs [qty]	Transition indicator presenting a comparison between the number of implemented measures from the two CE policy programs: Circular Economy Implementation Program 2021-2023 (UPCE'21) and the National Circular Economy Program 2023-2030 (NPCE'23). (PBL, n.d.-a)	Rijkswaterstaat (RWS) (PBL, n.d.-a)
Dutch Land Footprints [area]	Impact and physical indicator presenting the amount of land area in global use as a result of Dutch consumption or production. (PBL, 2025f)	PBL and CBS (PBL, 2025f)
Dutch Water Footprints [volume]	Impact and physical indicator presenting the amount of water use or water stress occurring globally as a result of Dutch consumption or production. (PBL, 2025g)	PBL (PBL, 2025g)
Circular Material Use Rate (CMUR) [%]	Physical indicator presenting the share of secondary materials relative to total material input in the Dutch economy (PBL, 2024a)	CBS (PBL, 2024a)
Sankey of Dutch Material Flows [mass]	Physical indicator presenting the Sankey diagram for the Netherlands, illustrating the national economy's material flows. (PBL, 2024b)	CBS (PBL, 2024b)

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Table 4.7 – continued from previous page

Indicator [unit]	Description	Data
GHG Footprints in the Netherlands [CO_2-eq]	Impact and physical indicator presenting the amount of GHG emissions occurring globally as a result of Dutch consumption or production. (PBL, 2025a)	PBL and CBS (PBL, 2025a)
Dutch Biodiversity Footprints [MSA-loss · ha · yr]	Physical indicator presenting the amount of biodiversity loss occurring globally due to environmental pressure resulting from Dutch consumption or production. (PBL, 2025e)	PBL and CBS (PBL, 2025e)

4.3.2 Finland

Finland's CE strategy (Finnish Government, 2021) and resolution (Ministry of the Environment, 2021) was launched in 2021 with the aim to achieve a transformation by which the circular economy will become the new foundation of the economy by 2035 (Ministry of the Environment, n.d.). The work is said to be guided by the objectives presented in Table 4.8.

Table 4.8: Finland's circular economy objectives (Finnish Government, 2021).

Goal 1	The consumption of non-renewable natural resources decreases and the sustainable use of renewable natural resources can increase in such a way that the total consumption of domestic primary raw materials in 2035 does not exceed the 2015 level. This objective does not apply to natural resources used for manufacturing export products.
Goal 2	Resource productivity will double by 2035 from the 2015 level.
Goal 3	The circular material use rate (CMUR) will double by 2035.

The strategy states that the indicators currently in use do not describe CE comprehensively and that development of better CE indicators is in progress (Finnish Government, 2023). As for now, the progress is said to be measured with the indicators presented in Table 4.9 (Ministry of the Environment, 2021). The agencies producing the data in Finland are Statistics Finland and the Finnish Environment Institute (SYKE). Eurostat is also used as a data source for some of the indicators. A qualitative discussion process and dialogue with experts and researchers resulted in the selection of indicators (H. Sorasahi, personal communication, 31st of March, 2026). The indicator selection was based on data availability, and that the framework should provide a holistic view on CE. The development of new indicators or data collection methods was not considered feasible.

Finland's evaluation report (Finnish Government, 2023) was published in 2023, and for each of the indicators mentioned in Table 4.9, there is an explanation and current status, and a traffic light evaluation done by experts in this report. Only the *Circular economy barometer* was not evaluated at this point. The barometer was implemented as nationwide surveys for companies and citizens and was published in 2024 (Pitkänen et al., 2024). Another evaluation report will be published in the spring of 2026, where the indicators are similar to the ones from 2023 (H. Sorasahi, personal communication, 31st of March, 2026).

Table 4.9: Finland's circular economy indicators.

Indicator [unit]	Description	Data
Domestic material consumption (DMC) [mass]	Measures the use of raw materials generated domestically. Imports and exports are also taken into account when calculating DMC. (Finnish Government, 2023)	Eurostat (Finnish Government, 2023)
Material input required by domestic end-use by material (RMC) [mass]	Raw Material Consumption measures the amount of raw materials needed to produce the final use (consumption) of the domestic economy. Takes into account all the materials needed to produce different products, instead of only examining the physical masses of products in international trade, as is done in DMC. (Finnish Government, 2023)	Statistics Finland and SYKE (Finnish Government, 2023)
Resource productivity (RP) [€ per mass]	Resource productivity is calculated by dividing gross domestic product (GDP) by domestic raw material consumption, or RMC. (Finnish Government, 2023)	Eurostat (H. Sorasahi, personal communication, 31st of March, 2026)
Circular economy material use (CMUR) [%]	The circular economy material use rate, measures the share of recycled material for economic use out of all material use. The indicator takes into account the import and export of waste. (Finnish Government, 2023)	Statistics Finland (Finnish Government, 2023)
Turnover of circular economy sectors and number of enterprises [€ and qty]	The indicator measures the number of different circular economy companies operating in Finland and the turnover of the sectors in question. Sectors consists of three categories: recycling, repair and reuse, and rental and leasing. (Finnish Government, 2023)	Statistics Finland (Finnish Government, 2023)

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Table 4.9 – continued from previous page

Indicator [unit]	Description	Data
Eco-innovations [index]	Eco-innovation is an umbrella term that encompasses a group of different innovative solutions that reduce environmental impact, improve energy efficiency, or support the transition to a more sustainable direction. The measurement of eco-innovations is based on the Eco-Innovation Index developed by Eurostat. (Finnish Government, 2023)	Eurostat (Finnish Government, 2023)
Innovative public procurement [%, survey, etc]	Measured through three different channels: surveys, marking circular economy procurement in the Hilma service, and text analytics of procurement contracts. (Finnish Government, 2023)	KEINO and others (Finnish Government, 2023)
Municipal, packaging and construction waste and recycling rate [mass and %]	Covers the amount and recycling rates of several waste indicators: municipal, packaging and construction waste. (Finnish Government, 2023)	Statistics Finland and SYKE (Finnish Government, 2023)
Circular economy barometer [survey]	Survey and interview survey of companies and consumers on attitudes and operating models supporting the circular economy. (Finnish Government, 2023)	SYKE (Finnish Government, 2023)

Another monitoring initiative separate from Finland's CE strategy, is the production of an indicator set in 2020 by Statistics Finland. This set aimed to demonstrate Finland's progress towards the circular economy with an emphasis on a business perspective (Statistics Finland, n.d.). These indicators does not clearly link to Finland's goals or objectives (N. Olsson, personal communication, 31st of March, 2026). There is an updated version from 2022 and 2023 with additional indicators. During the development, Statistics Finland looked at and compared the few already existing indicator sets, such as Eurostat and the Netherlands. The project was an externally funded one-time project, which limited the scope and resulted in the value-chain and business perspective of the indicator set. The data and statistics on the business side are extensive, making data collection and calculations easier and more accurate. However, there is no active funding to update this set at the moment. Even though these indicators can be of interest, the indicators directly connected to Finland's CE strategy (Table 4.9), which has been adopted by the government, are prioritised in this study. Therefore Statistics Finland's indicator set will not be included in the mapping.

4.3.3 Germany

In 2024, the German Federal Ministry for the Environment, Climate Action, Nature conservation and Nuclear Safety (BMUKN) published their *National Circular Economy Strategy* (NCES), developed together with the German Environment Agency (UBA) and stakeholder groups from the industry, civil society and the scientific community (BMUKN, 2024; W. Jander, personal communication, 26th of March, 2026). The aim of the strategy is to help reach national climate-neutrality, and to make Germany more competitive and economically resilient by 2045, as well as supporting the work towards achieving the goals of the *German Sustainable Development Strategy* (BMUKN, 2024). The implementation, monitoring and evaluation of the NCES is based around one guiding principle and three overarching strategic goals, presented in Table 4.10. Regular evaluation will be conducted by BMUKN, or the UBA, in order to assess the progress towards the goals and allow for necessary adjustments. The first progress report after the implementation of the strategy has yet to be published.

Table 4.10: Germany's circular economy principle and goals (BMUKN, 2024).

Guiding principle	Achieve an average intensity of raw material consumption (RMC) of 6–8 tonnes per capita per year.
Goal 1	Close material cycles through doubling the percentage of secondary raw materials in the total quantity of all raw materials used by 2030, supported by measures in all major material flows using the circular material use rate (CMUR) indicator.
Goal 2	Increase the security of raw material supply and raw material sovereignty through meeting 25 percent of the demand for strategic raw materials by 2030. The aim is for no more than 65 percent of any raw material to be sourced from a single third country. Monitored using the DIERec indicator (direct and indirect effects of recycling) in relation to primary raw material input (RMI)
Goal 3	Prevent waste through lowering the per capita volume of municipal waste by 10 percent by 2030 and by 20 percent by 2045 compared to 2020 levels.

In addition to the indicators monitoring the progress of the goals, the NCES presents some overarching indicators that will be used for assessing the environmental impact of CE (BMUKN, 2024). All indicators stated in the strategy are presented in Table 4.11. However, the NCES also expresses the need for an established monitoring framework for CE (W. Jander, personal communication, 26th of March, 2026). In 2025, UBA called for tender, resulting in multiple German research institutes currently working on the development of the national monitoring system. The project is led by the Wuppertal Institute for Climate, Environment and Energy, accompanied by the UBA, and considers the NCES as well as other existing frameworks such as

the Dutch monitoring system and the UNECE/OECD framework. In addition, Germany collects and reports data for the Eurostat indicators, however, in the upcoming monitoring system, these will be supplemented and expanded to stronger reflect national realities, e.g. through breaking down CMUR per material flows. The DPSIR framework will be used in the development, and a gap analysis of the indicators currently measurable and the ones that still need to be developed will be conducted.

The indicators in the upcoming monitoring framework will be selected based on the RACER criteria and data availability, and they will be classified into four areas: (i) National level CE indicators related to total material flows in the German economy and to the strategies goals, (ii) CE indicators relating to environmental and social economic developments due to CE, (iii) Individual actions area that relate to materials, products, and actors, and (iv) CE indicators that check the implementation of measures stated in the strategy for the different action areas (W. Jander, personal communication, 26th of March, 2026). The first monitoring report is planned to be published in 2028. Additionally, the NCES expresses that indicators will be developed for measuring the CE's contribution to climate change mitigation, as well as biodiversity conservation and the protection of natural carbon sinks (BMUKN, 2024). W. Jander (personal communication, 26th of March, 2026) states that research on these indicators has begun, but they cannot be included in an official framework yet, and it is unclear if there are models available for the necessary calculations.

Currently, the UBA presents statistics on resource conservation, as well as private households and consumption, categories that can be considered to be linked to CE, but are not explicitly classified as such by the agency (UBA, n.d.-a). Some of the indicators stated in the NCES are included under these categories, as well as indicators such as *Recycling of municipal waste* and *Environmentally friendly consumption*, which will likely be included in the monitoring system under development (W. Jander, personal communication, 26th of March, 2026). UBA also presents *Direct effects of recovery* (DERec) and *Cumulative energy demand* (KEA-saldo), illustrating the additional demand for primary raw materials and total primary energy that would arise if secondary raw materials were not used in Germany (UBA, n.d.-b). These will also be included in the future CE monitoring framework.

Table 4.11: Germany's circular economy indicators .

