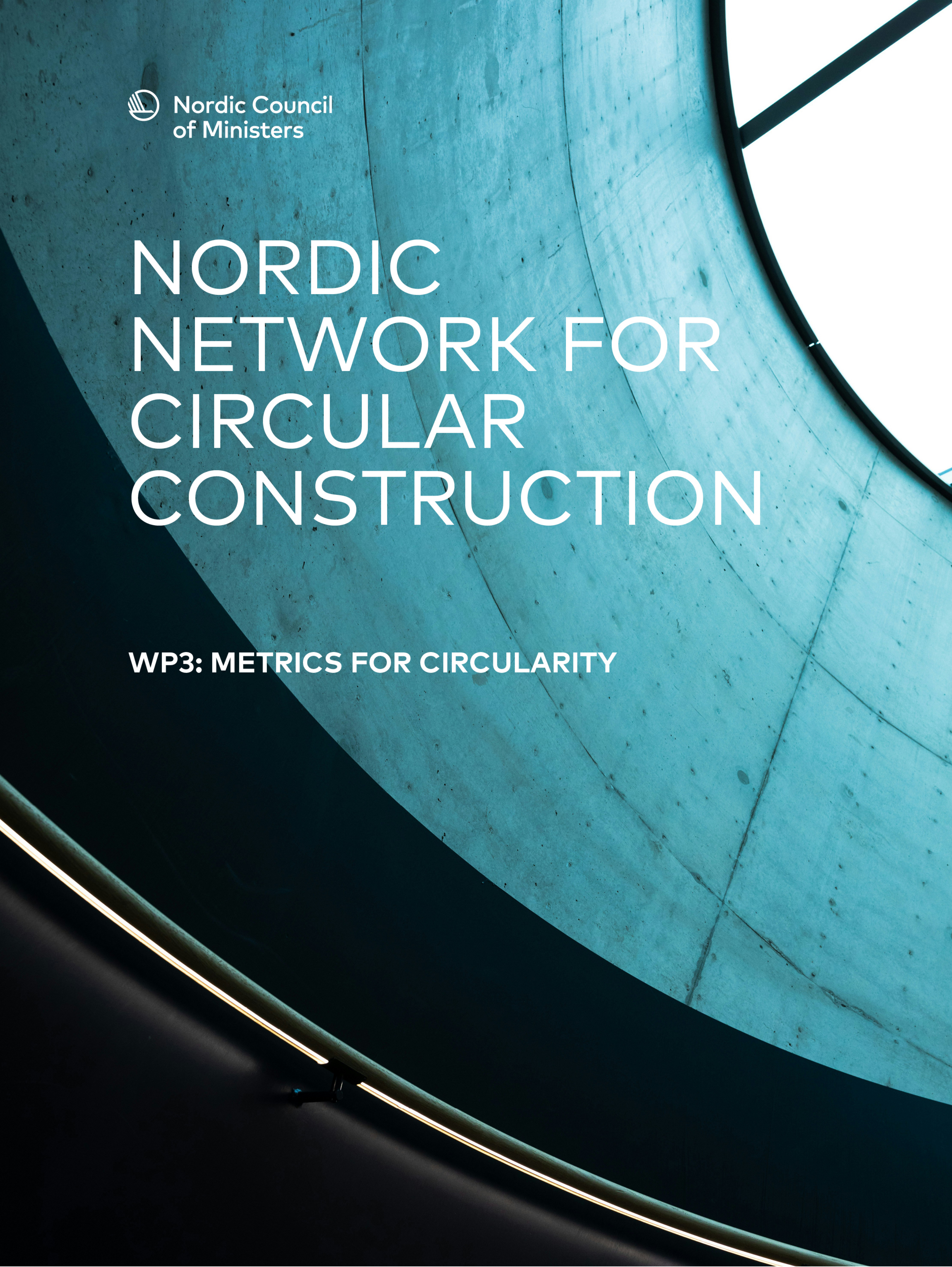

Nordic Council of Ministers

NORDIC NETWORK FOR CIRCULAR CONSTRUCTION

WP3: METRICS FOR CIRCULARITY

CONTENTS

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PREFACE

This report is developed under the Nordic Networks for Circular Construction (NNCC) programme, aiming to accelerate the implementation of the best circular economy practices in the Nordic construction sector. The programme contributes to the Nordic Vision 2030 of becoming the leading region in sustainable and competitive construction and housing with minimised environmental and climate impact. It aims to accelerate circular construction in the Nordic countries through collaboration, peer-to-peer learning and standard metrics. Deliveries include analysing the state of circularity of the Nordic sector, building new networks, defining the Nordic construction culture in relation to the New European Bauhaus, disseminating best practices, and influencing European collaboration. The programme runs from 2023-2025 and consists of the following focus areas:

- WORK PACKAGE 2: Barriers and opportunities
- WORK PACKAGE 3: Measuring progress
- WORK PACKAGE 4: Cultural change
- WORK PACKAGE 5: Dissemination
- WORK PACKAGE 6: National fora for circular construction
- WORK PACKAGE 7: Study on Green Public Procurement as a lever for circular economy

This report concludes Work Package 3, which specifically aims to establish a common Nordic framework for monitoring circularity in construction.

Norion Consult carried out the project with partners from NORSUS, Ethica, Chalmers University, and TRE Rådgivende Ingeniører og Biologer. The Finnish Ministry of Environment supervised the project and ensured compatibility with the overall programme. Finally, indispensable input and feedback were received through interviews and workshops from approximately 100 sector experts.

Bjørn Bauer, Norion – Project Director
Simon Claësson Kaarsgaard, Norion – Project Manager
Leonardo Rosado, Chalmers University
Tuuli Kassi, Ethica
Maria Ekblad, TRE
Regina Skattenborg, Norsus

For more information on Nordic Networks for Circular Construction, visit our website here: https://nordiccircularconstruction.com/

SUMMARY

The project aims at developing a joint Nordic monitoring framework for circular construction.

Implementing new indicators for circular construction involves a multifaceted challenge encompassing academic, political, and technical dimensions. This complexity may be a critical reason that macro indicators on circularity are often limited to simplified metrics such as recycling rates. The consequence is that most policy targets are likewise limited to the same simplified metrics; more ambitious policy targets lack from not being monitored.

The academic challenge is that available definitions of circularity are so broad that they define everything and nothing at once, much like sustainability. The political challenge is that new metrics may prove advantageous for society while concurrently posing challenges for specific groups. Finally, the technical challenge is collecting and ensuring high-quality data across national borders.

Findings from screening potential indicators, a systematic literature study of the impact of circularity strategies, a Nordic policy review, and stakeholder engagement activities have suggested eleven new voluntary indicators to measure circularity in the Nordic building sector. These cover a range of circularity strategies, time dimensions, and lifecycle stages. When evaluating them with the EU RACER criteria, they all receive a fairly robust score (around 4-6 points out of a maximum of 7 points).

Each indicator is elaborated in individual sections. Here, valuable metrics are suggested, and considerations for harmonising the monitoring approach across the Nordics are proposed. Existing data sources are also pointed out, and their limitations are discussed.

In the final section of the report, a Nordic draft implementation strategy is proposed to determine the steps required to reach the overall objectives with a new monitoring framework, being that *"the Nordic countries utilise a joint monitoring model for circular construction, enabling harmonised and periodic benchmarking of progress against national policy targets"*. Key strategy activities include establishing a Nordic Steering group and proposing a 5-year interval roadmap with benchmark values for each indicator proposed. Overall, the strategy activities suggest improved monitoring of the sector's ability to preserve the function of existing building stock. Finally, it is suggested that circularity scores from building certification schemes be utilised as critical proxies and that the required criteria and minimum weightings of the circularity criteria be introduced to building certification schemes and upcoming standards.