Indicator [unit]	Description	Data
Circular Material Use Rate (CMUR) [%]	The share of material recycled and fed back into the economy in overall material use - the ratio of the circular use of materials to overall material use. (BMUKN, 2024)	Eurostat (BMUKN, 2024)

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Table 4.11 – continued from previous page

Indicator [unit]	Description	Data
Raw Material Consumption (RMC) [mass]	Domestic raw material extraction and direct and indirect imports converted into raw material equivalents, minus the raw material equivalents used for the manufacturing of exported goods. (BMUKN, 2024)	Federal Statistical Office of Germany (UBA, 2025c)
Direct and Indirect Effects of Recovery (DIERec) [mass]	A secondary raw materials indicator, illustrating the extent to which primary raw materials would have to be extracted globally, assuming identical production patterns and technologies, if secondary raw materials were not utilized in Germany. (UBA, n.d.-b)	UBA (n.d.-b)
Primary raw material input (RMI) [mass]	Raw materials that were required both domestically and abroad for the production of goods that are used or in demand in the German economy. (BMUKN, 2024)	Federal Statistical Office of Germany (UBA, 2025d)
Total Raw Material Productivity (GDP/RMI) [€ per mass]	Measures progress towards decoupling economic growth and raw material use, through taking the sum of gross domestic product and imports in relation to primary raw material input (RMI). (UBA, 2025d)	Federal Statistical Office of Germany (UBA, 2025d)
Persons employed [%]	The proportion of employees subject to social security contributions in Germany working in the circular economy as a percentage of the total number of people employed. (BMUKN, 2024)	Eurostat (BMUKN, 2024)
Global environmental footprint of consumption [CO_2-eq]	Measures the global environmental impact caused by the consumption of German private households. (UBA, 2025b)	Federal Statistical Office of Germany (UBA, 2025b)
Patents related to waste management and recycling [qty]	Measures the number of patents related to recycling and secondary raw materials. The data is collected by Eurostat. (BMUKN, 2024)	Eurostat (BMUKN, 2024)

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Table 4.11 – continued from previous page

Indicator [unit]	Description	Data
Waste generation in municipal waste category [mass]	Total amount of municipal waste generated per year. The indicator represents the development of the municipal waste sub-stream, comprising the types of waste generated by municipal waste management companies. "Waste producers" are primarily private households, administration and commercial enterprises. (UBA, 2025a)	Federal Statistical Office of Germany (UBA, 2025a)

4.3.4 Austria

The CE strategy for Austria was adopted in 2022, with the vision to to transform the Austrian economy and society into a climate-neutral, sustainable circular economy by 2050 (BMK, 2022). It was developed and led by the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK). The strategy sets four goals, presented in Table 4.12.

Table 4.12: Austria's circular economy goals (BMK, 2022).

Goal 1	Reduction of resource consumption of Material footprint (MF) reduced to 7 tonnes per capita and year by 2050. Domestic Material Consumption (DMC) reduced to 14 tonnes per capita and year by 2030.
Goal 2	Increasing domestic resource productivity by 50% by 2030.
Goal 3	Increasing the circularity (CMUR) rate to 18% by 2030.
Goal 4	Reduction of material consumption in private households by 10% by 2030 (compared to reference year 2020).

These goals includes five performance indicators, which are presented in Table 4.13. The evaluation of the CE strategy will be published every five years (BMK, 2022). Hence, the first evaluation can be expected in 2027. Additionally, a progress report is planned to be created every two years that explains the implementation of the strategy. The first progress report was published in 2024, and it is a presentation of the implementation progress in 2023 rather than an evaluation of the implemented measures (BMK, 2024). For each performance indicator, the past year's progress relative to the defined goals is presented. The next progress report will be available in the summer of 2026 (M. Nagy, personal communication, 30th of March, 2026).

Table 4.13: Austria's circular economy indicators.

Indicator	Definition	Data
Material Footprint (RMC) [mass per capita]	The consumption of domestic and imported primary raw materials minus the exports (=Domestic material consumption) and the raw material requirement for the imported semi-finished and finished goods minus the respective exports (=Raw material consumption) in Austria. (BMK, 2024)	Statistics Austria (Nagy, 2026)
Domestic Material Consumption (DMC) [mass per capita]	The consumption of domestic and imported primary raw materials minus the exports. (BMK, 2024)	Statistics Austria (Nagy, 2026)
Domestic resource productivity (RP) [€ per mass and capita]	The economic performance in euros measured by the gross domestic product (GDP) divided by the total material usage (DMC) in Austria. The reference year is 2015. (BMK, 2024)	Statistics Austria (Nagy, 2026)
Circular Material Use Rate (CMUR) [%]	The circularity rate is the proportion of the recycled material in the entire material usage in Austria. (BMK, 2024)	Statistics Austria (Nagy, 2026)
Material consumption in private households (currently Generation of municipal waste) [mass per capita]	The material use caused by private consumption cannot currently be measured directly. The current indicator is the quantity of municipal waste in Austria divided by the total population. (BMK, 2024)	Environment Agency Austria (Nagy, 2026)

Except for the five performance indicators, no other CE indicators are included in the monitoring yet. The development of another indicator set is currently ongoing (Kreislaufwirtschaft HelpDesk, n.d.). This work proceeded after the strategy was adopted, where an expert group representing ministries, Statistics Austria, Environment Agency Austria, Austrian Institute of Economic Research (WIFO) and two universities prepared a proposal of indicators in addition to the indicators defined in the strategy (Nagy, 2026). To select the new indicators, the Eurostat framework was a starting point to emphasise comparability and data availability. The UNECE/OECD framework were also consulted. The principles for selection were that indicators must be CE relevant, regularly measurable, methodologically robust, and available as consistent time series. The suggestions were broad, but the final set of suggested indicators are similar to Eurostat's (M. Nagy, personal communication, 30th of March, 2026). The data for

the proposed indicators will be gathered from Statistics Austria, Environment Agency Austria, Eurostat, Austrian Research Promotion Agency and Austrian Council for Sciences, Technology, and Innovation (Nagy, 2026).

Furthermore, Statistics Austria works on a project ordered by BMK, about the development of indicators for CE, namely regarding the Eurostat indicators *Gross value added* and *Persons employed* (M. Nagy, personal communication, 30th of March, 2026). The developmental work started in the beginning of 2026, and is planned to be published towards the end of the year. M. Nagy (personal communication, 30th of March, 2026) states that Statistics Austria believes that it is possible to calculate these two indicators more accurately using the detailed data that they have. Nagy emphasises that the data sent to Eurostat for these indicators are more aggregated with missing values, partly because of confidentiality.

4.3.5 Belgium

Belgium is divided into three territorial decision-making regions: Flanders, Wallonia, and Brussels (European Union, n.d.). Flanders and Wallonia, the two larger regions, have their own separate strategies and frameworks for the transition towards a CE. The indicators that are presented in this section are therefore on a regional level. Brussels region is excluded from the study because of its city-level scale being outside the scope.

Flanders
Flanders' *Vision 2050* (Departement of Public Governance and the Chancellery, 2018) concludes that the previous CE initiatives in Flanders, like *Flanders Materials Programme*, has been merged into Circular Flanders. Circular Flanders is a CE hub and a collaboration of government, business, civil society and knowledge community (Circular Flanders, n.d.-c), and is the main actor for circular economy in Flanders. In 2017, they presented a kick-off statement for CE (Circular Flanders, 2017). The Flemish government have formulated an overarching aim for material use, presented in Table 4.14. However, there is no formal policy or strategy on CE (M. Pauwels, personal communication, 17th of April, 2026).

Table 4.14: Flanders' circular economy aim (M. Pauwels, personal communication, 17th of April, 2026).

Aim	Reduce Material Footprint by 30% in 2030 compared to 2010.

A monitoring web-tool consisting of 100 indicators, called the CE Monitor, is available at the Circular Flanders' webpage (Circular Flanders, n.d.-a). It combines data to provide a picture of Flanders' circularity (Circular Flanders, 2021). The framework has been built by the CE Centre, which is a group of researchers that is funded by Public Waste Agency (OVAM) and Department of Economy, Science and Innovation (EWI), and is currently active until 2026. However, the

monitor itself is funded by Circular Flanders (Circular Flanders, n.d.-d). In 2019, the Flemish government asked the CE Centre to develop a monitoring system, which was then published in 2021 (M. Pauwels, personal communication, 17th of April, 2026). It was updated in 2024, and will be updated again in 2026. The majority of data used is secondary data, produced by other agencies, but new data and methods are researched to develop and expand the system in the future. Currently, new data on reuse in Flanders are collected to provide indicators measuring higher up in the R-strategies (M. Pauwels, personal communication, 17th of April, 2026).

The monitor includes 27 indicators on macro-level, and they are set under the categories *circularity* and *effects*. These indicators provide information about consumption of materials, water, soil and space, and the emissions that it produces, see Table 4.15. The circularity indicators looks at material accounting and how much material that ends up in closed loops and are parted into inflow, outflow and R-strategies. The effects indicators measures material, socio-economic and environmental effects. The intermediate level indicators complement the macro-level, offering a look of what is going on behind the big macro trends, however, these are not included in this study.

A theory-driven approach by Reich et al. (2023) was mainly used when developing the indicator set. A combination of the DPSIR framework (presented in Section 2.3.1) and a societal needs perspective, called Needs satisfier system (NSS), formed the conceptual building blocks (Reich et al., 2023; M. Pauwels, personal communication, 17th of April, 2026). The NSS framework links services and material flows to corresponding socioeconomic output and environmental impacts (Reich et al., 2023). From these two systems, Reich et al. (2023) derived the Need satisfaction-Pressure-State-Impacts-Response (NPSIR) framework. Applying this method ensured inclusion of environmental and social indicators in the monitor, in addition to material flows.

The data and indicators are updated through an iterative process every two years. The goal of the CE monitor is to inform the policy makers on making better decisions on CE but they are currently questioning if the monitoring is achieving that goal (M. Pauwels, personal communication, 17th of April, 2026). They are not sure if the policy makers are finding the right information for their purposes. Because of this, they are in a redesign phase of the monitor through workshops and following up with policy makers to see if the monitor needs to be redesigned to better present the relevant information.

Table 4.15: Flanders' circular economy indicators (Circular Flanders, n.d.-a).

Indicator	Definition	Data
Direct Material Input (DMI) [mass]	All materials that physically enter the Flemish economy for both domestic consumption, and production destined for export. These come from extraction in Flanders or import.	OVAM and Steunpunt CE
Domestic Material Consumption (DMC) [mass per capita]	The net amount of materials consumed within Flanders, where exports are subtracted. This includes both short- and long-lived applications.	OVAM and Steunpunt CE
Water consumption [volume]	Total water consumption including tap water, surface water, rainwater, groundwater & other.	VMM
Share of industrial waste getting a second life [%]	The extent to which industrial waste is given a second life through reuse, use as a secondary raw material, recycling or composting.	OVAM
Household waste recycling [%]	The extent to which household waste in Flanders is recycled, composted or fermented.	OVAM
Production of secondary raw materials [mass]	The amount of secondary raw materials. That means materials that are originally by-products or materials that have reached the end of the waste phase and can be reused as raw materials under certain conditions.	OVAM
Reuse indicator [mass per capita]	Total product reuse in Flanders across all formal and informal reuse channels. Product reuse means that a discarded product is used by another user for the same function. Houses and motorised vehicles are not included in this indicator.	Steunpunt CE
Repair indicator [qty]	The number of product repairs in Flanders.	HIVA and VITO
Circular Material Use Rate (CMUR) [%]	The ratio of circular use of materials to overall material use.	OVAM and VITO
Production of household waste [mass per capita]	Includes all waste collected by, on behalf of or in cooperation with municipalities or inter-municipal authorities.	OVAM

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Table 4.15 – continued from previous page

Indicator	Definition	Data
Production of residual household waste [mass per capita]	The amount of household waste that is not collected selectively.	OVAM and VEKA
Production of primary industrial waste [mass]	The production of waste generated by the original waste producers.	OVAM
Production of primary industrial residual waste [mass]	The amount of primary industrial waste that is offered or collected non-selectively, and is the counterpart of residual household waste.	OVAM and Valipac
Incinerated, co-incinerated and landfill waste [mass]	The amount of waste that is either incinerated, co-incinerated or landfilled.	OVAM
Littering and fly-tipping cleaned up [mass]	Litter is the amount of smaller waste that is consciously or unconsciously left in a place where it is not allowed. Fly-tipping is the amount of waste people leave somewhere as a deliberate action where/when it is not allowed.	OVAM
Territorial emissions [CO2-eq]	The territorial GHG emissions within Flanders.	OVAM, VITO and VMM
Raw material input (RMI) [mass]	The sum of domestic extraction used and imports, expressed in raw material equivalents.	OVAM and Steunpunt CE
Material footprint (RMC) [mass per capita]	The raw materials needed directly and indirectly, through pre-chains abroad, in the entire production chain for Flemish consumption.	OVAM and Steunpunt CE
Land use [% of area]	Shows use of land in Flanders and paints a picture of the building density and amount of natural land that has been developed	Statbel
Carbon footprint of consumption [n/a]	All greenhouse gas emissions generated globally as a result of the consumption of Flemish inhabitants over the one-year period.	Departement Omgeving

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Table 4.15 – continued from previous page

Indicator	Definition	Data
Global concentration of emissions [ppm CO_2]	The average emission concentration in the global atmosphere.	NOAA
Soil contamination and remediation [%]	The progress of remediation of historical contamination to soils. The indicator provides the percent of exploratory surveys that has been conducted out of the 85 000 areas that is targeted to be completed in 2028.	OVAM
Material productivity (GDP/DMI or RMI or DMC or RMC) [€ per mass]	The ratio of gross domestic product to material consumption and expresses the efficiency of this consumption as the value added generated by the economy per unit of material.	OVAM, Statistics Flanders and Steunpunt CE
Employment in the circular economy [qty]	The evolution of employment in circular industries in Flanders. It covers jobs in sectors focusing on repair, waste management, renting and leasing, maintenance of motor vehicles, second-hand goods and building restoration.	Statistics Flanders
Turnover in the circular economy [€]	The turnover of a number of circular industries in Flanders (motor-vehicle maintenance, waste, renting and leasing, repair, building restoration and second-hand).	Bel-first
Turnover of approved reuse centres [€]	The size of the sector of approved reuse centres in Flanders based on turnover figures.	OVAM
Repair sector [%, qty and FTE]	Combines a number of data sources that provide more insight into the repair sector. It shows the turnover of the repair sector in Flanders, the number of repair organisations in Flanders, and the number of persons employed in the repair sector in Flanders	VITO

Wallonia

In 2021, the *Deployment Strategy of the Circular Economy in Wallonia* was published by the public CE authority Circular Wallonia (Circular Wallonia, 2024; V. Vassart, personal communication, 9th of April, 2026). The aim of the strategy is to promote and strengthen the implementation of CE, in order to contribute to economic recovery and redeployment of Wallonia, strengthen its competitiveness, create jobs, and address environmental challenges, as well as reduce vulnerability and dependence to the globalisation of value chains(Circular Wallonia, 2024). The strategy was structured around a vision, 10 ambitions and 60 qualitative measures, but did not include quantitative monitoring.