TABLE 1. THE SUGGESTED NEW VOLUNTARY INDICATORS FOR CIRCULAR CONSTRUCTION IN THE NORDICS

Shortlisted indicator	RACER score (0-7)	Life cycle stage	Circularity strategy	Implementat scale	Time dimension
1. Utilisation rate of existing building stock	4,88	Use: B1-B5	Preservation of function	Meso	Process
2. Total renovations vs demolition and new buildings	4,98	Construction: A4-A5 Use: B1-B5	Preservation of function Preservation of building Preservation of materials	Macro	Outcome
3. Circularity properties of buildings and rehabilitation projects	4,02	Construction: A4-A5 Use: B1-B5	Preservation of function Preservation of building Preservation of materials	Micro	Outcome
4. Land use change	4,76	Construction: A4-A5 Use: B1-B5	Preservation of function	Macro	Outcome Impact
5. Number of EPDs with "circular" properties"	5,06	Product: A1-A3	Preservation of component	Macro	Process Output
6. Share of certified building projects	4,44	Construction: A4-A5 Use: B1-B5	Preservation of materials	Macro	Process Output
7. Number of EU Taxonomy-aligned buildings	5,64	Construction: A4-A5	Preservation of component Preservation of materials	Macro	Output Outcome
8. Resource productivity in construction	3,9	Product: A1-A3 Construction: A4-A5 Beyond the system: D	Preservation of function	Macro	Outcome

9. Construction and demolition waste	4,82	End of life: C1-C4	Preservation of materials Embodied energy	Macro	Outcome
10. Recycling rates	4,62	End of life: C1-C4 Beyond the system: D	Preservation of materials	Macro	Outcome
11. Carbon footprint in the construction sector	4,62	Product: A1-A3 Construction: A4-A5 Use: B1-B5 End of life: C1-C4 Beyond the system: D	Preservation of function Preservation of building Preservation of component Preservation of materials Embodied energy	Macro	Outcome Impact

INTRODUCTION

EU and Nordic countries are actively promoting the uptake of a circular economy with the expectation that a circular economy contributes to a regenerative growth model that lowers environmental impacts of carbon emissions, resource use, and land use while providing jobs and economic activity (EC, 2020 & Finnish Government, 2021).

The construction sector is throughout its entire value chain – from extraction, manufacturing, transport, and construction to end of life – responsible for half of all raw material extraction, 40% of energy use, 35% of CO_2 -emissions and 25-30% of all waste produced (One planet network, 2020). A circular transformation offers a pathway to lower carbon emissions and resource use of the sector while limiting the negative environmental impact of construction and demolition waste.

Monitoring the circular performance is critical to accelerating the progress towards a circular construction sector. It can deliver knowledge of challenges, inform how far the Nordic countries are from realising specific circularity targets, and strengthen initiatives. Nevertheless, monitoring the circular transformation of the construction sector is currently dispersed. Moreover, the national Nordic circular economy strategies and monitoring frameworks in the construction sector are diverse in substance and scope (Castell-Rüdenhausen et al., 2021).

The challenge of measuring the circular economy has received much attention in recent years. Various methods have generated indicators and metrics for circular economy strategies beyond reuse, recycling, and recovery. The recognised 10R framework expands the EU waste hierarchy and introduces ten circular strategies within the circular economy umbrella term (EEA 2021).

- Refuse (R0)
- Rethink (R1)
- Reduce (R2)
- Reuse (R3)
- Repair (R4)
- Refurbish (R5)
- Remanufacture (R6)
- Repurpose (R7)
- Recycling (R8)
- Recover energy (R9).

Especially the first eight (R0 R7) strategies can contribute significantly to making the EU more circular, but our study indicates that research, monitoring, and policy targets are currently focusing mainly on R8 and R9. The need for better monitoring of circular construction is widely accepted, but it is not clear how to establish feasible monitoring frameworks that cover the most promising circular strategies. Hence, the project is aiming to respond to three guiding questions.

- What should ideally be monitored in terms of circular construction,
- What do stakeholders find it important to monitor, and
- What can realistically be monitored across the Nordics.

The project design, illustrated in Figure 1, reflects the guiding questions:

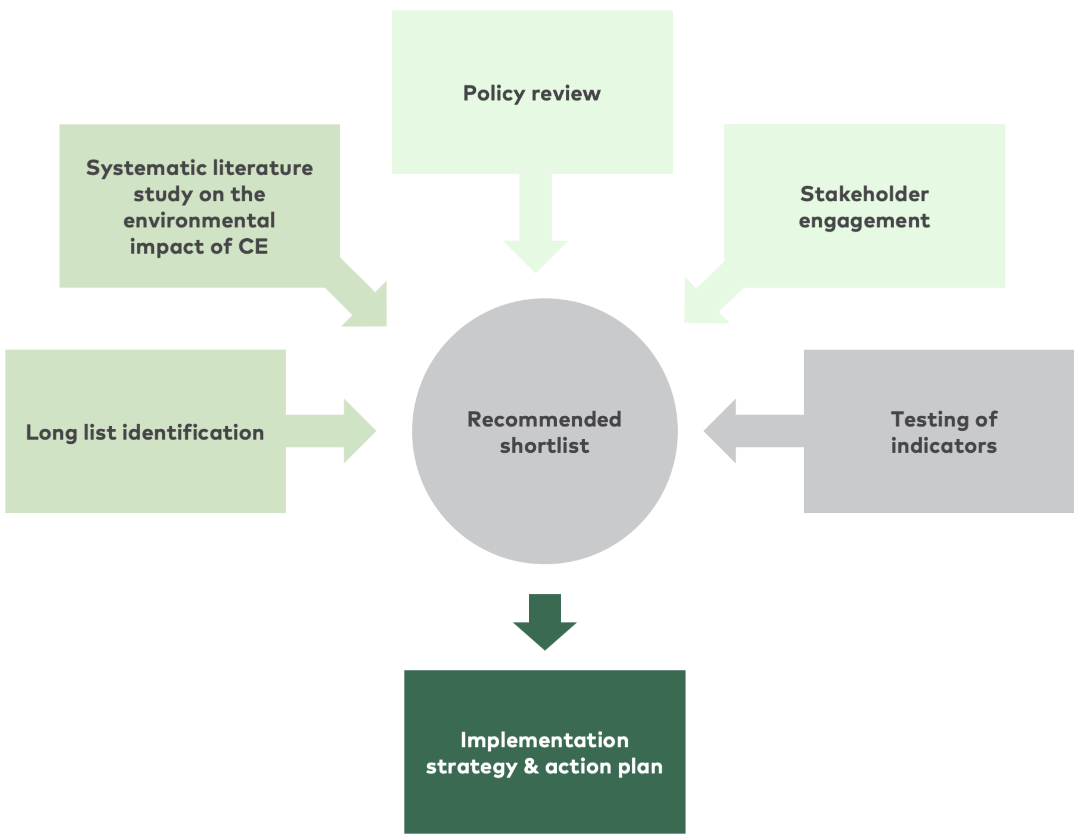


FIGURE 1. THE WP3 PROJECT DESIGN

The WP3 project has delivered the following outputs, which are summarised in the present report.

- A long list of metrics for measuring circular construction (Norion, 2023a).
- An overview of European and Nordic policies, certification schemes and standards for circularity in construction (Norion, 2023b).

- An account of literature and research covering the relationship between the circular economy, biodiversity, ecosystems, and chemicals (Norion, 2023c).
- A shortlist of the most relevant indicators for circular construction (Norion, 2023d) and
- A draft strategy for implementing the new monitoring framework for circular construction in the Nordics (Norion, 2023e).

The report is divided into three main chapters and three annexes:

The first chapter, HOW TO MEASURE CIRCULAR CONSTRUCTION, introduces a classification framework for breaking down 'circular construction' into concrete and measurable data points. Five categorial frameworks are combined to specify which circular economic strategies we are referring to, what time dimensions, which life cycle phases, what level of implementation, and what sustainability dimensions. Next, an overview of how the Nordic policy goals and targets are distributed across circular economic themes is presented. Eighty-six circular construction policy targets are identified and grouped, and the policy focus is compared across the Nordics to establish an overall objective to monitor progress. The chapter also discusses the role of certification schemes in monitoring the circular properties of buildings.

Chapter two, PRIORITISED INDICATORS FOR CIRCULAR CONSTRUCTION, presents the suggested shortlist of eleven prioritised indicators. Each indicator is elaborated, discussing potential metrics, the added value to the Nordics, and existing data points.

Finally, chapter three, DRAFT STRATEGY FOR IMPLEMENTATION OF THE NEW MONITORING FRAMEWORK, suggest an implementation pathway for the prioritised indicators in the Nordics.

Some of the processes that have led to the suggested shortlist are described in the annexes.

Annexe 1, STAKEHOLDER INTERESTS, describes feedback received on the suggested monitoring framework within the project during project workshops and interviews. Annexe 2, LINKAGES BETWEEN CIRCULAR ECONOMY, BIODIVERSITY, ECOSYSTEMS, AND CHEMICALS, explores peer-reviewed literature on the connection between circular construction and its environmental effect. Despite several research gaps, the review highlights some critical trade-offs that policymakers must consider when implementing circular economic strategies. Finally, Annex 3, LONGLIST OF INDICATORS, elaborates on screening literature and existing frameworks for possible indicators and proxies for circular construction. The longlist is also included, although without the classifications of the indicators.

HOW TO MEASURE CIRCULAR CONSTRUCTION

The term 'circular economy' is broad and ambiguous, sometimes used interchangeably with 'sustainability'. The boundaries of circular economy in academic fields have more than 221 suggested definitions (Kirchherr et al., 2022). So, when we discuss circular construction, we must be able to specify *which circular strategies we are talking about, what time dimensions, which life cycle phases, what level of implementation, what sustainability dimensions, etc.*

A classification model for circular construction was developed to help clarify the monitoring model and to ensure a common language during the development of new indicators. The classification framework was also applied to organise indicators, policy documents, and research papers and as a preference framework when clarifying stakeholder interests within the sector. This allowed the project team to understand what aspects of circularity dominate current research, policies, and monitoring frameworks and what the sector would like to understand better moving forward.

The taxonomy presents five overall category frameworks used to categorise each circular construction indicator[1]:

1. The circularity strategies and level of implementation are inspired by Potting et al. (2018) and developed further by Moraga et al. (2019). The lifecycle stages are from DS/EN 15978 (2012). The time dimension categories are inspired by Taplin et al., (2013). Finally, the scope of circularity is inspired by Keeble (1988).

TABLE 2. A TAXONOMY FOR A CIRCULAR CONSTRUCTION MONITORING FRAMEWORK

Category framework	Categories	Examples
Circularity strategies	Preserving the function/service life of the buildings: Refuse (R0); Rethink (R1); Reduce (R2).	Services are, e.g., square meters office space; parking space. These can be preserved for instance through rearrangements and adaptable designs. Rethinking the purpose can reduce the need for demolition and refuse the need to build new.
	Preserving products: Refurbish (R5)	Products are whole buildings or parts of buildings. These can be refurbished.
	Preserving component: Reuse (R3); Repurpose (R7)	Components are building products: Windows frames, doors, whole bricks, prefabricated elements, etc. These can be preserved through reuse, and repurposing (upcycling).
	Preserving materials: Recycle, downcycle (R8)	Materials are, e.g., crushed bricks and concrete and wooden parts for chipboards, and these are mainly recycled (downcycled).
	Preserving embodied energy: Recover (R9)	Embodied energy is, e.g., biogenic carbon in wood materials. The energy is recovered through, e.g., incineration.
Implementation scale	Micro level:	Material or product level/service, organisational level, or building level
	Meso level:	Building complex, cities and regions
	Macro level:	National level
Lifecycle stages	Production phase (A1-A3)	The phase includes: Extraction of raw materials; Transportation to manufacturing; Material production
	Construction phase (A4-A5)	Transportation to construction site; New construction (installation)
	Use phase (B1-B5)	Commissioning; Maintenance; Repair; Replacement; Renovation; Energy consumption for heating and building operation; Water consumption
	End of lifecycle phase (C1-C4)	Demolition; Transportation to waste treatment; Waste treatment, Landfill

	Benefits and loads beyond the building life cycle (D)	Reuse/Recycling and potential for recycling
Time and causal dimension	Process	Processes are activities, e.g., policy responses, workshops, collaborations
	Output	Outputs are the results of processes, e.g., number of workshops.
	Outcome	An outcome may represent a change in a group of people, organizations, or places, such as increased reuse or recycling.
	Impact	Impacts are the long-term effects on environment, society, and the economy.
Scope of circularity	Sensu stricto definition of circular economy: Environmental sustainability	The scope includes ecological metrics
	Sensu latu definition of circular economy: Environmental, Economic & Social sustainability	The scope includes ecological metrics, as well as economic performance, and social equity

MONITORING OF CIRCULARITY WITHIN POLICY FRAMEWORKS

As expressed by the Working Group on Performance Measurement of the Performance Development Network of the EU Agencies (2017) and the Bellagio Circular Economy Monitoring Principles (EEA, 2020), relevant indicators must be closely linked to the objectives. This is especially relevant since policy targets need to be defined with scientific-based facts, and indicators serve as measurable benchmarks for assessing progress towards those targets, enabling comprehensive and meaningful policy evaluation. A well-balanced interplay between policy targets and indicators is essential for crafting quantifiably achievable policies.

Waste-related legislation has been developed in the EU since the 1970s, and several circularity indicators have been developed to substantiate the Waste Framework Directive (CEC, 1975 and EC, 2008). EU policies introduced the concept of resource efficiency in 2011, and in 2015, the Commission approved an action plan to implement a circular economy in the Member States (EC, 2011 and EC, 2015a). In 2018, the European Commission proposed a monitoring framework for circular economies. More recently, the EU initiative Level(s) has been introduced as the new European framework for sustainable construction, with 4 of its 16 sustainability indicators focusing on circularity (EC, 2022b). Other EU metrics related to the circular economy across sectors include Resource Efficiency and Raw Material Scoreboards (EC, 2021).

Macro indicators derived from EU policies monitor circularity in the construction sector, often closely related to minimum criteria and targets to be achieved by each Member state. For instance, the Waste Framework Directive requires that at least 70% of non-hazardous construction and demolition waste by weight be prepared for re-use, recycling, and other material in each Member State by 2020.

NORDIC POLICY TARGETS FOR CIRCULAR CONSTRUCTION

An investigation of Nordic policies has revealed that circular construction is a theme of 86 policy goals and targets from the five big Nordic countries, distributed between circular themes, as shown in the figure below.