In 2024, Circular Wallonia launched the first implementation report for the strategy, for the period 2021-2023 (Circular Wallonia, 2024). The report is mainly a micro-assessment of Circular Wallonia, launched with an action plan with the aim of tracking and monitoring the actions undertaken from the strategy (V. Vassart, personal communication, 9th of April, 2026). The report includes *Strategic Objectives* (SO) and *Operational Objectives* (OO), both linked to indicators, see Table 4.16. Another implementation report for period 2024-2025 presenting the subsequent actions undertaken within the framework of Circular Wallonia is currently under development (Circular Wallonia, 2024; V. Vassart, personal communication, 9th of April, 2026).

Table 4.16: Wallonia's circular economy objectives (Circular Wallonia, 2024).

Objective	Description
SO 1	Replace fossil fuels or unsustainably produced resources with renewable resources available and widely available, wherever possible by 2050
SO 2	Increase resource productivity (ratio between gross domestic product and domestic resource consumption in Wallonia) by 25% between 2020 and 2035, which implies an absolute decoupling between the evolution of GDP and that of raw material consumption.
SO 3	Reduce direct demand for materials (DMI) and domestic consumption of materials by 25% (DMC) of Wallonia by 2030 compared to the year 2013.
SO 4	Increase by 20% the number of Walloon jobs contributing directly and indirectly to the circular economy by 2025 (i.e. an evolution from 6.8% in 2017 to 8.2% in 2025).
SO 5	Double the number of Walloon companies with circular economy practices by 2025.
SO 6	Reduce the average production of raw household waste in Wallonia below the threshold 100 kg per inhabitant per year by 2025.

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Table 4.16 – continued from previous page

Objective	Description
SO 7	Reduce waste from electrical and electronic equipment by 2 kg per capita by 2025 (that is, from 22.5 kg per capita to 20.5 kg per capita) thanks to the repair and savings of the functionality.
SO 8	Achieve a minimum quantity of reused goods of 8 kg per inhabitant per year by 2025.
SO 9	Collect and recycle at least 95% of household packaging by 2025.
SO 10	Achieving recycling rates exceeding 90% by weight for glass, paper/cardboard, beverage cartons and ferrous metals, 75% for aluminium and 80% for wood by 2025.
SO 11	Achieve a minimum recycling rate of 70% by weight for household plastic packaging and 65% for industrial plastic packaging by 2030.
SO 12	Achieve a vehicle recovery rate of over 95% by 2025.
SO 13	Use at least 30% recycled aggregates in public works projects.
SO 14	Reduce waste incineration by at least 50% between 2019 and 2027.
OO 1	More than 1,000 companies supported in their transition towards a CE by the end of 2023; more than 1,000 companies will have completed a diagnostic assessment; more than 600 companies will have initiated an action plan; more than 150 companies will have optimized logistics processes by 2025; and 30% of Walloon companies will integrate CE principles in purchases by 2025.
OO 2	Double the Research, Development and Innovation (RDI) budget dedicated to supporting circular economy approaches in order to reach an annual budget of 14 million euros over the period 2020-2025.
OO 3	Launch at least 25 innovative and/or pre-com- public procurement processes commercial by 2025; 50% of relevant regional public procurement contracts will incorporate a reflection or circular criteria; 75% of the ICT equipment procurement markets of the SPW and the UAP will be circular and ethical; All demolition/deconstruction contracts of the SPW and UAP and subsidized markets will include an inventory of materials and a selective deconstruction; Recycled materials will be used in all markets of SPW works and progressively in subsidized works by the Walloon Region.
OO 4	5,000 people will be trained on a subject related to their professions of the circular economy by 2025.

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Table 4.16 – continued from previous page

Objective	Description
OO 5	80% of Walloon companies will be familiar with the concept of economy circular by 2025; 2,000 economic operators will be made aware of the economy circular via training and awareness events by 2025; More than 5,000 people will participate in the 2nd edition of the week of the circular economy in 2022.

The strategy and monitoring framework in Wallonia was requested by the Walloon government as a part of the federal and national CE vision in Belgium, as well as the requirement to report CE statistics for the whole of Belgium to Eurostat (V. Vassart, personal communication, 9th of April, 2026). In addition, the needs of Walloon companies was also taken into consideration. The vision and framework was developed to answer the following questions:

- How can public policy contribute to the evolution of CE in Wallonia?
- How can the production of services and goods be more circular in Wallonia?
- How can the consumption of services and goods be more circular in Wallonia?
- How can Circular Wallonia contribute to reducing the environmental impact of Wallonia's economy?
- How can Wallonia become more independent, e.g in terms of Raw material import?
- How can Circular Wallonia create more jobs in CE?

The implementation report presents 10 *Aggregated indicators* (AI) of achievements and results, based on the main key action levers to deploy CE in Wallonia: *Standards and regulations*, *Financing*, *Public procurement*, *Demonstration, innovation and digital technology*, *Support*, *Networks and voluntary initiatives*, *Education and training*, *Information and awareness*, and *Collaboration and representation at Belgian, European and international levels* (Circular Wallonia, 2024). The AIs are used to track and demonstrate the daily activity and immediate outputs of Circular Wallonia's actions, e.g. through number of companies receiving support or number of organisations involved in CE initiatives. Therefore, the AIs do not directly present the state of CE, but rather reflect operational efforts for a CE transition (V. Vassart, personal communication, 9th of April, 2026).

Circular Wallonia is a part of the Department of Economy, and because of the wider scope of the indicators and the current lack of capacity within the department, Circular Wallonia relies partly on external colleagues in other departments within the Walloon government for data collection and monitoring of the CE indicators (V. Vassart, personal communication, 9th of April, 2026). The data used for the CE indicators mainly consist of existing secondary data, e.g. data already required to be collected by Eurostat. However, new methodologies for new indicators are required, but the development all depends on funding, capacity and resources

which is directly tied to the political vision in Wallonia. The current government does not support data monitoring and assessment of CE to the same extent as the previous government, which has resulted in a newly developed indicator set not receiving funding for data collection and implementation.

The implemented indicators monitoring the SOs, as well as the AIs, are presented in table 4.17. AI 5-9 are explicitly linked to the OOs (Circular Wallonia, 2024).

Table 4.17: Wallonia's circular economy indicators (Circular Wallonia, 2024).

Indicator [unit]	Description
Resource productivity (GDP/DMC) [%]	The ratio between gross domestic product (GDP) and domestic material consumption in Wallonia
Raw material consumption (RMC) [mass]	Measures the amount of raw materials needed worldwide for the consumption of the Walloon economy.
Direct material input (DMI) [mass]	Measures the amount of materials entering the Walloon economy.
Domestic material consumption (DMC) [mass]	Measures the amount of raw materials consumed in Wallonia.
Employment in CE [qty]	The number of Walloon jobs contributing directly and indirectly to CE.
Circular companies [qty]	The number of Walloon companies with circular practices.
Household waste generation [mass per capita]	The average production of raw household waste in Wallonia.
Generation of E-waste [mass per capita]	The production of waste from electrical and electronic equipment.
Reused goods [mass per capita]	The amount of reused goods per inhabitant per year.
Recycling rates of packaging [%]	The share of collected and recycled household and industrial packaging. Specifically monitored for glass, paper/cardboard, beverage cartons, ferrous metals, aluminum, wood, and plastics.
Vehicle recovery rate [%]	The percentage of a vehicle's total weight that is recovered through reuse, recycling, or energy recovery after it reaches end-of-life.
Recycling rate for aggregates [&]	Share of recycled aggregates used in public works projects.

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Table 4.17 – continued from previous page

Indicator [unit]	Description
Waste incineration [%]	Share of waste ending up being incinerated.
AI 1: CE mechanisms [qty]	The number of mechanisms for public support, financing, and public procurement, as well as the number of project applications to support the CE within the Walloon Region. (Circular Wallonia, 2024)
AI 2: Increased knowledge [qty]	The number of training programs and studies that have been developed to build knowledge about CE. (Circular Wallonia, 2024)
AI 3: CE tools [qty]	The number of Walloon tools developed to support the CE in priority value chains: bio-based, food, water, textile, construction, metallurgy, and plastics. (Circular Wallonia, 2024)
AI 4: Companies in CE [qty]	The number of companies that have received public funding from Walloon Region, through selected channels, to support their transition to a CE. (Circular Wallonia, 2024)
AI 5: Supported organizations in CE [qty]	The number of organizations that have received non-financial support through e.g. guidance, advice, or facilitation to help their circular transition. (Circular Wallonia, 2024)
AI 6: CE budget [€]	The total budget that is allocated across different areas of the Walloon Region to implement the circular economy strategy. (Circular Wallonia, 2024)
AI 7: CE public procurement [qty]	The number of public procurement contracts launched that incorporates CE clauses. (Circular Wallonia, 2024)
AI 8: CE education and training [qty]	The number of people, public officials, municipal eco-advisors, and students that are trained or educated in CE concepts and practices. (Circular Wallonia, 2024)
AI 9: CE awareness [qty]	The number of people that have been reached or exposed to the concepts of CE through events, education, companies, or communication channels. (Circular Wallonia, 2024)
AI 10: Involved organizations [qty]	The number of organizations that are actively involved in the governance and implementation of the Circular Wallonia strategy. (Circular Wallonia, 2024)

4.3.6 Gaps and Challenges

This section outlines gaps and challenges with national CE monitoring that were highlighted by the interviewees from each country. All interviewees are involved in their country's work on the national CE strategy and monitoring framework. However, they represent different agencies

and have different roles, reflecting the varying organisational structures of the countries' CE initiatives. The participants included statisticians, ministry officials, and researchers. See details in Table 4.5.

M. Nagy (personal communication, 30th of March, 2026) from Austria highlights the challenge of multiple existing definitions of activities and products that can be considered circular. Similarly, W. Jander (personal communication, 26th of March, 2026) from Germany mentions the challenges with coordination of different definitions and activities of CE that are split between different national agencies and statistical offices. Nagy and Jander both state that these differences often lead to data problems, such as uncertainties when comparing countries and frameworks. Nagy exemplifies this with the indicator *Material footprint*, which has been used for a long time in different frameworks as a key indicator. Eurostat has its tools and methods for calculating *Material Footprint*, but they are different from those used by OECD, as well as other national methods, leading to uncertainties. Accordingly, Nagy states that international agreements to operationalise the concepts of CE are needed. This would enable statisticians to identify which exact statistical codes, activities and products that are considered circular when collecting data. In the same way, Jander states that globally harmonised systems would facilitate increased accuracy and enhanced comparability between nations and actors.