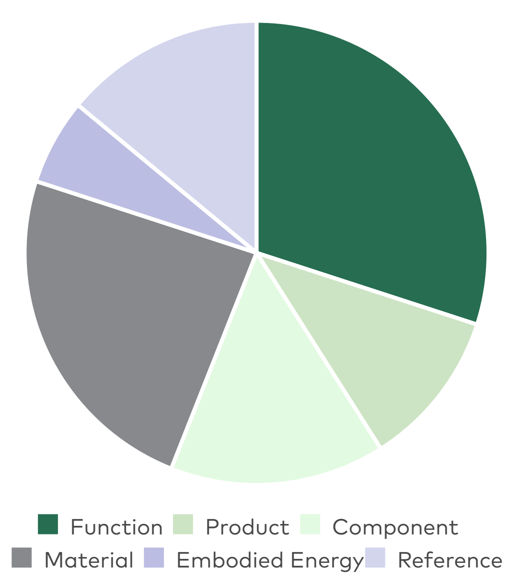


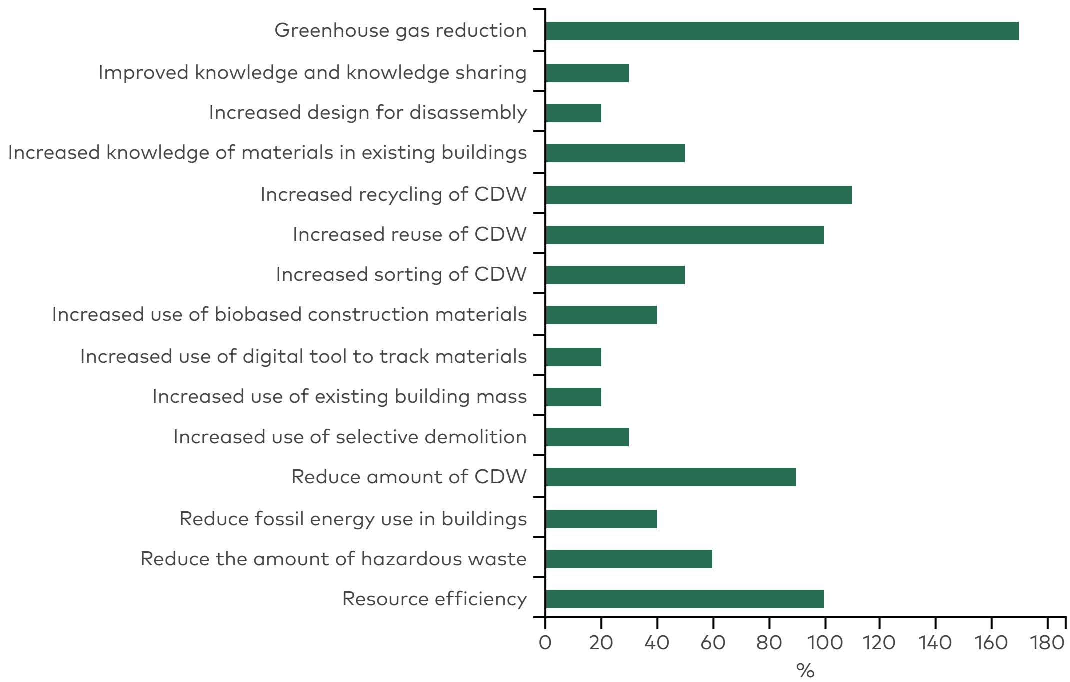
FIGURE 2. THE DISTRIBUTION OF NORDIC POLICY TARGETS ACROSS CIRCULARITY STRATEGIES

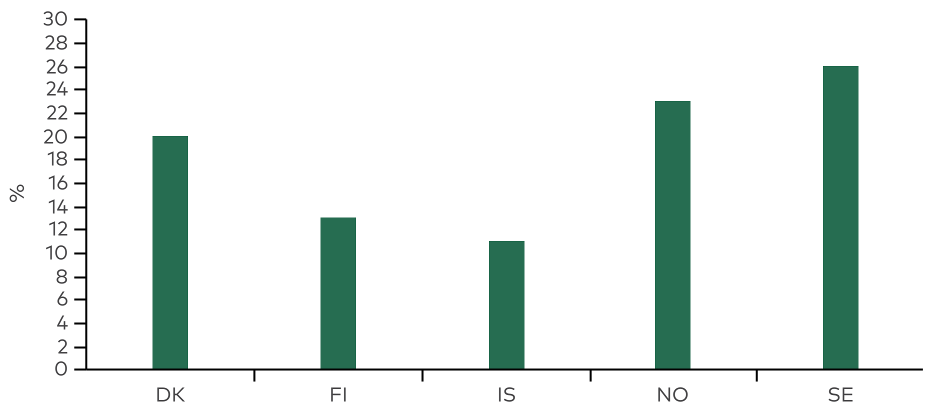
The exercise found that while many policy targets relate to recycling rates, there is also a significant political momentum towards preserving the function of buildings through circular strategies such as R0, R1 and R2.

Categorising the policy targets into thematic areas reveals how these are distributed more specifically.

TABLE 3. HEATMAP OF NORDIC CIRCULARITY POLICY TARGETS

	DK	FI	IS	NO	SE
Greenhouse gas reduction	3	4	3	4	3
Improved knowledge and knowledge sharing	0	0	1	0	2
Increased design for disassembly	0	1	0	0	1
Increased knowledge of materials in existing buildings	1	0	0	1	3
Increased recycling of CDW	4	1	1	3	2
Increased reuse of CDW	2	0	1	3	4
Increased sorting of CDW	1	0	0	2	2
Increased use of biobased construction materials	1	0	1	0	2
Increased use of digital tool to track materials	1	1	0	0	0
Increased use of existing building mass	0	0	0	2	0
Increased use of selective demolition	0	0	1	0	2
Reduce amount of CDW	2	1	1	3	2
Reduce fossil energy use in buildings	0	2	1	1	0
Reduce the amount of hazardous waste	1	0	0	4	1
Resource efficiency	4	3	1	0	2





Few goals and targets relate to the higher levels of the waste hierarchy, while almost a third target recycling and recovery of construction waste. Most of the goals focus on reducing negative externalities, especially concerning Greenhouse gas emissions. Half of the goals relate to the end-of-life phase of construction (lifecycle phase C1-C4). Most goals and targets are local (municipalities) or national, while very few are regional. The circularity goals mainly relate to the Nordic Council of Ministers' focus areas 1, 3, and 4, being 1) carbon neutrality and climate adaptation, 3) sustainable production, and 4) sustainable consumption.

Identifying Nordic policy targets for circular construction has been instrumental in selecting key indicators for circular construction in the Nordics – as accounted for in the next chapter.

PRIORITISED INDICATORS FOR CIRCULAR CONSTRUCTION

The project identified 243 indicators for circular construction, some well-established and others considered experimental/theoretical. The indicators were categorised using the project taxonomy and evaluated using the RACER criteria (Working Group on Performance Measurement of the Performance Development Network of the EU Agencies, 2017). The longlist was also supported with an intelligent filtering system, allowing the working group to combine search criteria easily. This structured approach provided inspiration and an initial overview of current approaches to monitoring circularity. Considering Nordic policy targets, the longlist was a starting point for shortlisting the key indicators that provided new enabling insights to the Nordic construction sector.

Eleven indicators have been shortlisted based on the collective findings of the project activities. The following two tables present the shortlisted voluntary indicators with respective suggested metrics. Based on their news value and potential impact, they are presented in a prioritised order.

TABLE 4. SHORTLISTED INDICATORS AND SUGGESTED METRICS FOR CIRCULAR CONSTRUCTION

Shortlisted indicator	Potential metrics
1. Utilisation rate of existing building stock.	• Total number of empty offices, commercial and rental housing.
	• Total number of free-time buildings/summer houses.
	• m^2 floor area per resident/staff in rental dwellings and offices.
2. Total renovations vs demolition and new buildings.	• Total m^2 of building permissions per year. • Total m^2 of demolitions projects per year. • Total m^2 of renovation/rehabilitation projects per year.
3. Circularity properties of buildings and rehabilitation projects.	• LCA calculation of: Abiotic depletion potential (ADP) for minerals and metals (non-fossil resources)

	• Abiotic depletion potential (ADP) for minerals and metals (non-fossil resources) • Share of the original building intact (exclusively for rehabilitation sites). • Life Cycle Assessment (LCA). • Digital twins and traceability initiatives (e.g. buildings as material banks, BIM, material passport). • Minimisation of problematic substances. • Good renovation potential. • Robustness/durability (endurance, reliability, extended guarantee, use and maintenance information). • Design for disassembly and deconstruction (incl. ease of access to modules with lower lifespans. • Adaptability of technical systems. • Adaptability of interior walls. • Reused building materials. • Recycled materials. • Bill of quantities, materials and lifespans. • Minimisation of waste on construction site. • Handling of construction site waste. • Deconstruction and demolition waste management plans.
4. Land use change	Index of % built land cover related to total land area.
5. Number of EPDs with "circular" properties	No. of EPDs (environmental product declarations) with more than 12% recycled/reused content, divided into product groups.
	No. of EPDs with recycled content above product group specific benchmarks
6. Share of certified building projects	No. or share of certified new building projects.
7. Number of EU Taxonomy-aligned buildings	No. or share of building projects aligned with the circularity criteria specified in the EU taxonomy.
8. Resource productivity in construction	Domestic material consumption.
	Domestic material consumption isolated to materials used mainly in the construction sector, e.g., timber, sand and gravel, clays and kaolin, limestone and gypsum.
9. Construction and demolition waste	Total amount of construction and demolition waste
	Construction and demolition waste per capita, in relation to turnover for the sector, or per new m^2 built.
10. Recycling rates	Circular material use rate (CMUR: recycling in relation to total material consumption).
	Recycling in relation to total construction and demolition waste
	% waste directed to landfill, backfill, and energy recovery in relation to total construction and demolition waste.
11. Carbon footprint in the construction sector	Whole-life carbon equivalents from the construction and building sector.

THE UTILISATION RATE OF THE EXISTING BUILDING STOCK

Different metrics related to the utilisation data are relevant at different levels of decision-making. Utilisation rates based on occupancy and vacancy can be monitored to inform high-level policies. This includes the number of empty offices and dwellings and the number of building types with generally low utilisation rates over time, such as free-time buildings. A more detailed categorisation of building types, such as residential, public, and commercial, is helpful for municipal zoning plans. Usage rate in terms of floor area per resident or staff is relatively accessible data that informs about the general efficiency of material consumption in the building sector.

Over time, more detailed Nordic indicators can be developed to monitor multifunctional usage, such as off-peak rental of public spaces. However, initially, three alternative new Nordic metrics are suggested, in prioritised order:

1. Total number of empty offices, commercial and rental housing.
2. Total number of free-time buildings/summer houses.
3. m^2 floor area per resident/staff in rental dwellings and offices.

Added value to the Nordics

The utilisation rate indicator is politically intricate as it may conflict with some lifestyle ideals of spacious living and reasonable aspirations to maintain some privacy regarding the usage of privately owned buildings. Simultaneously, oversized and underutilised buildings can never be considered sustainable, as their material and energy consumption cannot justify their value to society.

Interviewees suggest that municipal zoning authorities consider the utilisation rate of existing building stock before allocating areas for new construction in municipal zoning plans. Zoning planners use metrics to determine when and where urban development is needed and whether there are conversion possibilities, for example, from underused offices to apartments. Advanced metrics on utilisation rate may further inform planning officials about the types of spaces and buildings that are abundant or lacking. Utilisation rate metrics could even be used to refuse building permits to new buildings in areas where the utilisation rate is too low. Taxation on empty buildings could be applied as a market-based policy instrument to incentivise higher utilisation and prevent speculative investment. However,h such a policy may be difficult to enforce.

The utilisation rate is relevant to the non-growth and degrowth pathways regarding land use change and the number of new building permits. In these pathways, there will still be a need to change the functions within the existing building stock. The metric can help to identify building types available for conversion between functions.

Expert interviews suggest that metrics should not be limited to information about whether a building or space is being used overall but also about the utilisation rate on a weekly or even daily level. This level of monitoring is most beneficial on the organisation and company level for spaces shared between different user groups and for intensifying the use of certain types of spaces in public buildings, like school gyms, workshops, or town hall meeting spaces. Many real estate owners already use such insights on utilisation rates in their asset management and investment decisions.

Existing data points

The bodies responsible for national statistics were unfamiliar with utilisation statistics at the municipal or national levels. It was pointed out that the data sources that could be combined to form some statistics on utilisation rate would be too uncertain to build reliable statistics upon. However, several organisations have collected such statistics about housing or office space utilisation or rental rates on a smaller scale. These can be used as a proxy even if they may not reflect the utilisation rates in detail. The experiences from these projects also serve to develop further data collection on a Nordic scale with considerations for uncertainties.

For instance, on a municipal level, the metric has been covered as part of recent projects by the Finnish Ministry of the Environment, one called "*To demolish or to repair?*" and another project on office building conversions into housing (Valtioneuvosto, 2023). The Greater Helsinki area also produces statistics on vacant commercial spaces divided into office, retail, and industrial/warehouse categories (City of Helsinki, 2024). Finnish KTI Kiinteistötieto produces market analyses, including usage rates, on office, commercial and rental housing buildings in collaboration with the association of professional property owners, RAKLI (KTI, 2023). The ARA organisation (The Housing Finance and Development Center of Finland) keeps specific statistics on rental housing, and their overview reports include data on the overall number of empty rental flats within the ARA system and data on rental flat usage percentage by municipality. This data already informs critical financial decisions. Companies such as Swedish Vakansa use utilisation rate information to rent our multi-purpose facilities during off-peak hours/periods (Vakansa, 2024). There are also interesting examples of community-driven data collection projects that crowdsource the identification of empty buildings (Leerstandsmelder, 2021. Finally, several data points calculate the average dwelling per person across Europe (e.g., ENTRANZE, 2008).

TOTAL RENOVATIONS VS. DEMOLITION AND NEW BUILDINGS

The second suggested Nordic indicator is the share of total renovations and rehabilitation projects versus demolition and new building constructions. The indicator is a combination of three metrics:

- Total m^2 of building permissions per year.
- Total m^2 of demolition projects per year.
- Total m^2 of renovation/rehabilitation projects per year.

Monitoring is proposed only to include primary buildings (heated buildings) to limit the scope to material-intensive buildings. An alternative metric is the number of demolitions in relation to existing building stock, illustrating the annual discharge rate.

Added value to the Nordics

The amount of waste from demolition is about twice as high as from renovations. One of the focal points of the different national strategies regarding sustainability and waste reduction is to preserve existing building mass. The number of buildings renovated versus buildings demolished to make room for another building (including possible conversion to another use category) may serve as an exciting indicator for the sector.

This metric relates to the utilisation rate of buildings, as underutilised buildings could be converted to a more attractive use, thereby reducing the need for new construction.

Existing data points

The metric can be monitored by calculating the number of building permits for renovation up against the number of demolition permits for the same building plot. This data can be fetched and aggregated from Nordic Municipalities, as demonstrated with the CIRCUIT project for Vantaa (ReLondon, 2023).

In Eurostat databases and national statistics, aggregated data on building permissions is available, including new construction and renovation statistics. Eurostat [STS_COBP_A] provides valuable information about the number of new building permits; however, it is only for Denmark, Finland, Norway, and Sweden. The database, in practice, only provides values in m^2 and not as a number. The database differentiates between different building types, e.g., residential and non-residential buildings. However, no European dataset where refurbishment and new buildings are separated has been identified, even if such data exists nationally. Furthermore, it is not always necessary to apply for building permission when refurbishing a building unless the function of the building changes.