The practical difficulties of capturing circularity within these statistical definitions are further described by other interviewees. For example, N. Olsson (personal communication, 31st of March, 2026) explains that Finland uses industry classifications when measuring CE, which does not include a specific "CE industry", and at the same time, circular activities can be implemented in any sector. Olsson suggests that an entirely different dimension would be needed in these classifications to fully capture CE across the various industries. Moreover, K. Schotten (personal communication, 14th of April, 2026) from the Netherlands highlights the importance of recognising the dynamics between traditional circular practices within the linear economy, such as car repairing, and practices that have transitioned from linear to circular as a result of new circular business models or initiatives, such as car sharing services. Additionally, companies are rarely 100% circular and therefore it is important to make a differentiation between the circular part and the part that is still linear within a company.

H. Sorasahi (personal communication, 31st of March, 2026) from Finland states the importance of an indicator framework covering a wider group of companies that have CE operations. The CE comprises more than the recycling and repairing sectors, however that is challenging to quantify. Olsson points out that Finland has experimented with web-scraping and other modern data collection methods to compile national statistics on circular businesses. However, differences in how companies classify and present their activities make it difficult to collect consistent and comparable data. Similarly, Nagy recognises that the higher-level R-strategies (refuse, rethink and reduce) are more difficult to measure compared to lower levels, especially

on a macro-level. Individual companies can calculate added value of implementing higher R-strategies looking at their savings, but indicators that explicitly reflect gross value added when using these higher-level CE strategies on a macro-level are missing.

V. Vassart (personal communication, 9th of April, 2026) from Wallonia, Belgium, expresses that indicators related to public procurement, as well as specific waste streams and industry sectors, are missing from their national framework. Additionally, the monitoring of services, specific supply chains and their circularity is lacking. Likewise, Olsson states that services are harder to measure compared to material-level indicators. Jander emphasises the lack of indicators measuring the implementation of transition measures as a critical gap in Germany, as well as in connecting CE to the progress towards larger environmental objectives, e.g. climate change and biodiversity conservation goals. However, Schotten highlights the importance of rightfully capturing the economic and financial conditions required for a CE transition. The transition not only depends on environmental performance but also on the viability of circular entrepreneurship, circular businesses need access to finance so they can scale up and operate under fair market conditions.

Schotten explains that the Netherlands base their evaluation of the CE transition indicators on the traditional S-curve from sustainability transitions theory, as presented in Section 2.1. This concept has been successful in identifying a few indicators that have reached their saturated phase, such as the *Number of publications in CE*, resulting in them being phased out and replaced with a new and more relevant indicator. However, for many indicators the S-curve cannot be applied yet, as they are still in the emerging phase of their transition. The Netherlands are experiencing challenges on which indicators to keep, which to phase out, and what new indicators that are needed.

Sorasahi notes that in Finland, some national indicators are not tracked continuously from year to year, instead they are dependent on project-based measures, which results in lack of data. In addition, Olsson emphasises that it is very expensive to develop and implement new data collection methods. Olsson also states that the nationally reported Eurostat indicators are calculated using Eurostat's methods, but their values may differ because of the use of different data. The reason for this is that Eurostat sometimes makes estimations or uses different data sources, since national data is not provided for every date and every year. In Wallonia, Vassart points out that the responsibility for data collection is divided among different departments, making it challenging to coordinate and follow up the CE indicators as regularly as intended. Additionally, the monitoring and reporting is heavily dependent on capacity and resources, meaning that the funding received from the government is decisive for the national CE work and future expansions of the framework. With the current government in Wallonia, the funding has decreased for CE compared to the previous government.

M. Pauwels (personal communication, 17th of April, 2026) from Flanders, Belgium, emphasises that a lot of the debate in CE always comes back to the lack of data availability, but ultimately, with over 100 indicators, Flanders sees that just increasing the number or quality of indicators will not necessarily mean that policymakers will take more decisions for the CE. Indicators are only one part of the story, and they are important since they are evidence-based, but much more is needed about e.g. how the information is presented and what kind of information that is needed for the CE policies. Providing more data and indicators does not enhance the usability for stakeholders.

Additionally, Pauwels discusses national reporting of Eurostat's indicators. Since data is already reported to Eurostat, it is reasonable to utilise it. On other hand, it is necessary to be cautious of translating higher level frameworks to regional or local levels. The positive side is that it is coherent with what is reported, but on the contrary, downscaling it to other contexts is risky since strategies developed are context-specific and policymakers in one country will have different priorities than policymakers in another country. Eurostat tries to generalise and harmonise this with a certain set of indicators, but Pauwels suggests that it is more important to look into what the regional needs are.

4.4 Mapping of CE Indicators

This section presents the mapping of the identified CE indicators from the selected multilateral and national CE monitoring frameworks. The indicator categorisation is based on the Eurostat framework, with the following categories: *Production and consumption*, *Waste management*, *Secondary raw materials*, *Competitiveness and innovation*, *Global sustainability and resilience*, as well as an additional *Others* category. The *Others* category includes indicators that do not clearly fit within Eurostat's defined categories.

Table 4.19 presents the indicator mapping, providing an overview of what CE indicators that are used and specifically highlighting which ones that are used beyond the Eurostat framework, and within what frameworks they are applied. In addition, colour coding to present the data availability in Sweden for each identified CE indicator is included, see Table 4.18. Furthermore, the table specifies 15 indicators that were utilised in Statistics Sweden's (SCB) most recent project-based calculation of indicators in 2025 (the SCB set). For detailed descriptions and units of the indicators, see Section 4.1 and Section 4.3.

Table 4.18: Legend for colour coding used in Table 4.19 showing data availability in Sweden (E. Snölilja, personal communication, 5th of May, 2026).

Colour	Meaning
	Open-access data available
	Data exists but is not public
	Data is currently not available
	Status cannot be determined
*	Included in the SCB set

Table 4.19: Mapping of CE indicators. Blue highlighted indicators are from Eurostat. *Abbreviations: EU=Eurostat, NL=The Netherlands, FIN=Finland, GER=Germany, AUT=Austria, FLA=Flanders Belgium, WAL=Wallonia Belgium.*

Category	Indicator	Frameworks	
Production & Consumption	Material Footprint	EU, UNECE/OECD, NL, FIN, GER, AUT, FLA, WAL	*
	Resource Productivity	EU, FIN, GER, AUT, FLA, WAL	*
	Green public procurement	EU, NL, FIN, WAL	
	Total waste generation	EU, UNECE/OECD	*
	Generation of waste excl. major mineral wastes	EU	*
	Generation of municipal waste	EU, GER, FIN, AUT	*
	Food waste	EU	*
	Generation of packaging waste	EU, FIN	
	Generation of plastic packaging waste	EU	
	Domestic material consumption (DMC)	UNECE/OECD, NL, FIN, AUT, FLA, WAL	*
	Raw material input (RMI)	NL, GER, FLA	
	Direct material input (DMI)	NL, FLA, WAL	
	Sankey of national material flows	NL	
	Production of household waste	FLA, WAL	
	Production of residual household waste	FLA	

Table 4.19 – continued

Category	Indicator	Frameworks	
	Production of primary industrial waste	FLA	
	Production of primary industrial residual waste	FLA	
	Generation of E-waste	WAL	
	DMI/DMC	NL	
	DMC substitution	NL	
	Construction waste	FIN	
Waste Management	Recycling rate of municipal waste	EU, FIN	*
	Recycling rate of all wastes excl. major mineral waste	EU, UNECE/OECD	*
	Recycling rate of overall packaging	EU, WAL, FIN	*
	Recycling rate of plastic packaging	EU	
	Recycling rate of WEEE separately collected	EU	
	Recycling rate for aggregates	WAL	
	Recycling rate of construction waste	FIN	*
	Recycling rate of household waste	FLA	
	Incinerated, co-incinerated & landfill waste	FLA	
	Waste incineration	WAL	
	Waste going to final disposal	UNECE/OECD	
	Littering and fly-tipping cleaned up	FLA	
	Vehicle recovery rate	WAL	
	Share of industrial waste getting a second life	FLA	
	Repaired goods	FLA	
	Reused goods	FLA, WAL	
Secondary Raw Materials	Circular material use rate (CMUR)	EU, UNECE/OECD, NL, FIN, GER, AUT, FLA	*
	End-of-life recycling input rates aluminium	EU	
	Imports from non-EU countries	EU	
	Exports to non-EU countries	EU	

Table 4.19 – continued

Category	Indicator	Frameworks	
	Intra EU trade	EU	
	Production of secondary raw materials	FLA	
	Direct and Indirect Effects of Recovery (DIERec)	GER	
Competitiveness and Innovation	Private investments	EU, UNECE/OECD	*
	Persons employed	EU, UNECE/OECD, NL, GER, FLA, WAL	*
	Gross value added	EU, UNECE/OECD, NL, FIN, FLA	*
	Patents related to waste management and recycling	EU, GER	
	CE budget	WAL	
	Government and business R&D expenditure on CE-technologies	UNECE/OECD	
	Investment in waste management infrastructure, waste collection and sorting	UNECE/OECD	
	Financial resources for supporting circular activities	NL	
	Financially supported companies in CE	WAL	
	Companies with circular practices	FIN, FLA, WAL	
	Non-financial support for organisations in CE	WAL	
	Organisations involved in implementation of national CE strategy	WAL	
	Eco-innovations	FIN	
Global sustainability and resilience	Consumption footprint	EU	
	GHG emissions from production activities	EU, UNECE/OECD	
	Material import dependency	EU	
	EU self-sufficiency for raw materials, aluminium	EU	
	National territorial GHG emissions	NL, FLA	
	Global concentration of emissions	FLA	
	Carbon footprint of consumption and/or production	NL, GER, FLA	

Table 4.19 – continued

Category	Indicator	Frameworks
	Security of supply	NL
	Pollutant discharges from material extraction and processing to water	UNECE/OECD
	Soil contamination and remediation	FLA
	Intensity of use of fresh water resources	UNECE/OECD
	National water footprint	NL, FLA
	National land footprint	NL, FLA
	National biodiversity footprint	NL
Others	Policy instruments for stimulating CE market formations	NL
	Policy instruments and measures in the CE programs	NL
	Policy instruments for knowledge development by companies	NL
	Scientific publications on the CE	NL
	Consumer openness and circular behavior and associated environmental benefits	NL
	Circular economy barometer	FIN
	CE mechanisms	WAL
	CE tools	WAL
	CE awareness	WAL
	Increased knowledge	WAL
	CE education and training	WAL

4.5 Evaluation

In this section, the identified CE indicators are evaluated in three parts to determine their suitability and relevance in a Swedish monitoring framework. First, the indicators and categories are examined to identify common international practices and how national frameworks extend beyond the Eurostat framework. Second, the mapped indicators are assessed based on their current data availability in Sweden, identifying which indicators that can be implemented using existing statistics and where gaps in data collection remain. Finally, the results from the questionnaire distributed to the Delegation for Circular Economy are presented to reflect the perceived relevance of specific indicators within a Swedish context.

4.5.1 Indicators and Categories

In total, there are 82 indicators presented in Table 4.19. Beyond the Eurostat indicators, which account for 27 of them, 55 indicators are identified that are being used in other frameworks. Out of the studied countries, Wallonia have 13 unique indicators, followed by Flanders and the Netherlands with 11 each. In contrast, Finland includes 4, Germany has 1, and Austria has 0. A unique indicator is defined as one that appears solely within a single country's framework. Many of the Eurostat indicators are used at the national level as well. There are a total of 12 indicators that are used in at least three of the countries' frameworks, where 7 of them also appear in the Eurostat framework. These are presented in Table 4.20.

Table 4.20: CE indicators used by at least three countries. Blue highlighted indicators are from Eurostat.

Indicators
Material Footprint
Resource productivity
Green public procurement
Domestic material consumption (DMC)
Raw material input (RMI)
Direct material input (DMI)
Generation of municipal waste
Circular material use rate (CMUR)
Persons employed
Gross value added
Companies with circular practices
Carbon footprint of consumption and/or production

There are also a few indicators in the Eurostat framework that no country uses in their national CE frameworks, such as sector specific waste amounts and recycling rates, and imports or exports of recyclable raw materials within and outside the EU.

When looking at the types of indicators present under each category, they can generally be described as follows: the first includes material flows and amounts of waste; the second includes recycling rates, repair, and reuse; the third concerns secondary raw materials; the fourth is about economy and businesses; and the fifth is about environmental impacts and security. Regarding the 11 indicators placed in the *Others* category, it can be distinguished that they are related to strategic progress, such as the number of implemented policy instruments, tools, mechanisms and projects in CE, and research volume. They also reflect social aspects, such as public awareness, consumer behaviour, and knowledge.