Differentiating between these two in existing monitoring systems requires effort from municipalities and national statistical offices. As with the previous indicator, a non-growth and a degrowth strategy scenario is possible.

CIRCULARITY PROPERTIES OF BUILDINGS AND REHABILITATION PROJECTS

A building or rehabilitation project can be assessed over multiple circularity criteria. Some examples of criteria that may be pulled and aggregated using data collected by certification schemes are:

- LCA calculation of Abiotic depletion potential (ADP) for minerals and metals (non-fossil resources)
- Share of the original building intact (exclusively for rehabilitation sites).
- Life Cycle Assessment (LCA) available.
- Digital twins and traceability initiatives (e.g. buildings as material banks, BIM, material passport).
- Minimisation of problematic substances.
- Good renovation potential.
- Robustness/durability (endurance, reliability, extended guarantee, use and maintenance information).
- Design for disassembly and deconstruction (incl. ease of access to modules with lower lifespans.
- Adaptability of technical systems.
- Adaptability of interior walls.
- Reused building materials.
- Recycled materials.
- Bill of quantities, materials and lifespans.
- Minimisation of waste on construction site.
- Handling of construction site waste.
- Deconstruction and demolition waste management plans.

As a starting point and minimum requirement across the Nordics, it is suggested to prioritise the lifecycle assessment category *Abiotic depletion potential (ADP)* for minerals and metals (non-fossil resources)

Added value to the Nordics

The circularity properties of buildings reflect, among other things, the material usage, longevity, adaptability, repairability, and disassembly and demolition properties of buildings. The expert interviews suggest also evaluating the ability to relocate a building. Experts also suggest that this indicator could include the acquisition value of non-virgin materials and components compared to the overall acquisition value (%). The indicator should reflect the hierarchy of various material groups' impact on a building level, whether from resource scarcity, economic, or carbon footprint perspective.

A micro-level indicator of the circularity properties of building products, buildings, and rehabilitation projects would not be new. As elaborated in the following chapters, it is also not the authors' opinion that a new single-score circularity indicator should be introduced. However, the standpoint to be conveyed is that there is a need to harmonise the definition of circularity properties across upcoming standards, certification schemes, and monitoring frameworks in the Nordics. This includes introducing minimum requirements to the list of criteria and their weighting in relation to the overall score. It is suggested that a starting point be taken in the average weighting of the Nordic schemes, as it has been mapped in previous studies, e.g., by GXN and SBI (2018). Inspiration for requirements can also be found in Norwegian FutureBuilt's requirements for circular buildings and other certification schemes, which have recently been updated with a circularity index.

Certification schemes for products and buildings differ from policies by being voluntary and market-driven. The building sector is unique due to the market-driven certification industry. Data from this industry may provide unique information about the Nordic progress towards circularity.

The holistic nature of the existing certification schemes means that they generally include a selected set of indicators related to circular economic strategies. No certification systems focus entirely on circularity. Usually, green building certifications evaluate the sustainability of the building in a holistic approach, including circular economy measures. The schemes recognise and reward buildings designed, constructed, and operated in an environmentally responsible and resource-efficient manner. The single score approach may have some potential to address conflicting indicators: While low-carbon construction and circular construction have many synergies, they may also have inevitable trade-offs, for example, the potential initial carbon emissions of some solutions that have a very long lifespan and are suitable for disassembly in comparison to solutions that have a low initial carbon impact but also a short lifespan (Nordic Council of Ministers, 2022).

Circularity properties are likely to become a requirement within the reform of the Finnish Construction Act, which will oblige contractors to produce an account regarding the chosen life cycle strategy and measures for realising said strategy within the project in question to obtain a building permit. Currently, the account will not be scored, but the voluntary Nordic metrics could suggest ways of creating a scoring criterion for this requirement.

Existing data points

The interviewed stakeholder groups consider certification schemes the most feasible approach to monitoring circular construction while pointing to the need to harmonise the schemes within the Nordics.

TABLE 5. OVERVIEW OF CIRCULARITY REQUIREMENTS AND DATA AVAILABILITY

	Nordic Swan Ecolabel	EU Ecolabel	Cradle to Cradle	DGNB	BREEAM	Miljö-byggnad	LEED
Can you see which certified buildings have points for circularity?	No	No	No	No	No	No	No
Can you see how many buildings in a given year have received the certification, have points for circularity?	Yes	Yes	No	Yes	Yes	Yes	TBA
Are there must-have requirements for the certification that are circular?	Yes.	Yes.	Yes	Yes	TBA, but unlikely	Yes	No

Certification schemes monitor a building's circularity in several ways. The following table provides an overview of the circularity criteria in the Nordic schemes (based on Jensen et al., 2018; VCØB, 2021; BREEAM, 2023; Sweden Green Building Council, 2023; Nordic Ecolabelling, 2018; RTS, 2022a and RTS, 2022b). It must be noted that schemes are adopting circularity criteria more extensively over time, and certification schemes are expected to align increasingly with the EU Taxonomy for sustainable activities.

TABLE 6. OVERVIEW OF CIRCULARITY CRITERIA IN NORDIC CERTIFICATION SCHEMES

	Material passport	Waste management	Reuse/refurbish instead of demolishing. Use of reused and recycled materials	Design for disassembly and adaptability	LCA of buildings
Nordic Swan	A material log- book that ensures traceability of the building materials and chemical products that are included in the construction.			Design for disassembly and adaptability	LCA analysis of building
BREEAM	Requirements for reuse, recycling, and other material recovery (sorting requirements)	• Requirements for reuse, recycling, and other material recovery (sorting requirements) • A plan for reuse	• Requirements for the use of reused/recycled materials. • Pre-demolition audit • Demolition strategies • Demounting and reuse instead of demolition • Minimal intervention • Refurbishment over demolition	Concept for design with focus on circularity and durability	LCA analysis of building elements
DGNB		Minimising and sorting of waste	• Pre-demolition audit • Resource coordinator	• Flexibility and adaptability. • Design for disassembly.	LCA and design optimization on the basis of reduction of environmental impact. Use of materials with EPDs.

LEED		Minimising and sorting of waste	• Restoring existing buildings or structures • Use of reused or recycled building materials	Circular design – Focus om material durability	LCA of building to evaluate and reduce resource use
Miljöbyggnad	Document with all products and materials in the building				LCA for building in order to reduce the impact on global warming from the production. Use EPDs for specific products.
RST		Sorting of waste	Reuse of materials	Designer after "open building" concept to enable maintenance and repair	LCA for building materials to choose materials with low environmental impact

LAND USE CHANGE

This indicator monitors the development of land cover, specifically targeting buildings and other construction.

The minimum criteria suggested aim for a non-growth pathway is =< 100% index (e.g., with 2009 as baseline). However, a more ambitious degrowth pathway is available to re-establish nature. Under such a pathway, minimum criteria will need to define what is considered positive development of land cover to determine whether less built-up land cover results in rebound effects (e.g., more intense agriculture) instead of actual environmental benefits.

Added value to the Nordics

This indicator provides an overall proxy of the pressure from construction on the local environment. Seen as a static metric, the indicator provides little information about circularity since several factors, including population density, agricultural productivity, etc, influence land cover. However, assessing land cover over several years and relating this indicator with other indicators, such as m^2 new construction, can provide information about the political ability to increase the utilisation rate within existing buildings and land cover.