4.5.2 Data Availability in Sweden

The data availability for each identified CE indicator in Sweden is presented in Table 4.19. Appendix A.3 includes further information regarding where existing data can be found, and web links to the relevant statistics. Out of the 82 indicators, 37 of them have available data in Sweden, and for 5 of the indicators, data exists but it is not publicly available. Further, data for 4 of the indicators is not currently collected, and for 36 that data availability could not be determined. The details for each category is presented in Table 4.21.

Table 4.21: Data availability in Sweden for CE indicators.

CE Monitoring Categories	Total	Open-access data available	Data exists but is not public	Data is currently not available	Status cannot be determined
Production and consumption	21	14	3	0	4
Waste management	16	11	1	0	4
Secondary raw materials	7	4	0	1	2
Competitiveness and innovation	13	3	1	0	9
Global sustainability and resilience	14	5	0	3	6
Others	11	0	0	0	11

Regarding the data availability in Sweden for the 12 most common indicators used within the national frameworks, presented in Table 4.20, there are 9 indicators with open-access data available in Sweden, 1 where data exists but is not public, and 2 where the status cannot be determined.

4.5.3 The Delegation's Interest

In this section, the results from the questionnaire reflecting the Delegation's interests of the identified CE indicators are presented. The response rate from the members of the Delegation was 27%. Table 4.22 presents the average rating of each category.

Table 4.22: Average rating for each category, ranging from "low priority" (1) to "high priority" (5) for monitoring CE in Sweden.

Category	**Average**
Production and consumption	4.1
Waste management	4.1
Secondary raw materials	3.7
Competitiveness and innovation	3.1
Global sustainability and resilience	3.9
Others	3.1

These results illustrate that the categories *Production and consumption* and *Waste management* are rated the highest, closely followed by *Global sustainability and resilience*. *Competitiveness and innovation* and *Others* are rated the lowest. Since these results are averages compiled from the ratings of individual indicators or groups of indicators, a low rating for just one or two indicators can drag down the average for the entire category. Therefore, to ensure that high-rated individual indicators are not overlooked, those with an average rating of 4 or higher are presented in Table 4.23.

Table 4.23: CE indicators with an average rating equal to or above 4.

Indicators	Average
Production and consumption	
RMC, DMC, RMI, and DMI	4.0
DMI/DMC, DMC substitution and Resource Productivity	4.5
Green public procurement	4.75
Generation of waste based on different waste streams	4.25
Generation of waste based on waste source	4.0
Waste management	
Recycling of municipal waste	4.0
Recycling rate of waste for different waste streams	5.0
Waste incinerated and waste landfilled	4.5
Share of industrial waste getting a second life	4.5
Repaired goods and reused goods	4.8
Secondary raw materials	
Circular material use rate (CMUR)	5.0
Production of secondary raw materials	4.5
Competitiveness and innovation	
-	
Global sustainability and resilience	
Consumption footprints and GHG emissions from production and consumption activities	4.25
National territorial GHG emissions	4.5
Material import dependency and Security of supply	5.0
Others	
Policy instruments implemented to stimulate the circular economy transition	4.25

The high-rated indicators are distributed among the categories, however none of them are from the *Competitiveness and innovation* category, and only one is from the *Others* category. Data is currently available in Sweden for about half of this indicator set. The indicators *Recycling rate*

of waste for different waste streams, *Circular material use rate (CMUR)*, and *Material import dependency and Security of supply* were given rating 5 by all respondents, indicating that these are of high relevance. Data is available and public in Sweden for the *CMUR* and for all the identified CE indicators reflecting *Recycling rate of waste for different waste streams*. The data availability status in Sweden for *Material import dependency and Security of supply* is unclear.

Only a few of the indicators or indicator groups were left empty, with no clear trend across the respondents, with the exception of the group *DMI/DMC, DMC substitution och Resource productivity* which was left empty by 50%. In addition, two respondents expressed difficulties in understanding the definitions provided, as well as difficulties in prioritising the indicators.

5

Analysis and Discussion

The identification and mapping of CE indicators from selected national and multilateral monitoring frameworks have revealed several key points of interest. In this chapter, Sweden's current monitoring initiatives in relation to international ambition levels and the Eurostat framework are analysed. This is followed by a discussion of the role of national strategies and quantitative objectives and how it relates to monitoring. Furthermore, monitoring challenges and important considerations for indicator selection are addressed. Finally, potential pathways for the development of a Swedish CE monitoring framework, as well as limitations of the study and suggestions for further research are discussed.

5.1 Sweden's Current CE Monitoring

From the results of the study, it can be recognised that Sweden's CE monitoring initiatives are less ambitious compared to the other examined countries. Sweden has reported CE indicators through two project-based initiatives by Statistics Sweden (SCB), not commissioned by the government office. In addition, the indicators reported were all a part of the Eurostat framework with the exception of one. The mapping of CE indicators present that multiple indicators monitoring CE areas beyond the ones covered by Eurostat exist and are applied at national level in Europe. This indicates a reason to question if Sweden's past monitoring initiatives, as well as the Eurostat framework, include all possible monitoring areas of the circular economy.

The *Others* category in Table 4.19 presents indicators beyond EU's predefined categories, such as awareness and openness to CE, education, scientific publications on CE, as well as policy instruments and tools implemented by the government and companies to facilitate the transition. All indicators in this category are from the Netherlands and Wallonia, with the exception of one from Finland. What these indicators have in common is that they all reflect strategic and societal progress of the CE transition. Consequently, it can be concluded that this area is not included in the Eurostat framework, and thereby Sweden's previous monitoring as well. In addition, the SCB set did not include indicators from Eurostat's category *Global sustainability and resilience*, which monitors the environmental impact as well as import dependency and

self-sufficiency. These areas can therefore also be considered lacking from Sweden's previous monitoring initiatives.

However, national reporting of Eurostat's CE indicators can still be of importance. As highlighted by the interviewed statistician involved in the development of the SCB set, L. Sörme (personal communication, March 11, 2026) in Section 4.2.3, the national monitoring of these indicators increased availability, awareness and understanding of the national CE among agencies, municipalities and companies involved in the project. However, this reflects the interviewee's professional assessment rather than a systematically evaluated outcome. In addition, the conducted interviews with national stakeholders revealed how national statistics can be more recent, less aggregated, and more experimental than the data presented by Eurostat. More timely and detailed data can provide a more accurate representation of national circularity, which can support more informed decision-making. For example, Finland calculates their Eurostat indicators using the same methodology but the input data have differed multiple times due to Eurostat making estimations or using different data sources. Finland has also experimented with web-scraping and other modern data collection methods for some indicators, also resulting in different, and more experimental, input data. Similarly, Austria has developed more detailed data collection methods for two Eurostat indicators: *Gross value added* and *Persons employed*. In summary, national reporting may improve the accessibility and understanding of circular economy performance for the involved stakeholders within a country. Moreover, since Eurostat requires data according to their methodologies and models, national reporting can also be more recent, experimental, and detailed.

SCB has not received public funding to continuously calculate their CE indicators, meaning that it is uncertain when and if the SCB set will be followed-up in the future. In addition, solely applying a multilateral framework on a lower national or regional level has its drawbacks, as highlighted by Flanders, see Section 4.3.6. Strategies, and consequently the monitoring frameworks designed to support them, are context-specific. The interviewee from Flanders highlighted that downscaling a monitoring framework developed for another context may provide an incomplete basis for decision-making, which could contribute to policies or measures that are not well aligned with national priorities. However, it is important to acknowledge that national decisions are influenced by multiple factors and are not solely determined by monitoring results. Eurostat has aimed to create a generalised and harmonised framework, which provides advantages in terms of coherence and comparability across countries. While national and regional differences are reflected through the data and calculations of the Eurostat indicators, the standardised framework may not fully capture context-specific priorities or demands for every individual EU member state.

5.2 The Role of National CE Strategies and Quantitative Objectives

A noticeable difference between Sweden's CE strategy and the other examined countries' national strategies is that Sweden does not have quantitative objectives specifically connected to their CE strategy. All selected countries, except Flanders, have multiple quantitative targets specifically aimed for monitoring their transition. This relates to 'Relevance' in RACER, as quantitative objectives define what the indicators should track and how their data should be interpreted in relation to national goals. The goal of the Swedish strategy is for CE to contribute to achieving the national environmental objectives (Section 4.2.2) and the SDGs (Table 4.4). This approach considers CE as a means to reach other established policy objectives, and it is thus monitored through their associated indicators rather than by assessing the CE as an independent policy area. Compared to the examined countries in this study, Sweden's CE goal is therefore more general and broad, considering a larger number of goals, including 10 SDGs and the whole Swedish environmental objectives system. These include goals where CE is not referenced, as well as goals that cannot be linked to CE, e.g. the EQOs *A rich agricultural landscape* or *Safe radiation environment*. The Swedish CE goal not being more specific nor quantitative may be one of the reasons for Sweden not having a national CE monitoring framework.

However, looking at Flanders, they only have one quantitative overarching aim along with a monitoring framework consisting of over 100 indicators. This framework was developed at the request of and in cooperation with the Flemish government, with the aim of the indicators contributing to circular decisions by policymakers. This slightly different approach shows that it is possible to implement an advanced and accessible monitoring system that could be of use for policymakers without having a national CE strategy with several objectives. Even if indicators cannot be set in relation to a target value, trends can still be identified and actions can be taken. However, providing a large number of indicators will not necessarily lead to policymakers implementing actions for CE, as expressed by the interviewee (see Section 4.3.6). The indicators' usability for national policymakers have not been included in this study. However, it is important to acknowledge that the interpretation and application of indicators are crucial aspects of monitoring frameworks, rather than focusing solely on the number of indicators included. Figure 2.3 presents the indicator pyramid and illustrates that a higher quantity of information requires a higher level of expertise to interpret.

This study shows that Belgium and the Netherlands have done extensive work with CE monitoring, presenting a high number of unique indicators and addressing a broad range of CE areas. They developed their indicator frameworks using theory-based methods. Moreover, findings from the interviews highlighted that both Germany and Austria are engaged in actively developing their monitoring systems, with the presentation of new frameworks anticipated in the

near future. In addition, the interviews emphasised that national agencies are dependant on sufficient resources to maintain continuous monitoring and to expand or update their monitoring frameworks over time. Consequently, government funding plays a decisive role in the long-term development, which in turn is influenced by the national political context. For example, both Finland and Wallonia expressed challenges in securing enough funding for CE initiatives following changes in government and shifting political priorities.

5.3 Methodological Challenges with National CE Monitoring

The R-strategies, explained in Section 2.2, present several strategies for transitioning towards a CE, where the higher R-strategies (refuse, rethink, and reduce) focus on making and using products in a smarter way. Belgium and the Netherlands are the countries that could be said to include CE indicators which touch upon these higher-level strategies through measuring CE awareness, implemented policy instruments, tools and mechanisms, and knowledge development. However, these indicators cannot be seen to comprehensively cover the strategies, due to vague definitions which can easily be interpreted differently by different actors. Additionally, the interviews highlighted the difficulties to thoroughly measure higher-level R-strategies at the national level. The measures that are put in place help drive change and identify areas for improvement. Therefore, only measuring lower-level strategies risk that actions addressing the higher levels are not implemented to the same extent. The expression "What is measured gets done" mentioned by Miljö & Avfallsbyrån (2023) points towards this dilemma.

A main requirement when developing the monitoring frameworks in the studied countries was that the indicators must actually be possible to measure in practice, which aligns with the 'Easy to monitor' criterion in RACER. Thus, many indicators are based on data that is already collected for other purposes. In these cases, the focus is on gathering and organising existing data into a new setting to measure national progress towards the CE. However, there are also examples of indicators where the data is collected solely for the purpose of CE measurement. Based on this, it can be concluded that the studied countries have mainly chosen to use indicators that are measurable right now, rather than developing or applying new methodologies for data collection and indicator calculation. The available indicators can then be improved as research and new data collection methods develop over time. The CE field is developing rapidly and indicator frameworks will therefore be in need of regular updates.

Based on the interviews with national stakeholders, one critical challenge with creating a coherent and comprehensive CE monitoring framework is the many different definitions and interpretations of the CE concept, its strategies, activities and products. As highlighted by the interviewees from Germany, Austria, Finland, and the Netherlands, multilateral organisations, nations, regions, and companies all interpret and apply CE activities in different ways. They

expressed that this can result in uncertainties and differences in what is measured, both within a country between different agencies and across boarders between different countries. A reason for this may be the width of the CE concept, which serves as an umbrella term including multiple dimensions, as presented in Section 2.2. Several interviewees expressed the need for harmonised and globally agreed definitions, frameworks, and statistical codes, which would facilitate guidance in e.g. what indicators to include and how to collect the necessary data. It would also increase the comparability between different countries' circularity performance. This links to making the indicators 'Credible' and 'Robust' according to RACER framework. The UNECE/OECD guidelines can offer clarity and technical details required to assist national agencies with their definitions and monitoring tasks.