Existing data points

Eurostat provides statistical information about land area coverage, including the percentage of built-up areas. However, this information is only available on Eurostat (LAN_LCV_OVW) for some Nordic countries (Denmark, Finland and Sweden). Similar statistical information for the remaining regions must be fetched from national databases. Alternative units are km^2 and coefficient of variation for absolute value. The dataset also includes additional information about land cover, e.g., artificial, non-built-up areas.

NUMBER OF EPDS FOR "CIRCULAR" MATERIALS

The Environmental Product Declaration (EPD) is a standardised document informing about a product's potential environmental and human health impact. An EPD is used when calculating the life cycle assessments (LCA) for buildings (if there is no EPD, generic data is used).

The minimum criteria for recycling must be classified within product groups, as recycling is more or less feasible within certain building product groups. Furthermore, the indicator must include a benchmark for circular building products using the information available within an EPD.

The suggestion is to measure how much content by weight is recycled and count verified EPDs that can be classified as "best practice." Specifically, we suggest using the best practice benchmarks presented by WRAP (2004). These benchmarks consider technical possibilities and trade-offs.

For further development of the indicator, it may be possible to develop benchmarks related to the input by value (%). As the reporting requirements adapt to future specifications, it may also be possible to extract further information from the EPDs to evaluate the following criteria:

- Minimisation of problematic and Hazardous substances.
- Robustness/durability (Reference Service Life).
- Complexity in material compositions.

- Lightweight design.
- Standardised dimensioning.
- Minimisation of waste on the production site.

Added value to the Nordics

The indicator does not provide information about whether the products in question are being used or where they may be used. Instead, it is a proxy that informs about the national market maturity and level of innovation in circular products. The indicator suggests a high commitment to reused and recycled products, as achieving the necessary documentation is time-consuming and resource-consuming.

In Denmark, an LCA for new buildings and a limit value for all new buildings per m^2, together with a limit value of 12 kg/m^2 CO_2eq/m^2/year, will be required from 2023. The number of EPDs and reused building materials are expected to increase.

Existing data points

Verified EPDs are publicly available via national EPD databases and deemed robust against manipulation when the minimum criterion is incorporated. EPDs are based on a standardised reporting approach based on life cycle assessments and are subject to third-party validation. Furthermore, it requires significant resources to produce and publish an EPD, meaning that the products can be expected to represent some market value. While there are some 30.000 verified EPDs in Europe, there are just as many unverified EPDs delivered directly to clients by manufacturers on demand. It is suggested that the NCM focus on the verified EPDs initially since the proxy only informs about the commitment to recycled content if it requires some investment from the companies.

SHARE OF CERTIFIED BUILDING PROJECTS

This indicator suggests monitoring the development of each Nordic scheme's adaptation and relating it to each scheme's unique properties. As a baseline, it is suggested that the development of each scheme within each country be monitored and not compared between countries or mixed schemes.

Added value to the Nordics

Compared with the macro indicators established through EU policies and monitoring frameworks, the micro and meso indicators in certification schemes have the potential to cover a broader range of CE strategies. Most certification schemes accredit CE strategies directly when assessing the environmental performance of buildings, and they often include qualitative indicators with third-party validation, thus providing more in-depth information about circularity through single-score units. However, they may be less comparable across the Nordics since the weighting and selection of criteria vary. Some certificates are relatively easy to achieve, while others require significant resources. Further, the overall credit of each building project is affected by many additional indicators. As such, there is no guaranteed correlation between circularity practices and building certificates.

If qualitative information from each building's certifications cannot be pulled, aggregated, and compared on a Nordic scale, then monitoring the expansion of certified buildings may serve as an alternative proxy.

Certification schemes are increasing in popularity. Focusing on DGNB in Denmark, there has been a 600% increase in certified buildings from 2018 to 2023. Overall, there has been a 200% increase in certified buildings in the Nordics from 2019 to 2021. This significant increase suggests that the scheme operators may be perceived as crucial sources of information on the circularity properties of the future building stock.

Existing data points

Information about the number of certified buildings within each scheme is typically available on the program operators' websites. The following table provides a snapshot of some of the Nordic schemes for 2021 (based on STARK Group, 2022).

TABLE 7. OVERVIEW OF CERTIFIED BUILDINGS IN 2021 (NOT EXHAUSTIVE LIST)

Country	Certificate	Total no. of certified buildings in 2021
DK	DGNB	34
FI	BREAM	343
FI	LEED	265
FI	Nordic Swan	15
NO	BREEAM-NOR	59
SE	BREEAM	33
SE	GreenBuilding	327
SE	LEED	9
SE	Miljöbygnad	611

NUMBER OF EU TAXONOMY-ALIGNED BUILDINGS

The suggested indicator monitors building companies' compliance with selected conditions in the EU Taxonomy for Sustainable Activities (2024), specifically the first condition (a), "Transition to a circular economy."

The 5.1 criteria, *"Construction of new buildings and major renovations of buildings for the transition to a circular economy"*, covers the construction sector. To comply with condition A, the following criteria must be met:

1. At least 90 % (by weight) of the non-hazardous construction waste generated on the construction site is prepared for reuse or recycling.
2. A life cycle assessment of the entire building or the renovation works has been calculated according to Level(s)
3. Design for adaptability/design for disassembly
4. The asset contains at least 30% (by weight) of recycled, re-used, re-manufactured, and by-products.
5. The design promotes material and resource efficiency by following relevant standards or best practice design guidance on material efficiency.
6. Components and materials used in the construction do not contain asbestos or substances of high concern.
7. Digital tools that support preserving and extending service life and future adaptation and reuse:
    - Detailed material specification records as part of a building information model/digital twin or in a separate schedule or material passport.
    - A maintenance schedule, including a technical description of the building and its systems and a schedule for future maintenance.

Added value to the Nordics

The proposed indicator utilises that an emerging data stream will provide open-source building information about circularity. The taxonomy only applies to companies with over 500 employees, targeting less than 50 Nordic construction companies. Furthermore, the indicator does not go back in time. Despite these limitations, the indicator is a valuable proxy for the circularity tendencies within the most significant national companies. This obligation is also expected to cover even smaller companies in the future10. The wording of the EU taxonomy is not final. Therefore, the wording and ambition regarding *"Construction of new buildings and major renovations of buildings for the transition to a circular economy"* can change.

Existing data points

The EU Taxonomy is the upcoming classification system that categorises investments as environmentally sustainable in EU countries. This taxonomy is set to be a driving force for increased sustainable economic activity (green loans, etc.) in the EU.

This standard set of criteria is set to be a driving force for increased sustainable economic activity (green loans, etc.) in the EU. At the same time, the increased transparency created by the classification system is expected to decrease greenwashing. The taxonomy is expected to be implemented in 2023, and it sets four conditions (a - d) that must be complied with and documented to meet the standards of being environmentally sustainable in the EU. Under these conditions, several requirements describe how to live up to the taxonomy.

RESOURCE PRODUCTIVITY IN CONSTRUCTION

Resource productivity covers the ratio of domestic material consumption (DMC) compared to gross domestic product (GDP).

Instead of relating to GDP, we suggest annual turnover within the construction sector as the denominator. The challenge is that annual turnover can be isolated to the sector, but DMC cannot. We can assume that the non-metallic minerals are mainly from the construction sector. The Eurostat dataset (Env_AC_MFA) allows for isolating data to certain material groups and has data available for Norway, Finland, Sweden, Denmark and Iceland.

Because we use economic variables, the indicator would need to be adjusted to adjust to fluctuations from economic factors such as inflation and economic crisis since these changes will impact the indicator's performance. It is not possible to isolate the turnover to the selected material groups. The datasets can also be used to visualise DMC per capita; however, DMC is still on a national basis and is not yet isolated to construction. Using the built area measured in m^2 as the denominator is also possible.