A challenge in harmonising CE definitions for coherent national reporting of indicators, which was also highlighted in the interviews, is that there cannot be a defined CE industry. Circular activities can be incorporated across all sectors of the economy in different ways and to varying degrees. Consequently, an idea from the interviewee from Finland was to introduce a whole other statistical dimension for circularity, capturing the circular activities across industries rather than focusing on specific sectors alone. This could contribute to generating 'Credible' data according to the RACER criteria. Multiple of the studied countries are monitoring companies with circular practices, as well as persons employed at circular businesses. However, emerging circular business models, such as product-as-a-service and sharing models, may be overshadowed by more established circular activities, such as repair services, that have long existed within a linear economy. As a result, monitoring frameworks may not rightfully capture the implementation and uptake of newer circular business models.

Similarly, the interviewee from the Netherlands emphasised the importance of monitoring economic and financial conditions, as the transition depends on the ability of circular entrepreneurship and businesses to scale up and operate under fair market conditions. This is consistent with sustainability transition theory, which views the CE transition as a multidimensional process requiring changes across economic, technological, social, and institutional dimensions. Therefore, it can be considered important for a comprehensive monitoring framework to fully capture these different dimensions.

Another challenge, seen in both Finland and Sweden, involves potential data gaps when evaluating CE trends, resulting from non-continuous data gathering. One way to tackle this is to implement a strategic monitoring process similar to the Netherlands, where the structure and timing of follow-ups are clear. They set an example that could serve as inspiration for Sweden through a two-year reporting cycle. Under this scheme, a monitoring report is presented at the beginning of the year to detail the progress of implementation and the status of the indicators, which then informs the CE strategy updates published later that same year. This plan provides responsible agencies with clear expectations for the work ahead. Furthermore, the continuous

updates ensures that CE efforts remain active and indicates a commitment towards a leading role in the field. The interviewed stakeholder from the Netherlands highlighted that updates can be grounded in sustainability transition theory (Section 2.1) to evaluate indicator development and 'Relevance' (RACER). Specifically, an indicator's progress can be assessed by mapping it onto the S-curve, thereby determining the novelty or maturity of the captured CE aspect.

Moreover, there were no contradictions between the scientific literature (see Section 2.3.2) and the results from this study. Instead, the results rather confirmed what was stated in the literature. For example, the literature highlighted that higher R-strategies are difficult to measure, and this study confirmed this, even for the countries that have many indicators in place. The broad CE concept has also been highlighted by both the literature and the interviewees as a challenge. The interviewed statisticians expressed difficulties in determining which data to include in the national monitoring of some indicators due to unclear definitions and a lack of statistical codes for CE strategies, activities and products. Similarly, interviewed ministry officials and researchers reported difficulties in determining which areas of circular economy that should be covered by their national monitoring frameworks. Furthermore, the literature highlighted that actual actions must come out of the indicator data provided. This was also discussed during the interviews, where it was stated that having more indicators and data does not automatically imply that more actions are being taken. Finally, the literature highlighted that social indicators are often missed in CE monitoring. However, this study identified that a few social indicators are actually being used by some of the studied countries, but not all of them.

5.4 Considerations for Selection of CE Indicators

The CE transition is a sustainability transition, as presented in Section 2.1. A sustainability transition is a long-term process, evolving over decades, which explains why CE indicators change slowly and requires time before numerical results change. Therefore, it is valuable to include indicators that provide earlier insights into the transition, such as the Netherlands' transition indicators or Wallonia's aggregated indicators. These can capture the actions towards circularity that are being taken strategically even though these effects are not apparent, e.g. in the environment, yet.

Furthermore, indicators monitoring absolute scales should be differentiated from indicators reflecting relative amounts, which addresses the 'Robust' criterion in RACER. Absolute indicators present an absolute amount or quantity and are important for understanding physical flows and environmental loadings in total terms, e.g. material flows. On a national level, it is common to include absolute indicators for specific materials. Large numbers reflecting material volumes may overshadow smaller but more critical flows with larger environmental impacts.

Relative indicators reflect performance relative to a reference, which is advantageous when

comparing performance across countries or sectors, and over time. Relative indicators are therefore unitless (percentages, indices, rates), and hides the magnitude of physical flows. This means that a country can improve relative indicators, e.g. recycling rates, while absolute indicators still develop in the undesired direction, e.g. material use, giving a false impression of progress in circularity. Accordingly, relative improvements do not automatically mean reduced environmental impact. Conversely, high absolute values, e.g. waste generation, may necessarily not mean low circularity but rather reflect a large population or industry sector.

Misinterpretations can also occur when comparing indicator values across countries without accounting for national characteristics such as population size, economic structure, industrial profile, and natural resources. The values of both absolute and relative indicators are highly influenced by these characteristics. For example, a country with a large mining sector will have huge numbers in waste generation, while if that same country uses its mining waste as filling material in construction their recycling rate and *CMUR* will be very high. In both cases, it can be misleading when comparing with a country that does not have a significant mining sector. This highlights the importance of including multiple CE indicators in a monitoring framework, giving a comprehensive and representative reflection of a country's characteristics and circularity performance. As suggested by the UNECE/OECD guidelines, a set of 20-25 core indicators is a reasonable number. The indicator pyramid, Figure 2.3, indicates that core indicators are suited for policymakers and should be more limited in number than the full set of indicators.

5.5 Future Pathways for CE Monitoring in Sweden

Instead of proposing one single pathway for CE monitoring in Sweden, this section discusses different directions based on the study's findings and the current national context. These pathways include Sweden measuring CE nationally, in addition to Eurostat publishing data for Sweden. The pathways imply an increased effort of national monitoring, and it is important to address that increased monitoring and a higher number of indicators do not necessarily lead to more decisions or actions for a CE. Despite this, the examined countries have national indicator frameworks where they report data nationally. Whether this actually leads to increased circularity in the country has not been studied, but it demonstrates an ambition to measure and understand the transition towards a CE.

Furthermore, the studied countries have quantitative CE objectives, which show a clear direction for what indicators to prioritise. In contrast, Sweden does not look at CE as its own policy area with specific targets. Instead, Sweden has chosen to focus on broader, higher-level goals that CE helps to achieve, so it is logical that monitoring efforts have focused on these broader goals. However, if Sweden were to adopt quantitative objectives directly for CE, like the other studied

countries, this would support the implementation of a national CE monitoring framework and also influence its development.

Whether or not quantitative targets are in place, indicator selection in Sweden still remains a political choice based on what is seen as most relevant and valuable to monitor. This selection depends on the perspective of what the CE should encompass and focus on. For instance, priorities may differ based on whether the aim is to make monitoring accessible quickly by building on current work and available data, or whether the framework should be as holistic as possible, covering a wider range of CE dimensions. Therefore, three different pathways are presented: continue to monitor the SCB set, expand the SCB set with additional indicators, or develop a new framework. However, it is also possible that elements from each pathway could be combined into alternative approaches forward.

5.5.1 Continue to Monitor the SCB set

One approach is to introduce continuos monitoring of the indicators previously reported by SCB, as presented in Section 4.2.3. Thus far, these indicators have been produced only trough project-based initiatives rather than as part of a continuous monitoring program. With the exception of one, the included indicators in the SCB set are data already reported by Eurostat. Data availability has been identified as a crucial criterion by several of the countries interviewed in this study. In line with this, the SCB set and Eurostat already has established methodologies and available national data. This study has identified benefits with national monitoring of Eurostat indicators, stated in Section 5.1. Statisticians from Finland and Austria provided examples of how national calculations can utilise more experimental and innovative data collection methods, resulting in more detailed and recent data than those published by Eurostat. Furthermore, because of the complexity of the data and the required knowledge to communicate the results, as expressed by the interviewed statistician involved in the development of the SCB set, national monitoring could help with providing the necessary understanding. Implementing this approach however, would require a government mandate and dedicated funding, which are currently lacking. In addition, this would also entail that certain areas of the CE and the transition, as well as national characteristics or priorities, would not be captured, as addressed in Section 5.1.

However, the question arises whether it is sufficient to rely on the indicators calculated and published by Eurostat, rather than reproducing the calculations at the national level. For policymakers, it may be of limited importance whether the indicators are calculated by Eurostat or by national authorities. When utilising the data presented by Eurostat, nations can avoid the costs of making their own calculations. However, since this study did not include policymakers in the interviews, it is difficult to draw conclusions regarding the depth to which policymakers must understand the data and the underlying methodologies for it to be useful for them, and to guide

their actions for a CE. This limitation is discussed further in Section 5.6, and it is identified as an area for future research in Section 5.7. Therefore, using Eurostat's statistics to assess Sweden's CE performance remains an alternative to national CE monitoring.

5.5.2 Expand the SCB set

To address the CE aspects that are not currently covered in the SCB set, another approach is to develop it further by adding complementary indicators. Table 4.19 identifies several indicators from Eurostat, the studied countries, and the UNECE/OECD framework, that could be used. Given the results of the evaluation of the data availability in Sweden for the identified CE indicators in Section 4.5.2, Sweden will most likely need to produce more data than today.

The SCB set was based on the Eurostat indicators, but it does not include all of them, therefore it could be developed by looking into remaining Eurostat indicators, e.g. the indicators from the *Global sustainability and resilience* category. Beyond the Eurostat framework, this study presents additional indicators in this category, see Table 4.19, mainly identified from the Netherlands and Flanders. Another argument for this specific category is that Sweden's goal formulated in their national CE strategy and action plan is to contribute to achieving the national environmental objectives, which this category addresses. The category's primary focus is on environmental indicators such as impact footprints.

Another aspect not covered by the SCB set is the transition process itself, as well as strategic and social aspects. These are areas that the literature identifies as frequently neglected in CE monitoring as well. The study has identified Belgium and the Netherlands to have several unique indicators capturing these complementary aspects, such as implemented policy instruments supporting the transition, scientific publications, public awareness, and education and knowledge development.

5.5.3 Develop a New Framework

Lastly, Sweden could develop a CE monitoring framework of its own. The main advantage of this approach is that the framework could be tailored specifically to the country's conditions and priorities. This could thereby include indicators that reflect industries and value chains that are particularly important to the Swedish economy, as well as indicators that monitor environmental impacts on natural resources, ecosystems, and geographic characteristics that are of significance to Sweden.

The selection of indicators for this framework could be based on the results of a survey similar to the one produced in this study. In addition to the Delegation for Circular Economy, other national stakeholders, including policymakers, researchers and experts, and industry actors, could be given the opportunity to provide expertise and contribute to the selection of the

national CE indicators. The highest-rated indicators from the Delegation, presented in Table 4.23, could serve as a potential starting point. This suggestion primarily focuses on the measurement of CE on material and waste flows, though a few metrics for environmental impacts and the transition are still included. However, social and economic indicators are not included in this selection. Data is available for about half of the indicators in Sweden currently, meaning that implementing this suggestion would require further development of Swedish statistics and raw data collection.

Another starting point to create an indicator set without excessive effort can be to look into the most frequently used indicators by the countries explored in this study, see Table 4.20. Due to them being most common, they could be considered important when measuring the CE. The majority of these indicators already have available data in Sweden.

Since data availability has been identified as a crucial criterion for developing a national CE monitoring framework, another alternative for the selection could be to solely look into the indicators with available data in Sweden today (green and yellow-marked in Table 4.19). This approach utilises data that are already measured under other obligations but that are suitable for understanding CE, combining it into a CE context accessible in one place. The data availability in Sweden is greater for the first three categories: *Production and consumption*, *Waste management*, and *Secondary raw materials*, see Table 4.19. Most of these indicators reflect the lower-level R-strategies, such as waste generation in multiple categories, recycling rates for different materials and waste streams, and waste that is imported, exported, or incinerated. Additionally, none of the unique indicators reflecting the strategic and societal aspects of the transition in the *Others* category have known data availability, highlighting a potential gap. Determining whether relevant national data exist would require consultation with agencies beyond SCB, nevertheless, it is likely that these indicators are not currently measured in Sweden. Therefore, solely selecting indicators with available data will not fully represent the multiple dimensions of the CE, and further developed data collection methods would therefore be required.

The DPSIR and RACER frameworks, developed by the EU, have been used by Germany and Belgium when developing their CE monitoring frameworks. Other identified frameworks are MIS, used in the Netherlands, and NPSIR, used in Belgium. Therefore, another approach for Sweden could be to apply one or several of these identified methods to construct an indicator set specifically for Sweden's characteristics. In addition, the UNECE/OECD framework provide generalised guidelines for implementing a CE monitoring framework at a national level, which is why another suggestion is for Sweden to proceed from this, when the final version is published.

5.6 Limitations of the Study

In this study, the primary data sources were national documents, such as CE strategies and monitoring reports, and information from official public websites. Some information was only available in the countries' native languages, and not in English. Consequently, these documents and websites were translated using Google Translate or Google Gemini 3.5 Flash (see details in Appendix A.4), which may have influenced the understanding and interpretation of the content.

Another limitation of the study is the low response rate to the questionnaire. Even though a response rate of 27% is not uncommon for a questionnaire, in this study, it means that only 3 responses (plus one from the Secretariat) were received. Due to the small number of respondents, the results cannot be considered representative of the Delegation's overall interests and priorities. Further, two respondents expressed difficulties in prioritising the indicators and regarding the understanding of some of the questions.

Regarding data availability, the status could not be determined for many of the identified indicators, see Table 4.19. One reason for this difficulty is that the indicator descriptions are sometimes limited or unclear, making it uncertain what the indicator actually includes or how it is measured. This might have influenced the results, potentially leading to more grey-marked indicators than there would have been if more detailed information were available.

Another methodological limitation in the questionnaire was that *Resource productivity, DMI/DMC, and DMC substitution* were grouped into a single question. This was a drawback because they are quite different, especially since *Resource productivity* is a commonly used indicator that should have been rated on its own, whereas the other two were identified as unique indicators used by only a single country. This issue became clear because two respondents left the question blank.

Further, a limitation is the different roles of the national stakeholders interviewed in this study. The interviewees represent different agencies and organisations and have different roles, including researchers ($\approx 43\%$), statisticians ($\approx 28.5\%$), and ministry officials ($\approx 28.5\%$). Their specific roles naturally influence their answers to the interview questions, particularly their perspectives on their perceived gaps and challenges with the national monitoring system. For example, the statisticians detailed specific data challenges, while the ministry officials highlighted the policy perspective, having less direct involvement with the data itself. Only one person was interviewed per country, with the exception of Finland, meaning that all roles were not interviewed for every country. This was due to the methodological choice of contacting the responsible agency for the national CE strategy and them referring the request to an available person that they considered suitable to participate. Therefore, the professional role of each person interviewed likely shaped how that specific country's gaps and challenges are presented in

this study.

Lastly, the assessment of the indicators' data availability in Sweden can be considered a limitation of the study, as it is based on an evaluation conducted by a statistician at SCB rather than by the authors themselves. Given that SCB is Sweden's national statistical agency and was responsible for previous CE monitoring initiatives, the assessment is a relevant and credible source of information. Nevertheless, the authors were not directly involved in the evaluation process and were therefore unable to verify the assessment, which may affect the transparency and reproducibility of the results.

5.7 Future Research

Several of the identified CE indicators in this study were marked by Statistics Sweden (SCB) to have an unclear status regarding the data availability in Sweden. The assumption that these indicators are likely not monitored in Sweden was therefore made. In future research, the data availability of these indicators could be investigated further through consulting with additional Swedish agencies with data collection responsibilities.

While this study was conducted, the draft of *UNECE/OECD Guidelines for measuring circular economy: Part B*, was published. The final version is expected later in 2026. This comprehensive international collaboration has detail and practical guidelines to produce indicators to monitor CE on a national level, and is certainly useful to be studied further in relation to the Swedish context. Since this framework strongly focus on harmonisation with already existing statistical reporting, this might help to overcome some of the shortcomings that have been identified in this report.

In addition, the European Environment Agency (EEA) has developed a monitoring framework called the *Circularity Metrics Lab* (CML), using European datasets, national statistics, surveys, and novel dataflows to assess the progress towards a circular economy for the whole of Europe (EEA, n.d.). The framework includes over 65 macro-level CE indicators distributed across several categories. This framework was excluded in this study due to time constraints, the fact that the framework has not been adopted at a national level, and because none of the studied countries reported using it. Future research could therefore explore these indicators further and investigate the possibility of using them at the national level.

Since it has been concluded that mostly lower R-strategies are targeted by existing indicators, this emphasises the need for more research into CE indicators and how statistics for higher-level R-strategies could be developed. This includes researching how to assess strategies like refuse, rethink, and reduce. The difficulty with this lies in measuring things that do not happen, for example when someone avoids a purchase and borrows something instead. One question

to investigate further could be whether the data from what *is* being done can indirectly imply and explain what is being avoided, and if this is sufficient. How to measure higher R-strategies was not addressed in the articles from the literature review, it was rather stated as an existing gap. However, Vulsteke et al. (2026) discussed how to measure longevity and maintenance of quality, which could touch on higher R-strategies, although this was done at a material, product, and component level.

Another area for future research is to evaluate how policymakers utilise CE indicators in their decisions. This study has focused on which indicators that are used internationally, but not how they are or could be used in a political context, neither in Sweden nor internationally. However, this study has concluded that more indicators does not constitute more circular decisions, which highlights the importance of also evaluating how these identified indicators are presented and used by the national policymakers. This study identified that the Netherlands and Belgium utilise a high number of indicators, specifically in areas not covered in the Eurostat framework or the other studied countries. Therefore, it would be valuable to examine these two nations more closely to understand how their indicators inform policymaking, and whether these additional areas contribute to this work.

Finally, it would be interesting to conduct further research on what the indicators actually show and what values and trends they present for the countries. This is also important for understanding how they can be used and how they relate to circularity performance. It is especially important since indicators will likely show different trends, where some are positive and some are negative, which affects decision-making regarding how to prioritise between different results.

6

Conclusion

Sweden has a material consumption of 25 tonnes per person and year. This equals the consumption of four Earths if the global population consumed in the same way. A national transition to a circular economy has the potential to significantly reduce this number through decoupling resource use and environmental impacts from socioeconomic welfare. The Delegation for Circular Economy emphasises the need for a national monitoring framework consisting of CE indicators measuring the transition towards a circular economy in Sweden. This thesis aimed to identify, map, and analyse macro-level CE indicators that could contribute to Sweden's CE monitoring.

Through a literature review, review of documents, interviews, and mapping and evaluation of identified CE indicators, the following research questions were addressed: (i) *How is the circular economy monitored in Sweden?*, (ii) *How is the circular economy monitored internationally?*, and (iii) *Which indicators from international circular economy monitoring frameworks could Sweden consider for national monitoring?*. This study has examined the CE strategies and monitoring of the Netherlands, Finland, Germany, Austria, and Flanders and Wallonia in Belgium. Multilateral monitoring frameworks considered include Eurostat and the UNECE/OECD framework.

Overall, it can be concluded that there is no single method for selecting indicators to measure a nation's transition to a circular economy. Nevertheless, examples from other countries provide various approaches for how Sweden might proceed with the next steps of its own monitoring framework. Currently, Sweden has a national CE strategy and action plan from 2020 and 2021, respectively, including the goal that CE should contribute to achieving the national environmental objectives and the SDGs. No quantitative goals or CE indicators are included in the strategy nor the action plan, and no follow-up report has been published. However, Statistics Sweden (SCB) has conducted two project-based CE monitoring initiatives for the period 2020-2023 and in 2025, presenting national data on several of the Eurostat indicators. Currently, there are no national commissions or financing for SCB to continuously update or expand the CE monitoring in Sweden.

The examined countries demonstrate varying levels of ambition in CE monitoring compared with Sweden. All of the studied countries either have a recently updated national CE strategy with quantitative objectives and additional indicators, or a comprehensive CE monitoring framework. The mapping presented multiple CE areas and indicators beyond what Sweden has previously reported on. Belgium and the Netherlands showed extensive work with CE monitoring, presenting a high number of unique indicators. These included indicators monitoring the transition reflecting strategic and societal progress, e.g. policy instruments implemented, companies with CE practises, openness and awareness, and education. In addition, they monitor the environmental impact and contribution of the CE through indicators measuring emissions and footprints. Currently, with a few exceptions, CE indicators from Germany, Austria, and Finland do not go beyond the Eurostat framework. However, both Germany and Austria are engaged in actively developing their monitoring systems, with the presentation of new frameworks anticipated in the near future.

The most effective indicators depend on how CE is defined and which strategic goals the indicators are aimed at monitoring. If Sweden were to adopt quantitative objectives directly for CE, like the other studied countries, this could support the implementation of a national CE monitoring framework and also influence its development. The results of the study show that the most common approach among the examined countries is to establish three to four targets, each including one CE indicator, complemented by a broader set of supporting indicators. However, as Flanders demonstrates, a monitoring framework can still be implemented regardless of whether a CE strategy is in place. National monitoring demonstrates an ambition to measure and understand the transition towards a CE, however, comprehensive monitoring and a high number of indicators do not imply that more decisions or actions are implemented for a CE.

The study identifies three potential pathways for the development of a Swedish CE monitoring framework. The first pathway suggests the introduction of continuous national monitoring of the indicators that SCB has previously reported on in its projects. This alternative builds on existing statistical structures and ensures high data availability. However, it risks leaving several areas of the CE and the transition unmonitored. The second pathway extends the current SCB set by incorporating additional complementary indicators identified from the studied countries and the multilateral frameworks. This expansion could improve the coverage of environmental impacts, strategic transition aspects, and the social dimension, however it would require increased data collection measures.

The third pathway suggests the development of a new national CE monitoring framework, tailored specifically for Swedish conditions and priorities. This could capture more context-specific aspects than Eurostat, through including indicators monitoring e.g. key national industries, value chains, and environmental characteristics. Similar to the second pathway, this approach would require substantial development of new data collection systems and increased

statistical capacity. Sweden could also apply established methodologies and frameworks, such as DPSIR, RACER, MIS, NPSIR or the upcoming UNECE/OECD framework, to develop a national monitoring system. Across all pathways, indicator selection is a political and strategic choice, influenced by data availability, policy priorities, and differing interpretations of what the CE should encompass. In addition, combining elements from the three pathways may also represent a viable way forward for Sweden.

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A

Appendix

A.1 Interview Guide

Table A.1: Interview guide used for the semi-structured interviews with the national stakeholders from the studied countries.

Interview Guide
Briefly introduce the study, its objectives, and how the interview will be structured and used in the report.
Introductory question
Could you briefly introduce yourself and describe your role in relation to circular economy work and/or indicator development?
Theme 1: Indicator framework in practice
Do our identified CE indicators accurately represent the indicators used by your organization?
How was the CI measurement framework developed? • What criteria were used to select the indicators? • Are the indicators connected to specific policy goals or national strategies?
Which organizations or actors are responsible for producing and maintaining the data? Do the monitoring requirements originate from a specific directive from an authority?
Are the CE indicators mainly based on primary data collected specifically for this purpose, or on existing secondary statistical data? Did the development of the framework require new methods for data collection or indicator calculation?
Is there an ongoing process to further develop or expand the CI framework?
Theme 2: Opportunities and limitations
Do you see any research or measurement gaps within the framework? Which indicators or areas of CE do you think are missing from the framework?
Ending open question
Is there anything else you would like to add that we have not discussed but that you think is relevant for understanding the monitoring of CE in your country?

A.2 Mapping: Clarifications

Table A.2: Clarifications of the detailed changes of the identified indicators' names to standardised terminology used in the mapping.

Country/Framework	Original Indicator Name	Mapping Name
General	Raw Material Consumption	Material Footprint (Eurostat terminology)
	Turnover or Added Value indicators	Gross value added
The Netherlands	Value added of the circular economy	Gross value added
	Use and impact of circular public procurement	Green public procurement
	GHG footprints in the Netherlands	Carbon footprint of consumption and/or production
	National CO_2 emissions	National territorial GHG emissions
Germany	Global environmental footprint of consumption	Carbon footprint of consumption and/or production
	Waste generation in municipal waste category	Generation of municipal waste
Finland	Turnover of circular economy sectors and number of enterprises	Gross value added; Companies with circular practices
	Innovative public procurement	Green public procurement
	Municipal, packaging and construction waste and recycling rate	Construction waste; Generation of municipal waste; Generation of packaging waste; Recycling rate of construction waste; Recycling rate of municipal waste; Recycling rate of overall packaging
Austria	Material consumption in private households	Generation of municipal waste
Flanders	Water consumption	National water footprint
	Household waste recycling	Recycling rate of household waste
	Reuse indicator	Reused goods
	Repair indicator	Repaired goods
	Territorial emissions	National territorial GHG emissions
	Land use	National land footprint
	Material productivity	Resource productivity

Continued on next page

Table A.2 – continued from previous page

Country/Framework	Original Indicator Name	Final Mapping Name
	Employment in the circular economy	Persons employed
	Turnover in the circular economy	Gross value added
	Turnover of approved reuse centres	Gross value added
	Turnover of repair organisations	Gross value added
	Number of repair organisations	Companies with circular practices
	Employment in repair organisations	Persons employed
Wallonia	Supported organizations in CE	Non-financial support for organisations in CE
	Companies in CE	Financially supported companies in CE
	Employment in CE	Persons employed
	CE public procurement	Green public procurement
	Involved organisations	Organisations involved in implementation of national CE strategy
UNECE/OECD	National recycling rate	Recycling rate of all wastes excl. major mineral waste
	Business investments in CE activities	Private investments

A.3 Data Availability: Excel sheet

Attached below is the Excel sheet (in Swedish) provided by Emma Snölilja at Statistics Sweden (SCB). It details data availability for the identified indicators in Sweden, including where existing data can be found and web links to the relevant statistics.

Circular Economy Indicator	Data tillgänglighet	Var?	Länk till statistiken
Material Footprint / Raw material consumption (RMC)	1. Det finns data	SCB, Materialflödesräkenskaper, ligger under miljöräkenskaper	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/miljoekonomi-och-hallbar-utveckling/miljorakenskaper/
Resource Productivity [GDP/(DMC or RMI or DMI or RMC)]	1. Det finns data	SCB, Materialflödesräkenskaper, ligger under miljöräkenskaper	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/miljoekonomi-och-hallbar-utveckling/miljorakenskaper/
Green public procurement	4. Kan inte uttala oss om indikatorn	Vet inte om data finns.	
Total waste generation per capita	1. Det finns data	Naturvårdsverket	
Generation of waste excl. major mineral wastes per GDP unit	1. Det finns data	Naturvårdsverket	
Generation of municipal waste per capita	1. Det finns data	Naturvårdsverket	
Food waste	1. Det finns data	Naturvårdsverket	
Generation of packaging waste per capita	2. Det finns data men den är inte publik	Naturvårdsverket och SCB	
Generation of plastic packaging waste per capita	2. Det finns data men den är inte publik	Naturvårdsverket och SCB	
Domestic material consumption (DMC)	1. Det finns data	SCB, Materialflödesräkenskaper, ligger under miljöräkenskaper	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Raw material input (RMI)	2. Det finns data men den är inte publik	Finns data till fram till 2022	
Direct material input (DMI)	1. Det finns data	SCB, Materialflödesräkenskaper, ligger under miljöräkenskaper	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/miljoekonomi-och-hallbar-utveckling/miljorakenskaper/
Production of household waste	1. Det finns data	SCB i statistikdatabasen (SSD) Naturvårdsverket är ansvariga	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Production of residual household waste	4. Kan inte uttala oss om indikatorn	Har ingen data om det här	
Production of primary industrial waste	1. Det finns data	SCB: statistikdatabasen (Naturvårdsverket ansvariga)	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Production of primary industrial residual waste	4. Kan inte uttala oss om indikatorn	Osäkra, se fliken "pri. Industrial residual waste" för mer info.	
Generation of E-waste	1. Det finns data	Naturvårdsverket och SCB	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-elutrustning-och-batterier/
DMC substitution	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Construction waste	1. Det finns data	SCB, SSD, Finns delvis mängd för byggsektorn men inte byggavfall. Kan ev. gå att få fram återvinningsgraden men finns risk för undertryckning). Byggsektor finns särredovisad, ej byggavfall. Finns även vissa data på Naturvårdsverket	
Recycling rate of municipal waste	1. Det finns data	Naturvårdsverket	
Recycling rate of all wastes excl. major mineral waste	1. Det finns data	Naturvårdsverket	
Recycling rate of overall packaging	1. Det finns data	Naturvårdsverket	
Recycling rate of plastic packaging	1. Det finns data	Naturvårdsverket	
Recycling rate of WEEE separately collected	1. Det finns data	SCB och Naturvårdsverket	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-elutrustning-och-batterier/
Recycling rate for aggregates	1. Det finns data	Lite osäker här eventuellt kan man ta fram något liknande från statistikdatabasen (SCB) där uppgifter finns för olika branscher.	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Recycling rate of construction waste	1. Det finns data	Naturvårdsverket, osäker på om det finns uppdaterad data.	
Recycling rate of household waste	2. Det finns data men den är inte publik	SCB i statistikdatabasen (Naturvårdsverket ansvariga). Finns mängd, återvinningsgraden är inte framräknad men går att räkna fram. (Finns risk för undertryckning/sekretess som gör att det inte är möjligt att räkna fram).	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Incinerated, co-incinerated & landfill waste	1. Det finns data	SCB i statistikdatabasen (Naturvårdsverket ansvariga). Finns uppdelat på kategorierna: förbränning med energiåtervinning, förbränning utan energiåtervinning och deponering. Finns dock en osäkerhet på vad som menas här om det ev. ingår något som vi inte redovisar eller tvärtom.	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Waste incineration	1. Det finns data	SCB i statistikdatabasen (Naturvårdsverket ansvariga).	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Waste going to final disposal	1. Det finns data	SCB i statistikdatabasen (Naturvårdsverket ansvariga). Allt som publiceras är "final disposal"/slutdeponering.	https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/avfall/avfall-uppkommet-och-behandlat/
Littering and fly-tipping cleaned up	4. Kan inte uttala oss om indikatorn	Det här finns hos Naturvårdsverket, kan även finnas på håll Sverige rent	https://www.naturvardsverket.se/data-och-statistik/avfall/nationell-skrapmatning/
Vehicle recovery rate	1. Det finns data	SCB, SSD (data från Transportstyrelsen)	
Repaired goods	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Reused goods	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Circular material use rate (CMUR)	1. Det finns data	Naturvårdsverket/SCB	
End-of-life recycling input rates aluminium	3. Mäts inte idag	Tror inte det finns data	
Imports from non-EU countries	1. Det finns data	Naturvårdsverket - tror det är den här statistiken ni är intresserad av	https://www.naturvardsverket.se/data-och-statistik/avfall/avfall-import-export/
Exports to non-EU countries	1. Det finns data	Naturvårdsverket - tror det är den här statistiken ni är intresserad av	https://www.naturvardsverket.se/data-och-statistik/avfall/avfall-import-export/
Intra EU trade	1. Det finns data	Naturvårdsverket - tror det är den här statistiken ni är intresserad av	https://www.naturvardsverket.se/data-och-statistik/avfall/avfall-import-export/
Production of secondary raw materials	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Share of industrial waste getting a second life	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
DIERec	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	

Circular Economy Indicator	Data tillgänglighet	Var?	Länk till statistiken
Private investments	1. Det finns data	SCB, Företagens ekonomi	https://www.scb.se/hitta-statistik/statistik-efter-amne/naringsverksamhet-och-utrikeshandel/foretagens-produktion-forsaljning-och-ekonomi/foretagens-ekonomi/
Persons employed	1. Det finns data	SCB, Företagens ekonomi	https://www.scb.se/hitta-statistik/statistik-efter-amne/naringsverksamhet-och-utrikeshandel/foretagens-produktion-forsaljning-och-ekonomi/foretagens-ekonomi/
Gross value added/Turnover from CE sectors	1. Det finns data	SCB, Företagens ekonomi	https://www.scb.se/hitta-statistik/statistik-efter-amne/naringsverksamhet-och-utrikeshandel/foretagens-produktion-forsaljning-och-ekonomi/foretagens-ekonomi/
Patents related to waste management and recycling	2. Det finns data men den är inte publik	Ska finnas data men ska vara komplicerad och främst tidskrävande att ta fram.	
CE budget	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Government and business R&D expenditure on CE-technologies	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Investment in waste management infrastructure, waste collection and sorting	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Business investments in CE activities	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Financial resources for supporting circular activities / Financially supported companies in CE	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Companies with circular practices	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Non-financial support for organisations in CE	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Organisations involved in implementation of national CE strategy	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Eco-innovations	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Consumption footprint	3. Mäts inte idag	Misstänker att vi kan ta fram den här datan men inget vi har idag.	
GHG emissions from production activities	1. Det finns data	SCB: finns under rubriken "utsläpp till luft"	https://www.scb.se/mi1301
Material import dependency	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
EU self-sufficiency for raw materials, aluminium	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
National territorial GHG emissions	1. Det finns data	Naturvårdsverket	https://www.naturvardsverket.se/data-och-statistik/klimat/sveriges-utslapp-och-upptag-av-vaxthusgaser/
Carbon footprint of consumption	1. Det finns data	SCB - miljöpåverkan från konsumtion	https://www.scb.se/mi1301
Security of supply	4. Kan inte uttala oss om indikatorn	Har inte data	
Pollutant discharges from material extraction and processing to water	3. Mäts inte idag	SCB delvis. Det finns branchindelade utsläpp av vissa föroreningar (P, N, COD), men för andelen renat industriellt vatten är det oklart om det finns	https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0106/MI0106T06/
Soil contamination and remediation	3. Mäts inte idag	Data över förorenade områden finns, men osäkert om det finns statistk över åtgärder.	https://www.naturvardsverket.se/data-och-statistik/fororenade-omraden/fororenade-omraden/
Intensity of use of fresh water resources	1. Det finns data	SCB publicerar data över totalt årligt vattenuttag. Dividera detta med uppgifter om total förnybara vattenresurser från annat håll (SGU?). Men FN/Aquastat publicerar uppgifter om "water stress" som bör motsvara indikatorn.	https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0902__MI0902D/VattenUttag/ https://data.apps.fao.org/aquastat/?lang=en
National water footprint	4. Kan inte uttala oss om indikatorn	svårigheter med indata	
National land footprint	4. Kan inte uttala oss om indikatorn	svårigheter med indata	
National biodiversity footprint	4. Kan inte uttala oss om indikatorn	svårigheter med indata	
Policy instruments for stimulating CE market formations	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Policy instruments and measures in the CE programs	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Policy instruments for knowledge development by companies	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Sankey of national material flows	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Scientific publications on the CE	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Consumer openness and circular behavior and associated environmental benefits	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Circular economy barometer	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
CE mechanisms	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
CE tools	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
CE awareness	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
Increased knowledge	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	
CE education and training	4. Kan inte uttala oss om indikatorn	Vet inte om data finns	

Pri. Industrial residual waste

Här är vi osäkra men det är möjligt att ”Primary industrial residual waste”: överensstämmer med avfallsslaget EWC 10.2 – *Mixed and undifferentiated materials* som rapporterats i industribranscher, som finns i WStatR (ASP).

Listan på tillhörande LoW-koder finns i appendix till avfallsstatistikförordningen, här:

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En sammanfattad definition finns i manualen:

Mixed and undifferentiated materials (10.2): items 35/36. These are unspecified and mixed waste without any general waste source. This category covers not only mixed packaging, but also mainly residual categories from different branches of industry (food production, textile industry, combustion plants, surface treatment of metals and plastics, etc.). These residual categories are often used for nation-specific waste codes. Mixed and undifferentiated materials are hazardous when containing heavy metals or organic pollutants.

Men de kan även mena EWC 10.1 *household and similar wastes* som rapporterats i industribranscher. Från manualen:

Household and similar wastes (10.1): item 34. These wastes are mixed municipal waste, bulky waste, street cleaning waste like packaging, kitchen waste, household equipment except separately collected fractions. They originate mainly from households ***but can also be generated by all economic activities*** *in canteens and offices as consumption residues. Household and similar wastes are non-hazardous.*

A.4 Usage of AI

AI tools were used for two purposes in this thesis. First, they were used to translate documents, or parts of documents, that were not available in English or Swedish. For this, Google Translate or Google Gemini was used. This was necessary to be able to include the documents as a source of information, however, the interpretation of the documents may have been affected by this translation. Second, Google Gemini and ChatGPT were used to polish text and formulations written by the authors. This was done to improve grammar and language flow, but no content was generated by the AI. More specifically, Google Gemini 3.5 Flash and ChatGPT version 5.5 were used for this.

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