Added value in the Nordics

This is a macro indicator that monitors resource productivity and extraction of virgin materials. Indirectly, it indicates higher rates of secondary material used in products and strategies, increasing the lifespan of already existing products. The outcome will be a lower extraction of virgin mineral materials.

Existing data points

DMC is already covered in various national Strategic Programmes for CE. Resource productivity is also one of the indicators used to measure Sustainable Development Goals within the EU. As stated in various national white papers and approved by the Parliament, an overarching goal is decoupling economic growth from waste generation and resource use.

Some regions have mapped the flow of raw material extraction to their destinations and are thus able to provide statistics about the amount of raw material destined for construction. The indicator would be much improved if such data could be collected for all Nordic regions.

CONSTRUCTION AND DEMOLITION WASTE

Several indicators and tools measure the amount of waste produced during construction projects. We suggest three parallel indicators:

1. Construction and demolition waste per capita,
2. Construction and demolition waste per square meter built
3. Construction and demolition waste related to turnover from the sector.

We suggest using monitoring against the following benchmarks for indicator no. 1-3: ≤ 40 kg waste/new m^2 built, 15 kg waste per 1000 EUR generated, and 800 kg total per capita.

Added value in the Nordics

Reduced waste per GDP, in combination with a higher share of rehabilitation projects, will show a positive trend towards a circular economy with higher rates of reuse at one end and higher recycling rates of old construction elements as the technology develops.

Measuring and reporting both construction waste and operational waste is ideal, and it is already implemented in BEEAM NOR, which covers both aspects (Wst 01 – covers both the total amount of waste from construction and what percentage is being sorted for reuse or recycling), and Wst 03 which covers operational waste). One credit is awarded if the total waste from the construction site is ≤ 40 kg/m^2. Building projects must meet the ≤ 19 kg/m^2 benchmark to achieve the maximum number of points on this indicator.

Existing data points

Waste statistics have been used for a long time in the construction sector and are relatively easily accessible. CC Build and CIX can measure this indicator on a building project scale. Eurostat also has all the necessary macro statistics for

Denmark, Norway, Finland, Sweden, and Iceland. Some datasets, e.g., [ENV_WASGEN], even allow for isolating specific waste fractions.

RECYCLING RATES

Three parallel indicators are suggested. While the first two indicators already have somewhat robust data, the third indicator may need further development of national monitoring systems to isolate material consumption in the construction sector.

1. Recycling in relation to total construction and demolition waste
2. % waste directed to landfill, backfill, and energy recovery in relation to total construction and demolition waste.
3. Circular material use rate (CMUR: recycling in relation to total material consumption) for the construction sector.

Added value to the Nordics

Recycling rate indicators are relevant because, while they align with the lower parts of the waste hierarchy, recycling is still a much-preferred circular strategy over backfilling, incineration, and landfilling. It is a widely accepted indicator as reporting under the Waste Directive is mandatory. To enable comparison across the Nordics, total waste and material consumption are suggested to be used as denominators.

Further, it is recommended to ensure harmonised definitions that exclude backfilling operations from the definition of recycling. In Denmark, this has recently been done in recognition that backfilling is an irreversible and low-grade preservation strategy (downcycling) that only maintains a little of the value of looped materials.

Existing data points

It is mandatory to report the amount of waste received at the different treatment plants and shipped further in the waste treatment system. The waste-data system often only tracks waste materials for recycling (closed loop) and recycling (open loop), while materials for reuse are not tracked and documented. Monitoring this indicator compares the annual percentage of recycling in relation to total waste treatment.

The EUROSTAT dataset [ENV_WASTRT] is an important data source; however, this dataset has some significant limitations, and much effort is needed to ensure that the reporting methodologies are harmonised across the Nordics. To give an example of a reporting challenge, Denmark recently changed the definition of recycling to exclude backfilling operations.

CARBON FOOTPRINT IN THE CONSTRUCTION SECTOR

Monitoring the kilograms of CO_2e per square meter built may inform the overall development of reuse, recycling, and the introduction of renewable/bio-based strategies in new production and maintenance.

Added value to the Nordics

Construction's carbon footprint is a robust, widely accepted metric with a strong synergy with circular construction. However, when defining the target for this metric, it is also essential to carefully consider not only synergies but also possible trade-offs, which have been covered in the WP3 phase 2, as well as in other recent Nordic studies, for example, in a recent study conducted by SYKE, NTNU and TALTECH resulting in a publication with the title *Synergies and Trade-offs between carbon footprint and other environmental impacts of buildings*[2]. Recent and current reforms of Nordic building acts introduce new carbon limits for the carbon footprint[3]. A national-wide implementation of circular economic strategies is unavoidable if the Nordic countries are to meet their current national goals and targets for carbon reductions, especially towards 2025 and 2030. Some expert interviewees pointed out that in Finland, circular construction is generally seen mainly as a tool for minimising the carbon footprint of buildings, whereas in other Nordic countries where natural resources may be even more scarce, minimising the use of virgin resources may weigh higher. In Denmark, carbon limits are the primary policy that incentivises circular strategies.

The interconnectedness of circularity and carbon reductions in both the physical and political domains highlights the importance of this indicator in the context of NNCC.

Existing data sources

Unfortunately, the Eurostat dataset is quite limited, as it only shows the carbon emissions from the construction sector at an aggregated European level. Further investigation is needed to collect national sector-specific data. Only a few national reports inform about the overall emissions from the construction sector nationally.

However, it is expected that the new limit values and their dependency on LCA tools will improve data collection through increased use of bills of materials and draw attention to the need for resource use reduction.

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2. Nordic Council of Ministers (2022). Trade-offs between carbon footprint and other environmental impacts of buildings. Available at: https://pub.norden.org/temanord2022-551/temanord2022-551.pdf
3. See overview of the recent development regarding carbon limit values at table 1 in Kaarsberg, S.; Kress, L. (2023) Policies Enabling the Reuse of Construction Products in the Nordics. https://pub.norden.org/us2023-441/#130356

DRAFT STRATEGY FOR IMPLEMENTATION OF THE NEW MONITORING FRAMEWORK

The following section conceptualises the findings collected throughout the WP3 project within an action plan for implementing the shortlisted indicators in the Nordics.

The strategy is structured according to the Logical framework approach (LFA), which emphasises the need to thoroughly understand the problem to be solved and define the intended impact before formulating project activities (Norad, 2015). Developing the strategy can, therefore, be described as a back-casting exercise.

The following section describes each element in the strategy.

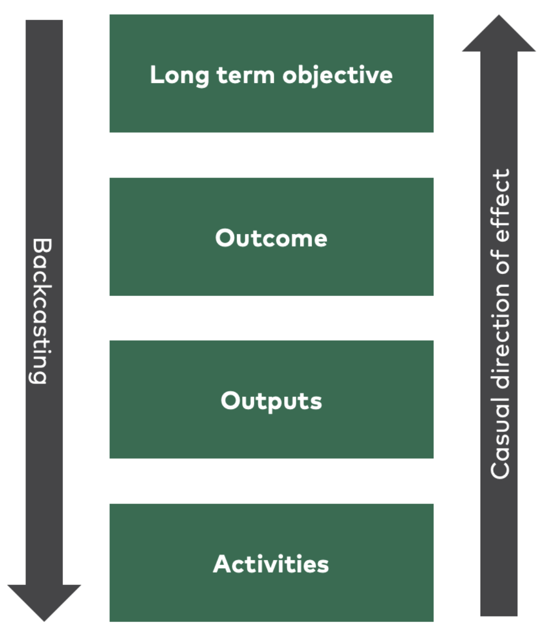

FIGURE 3. The overall strategy structure

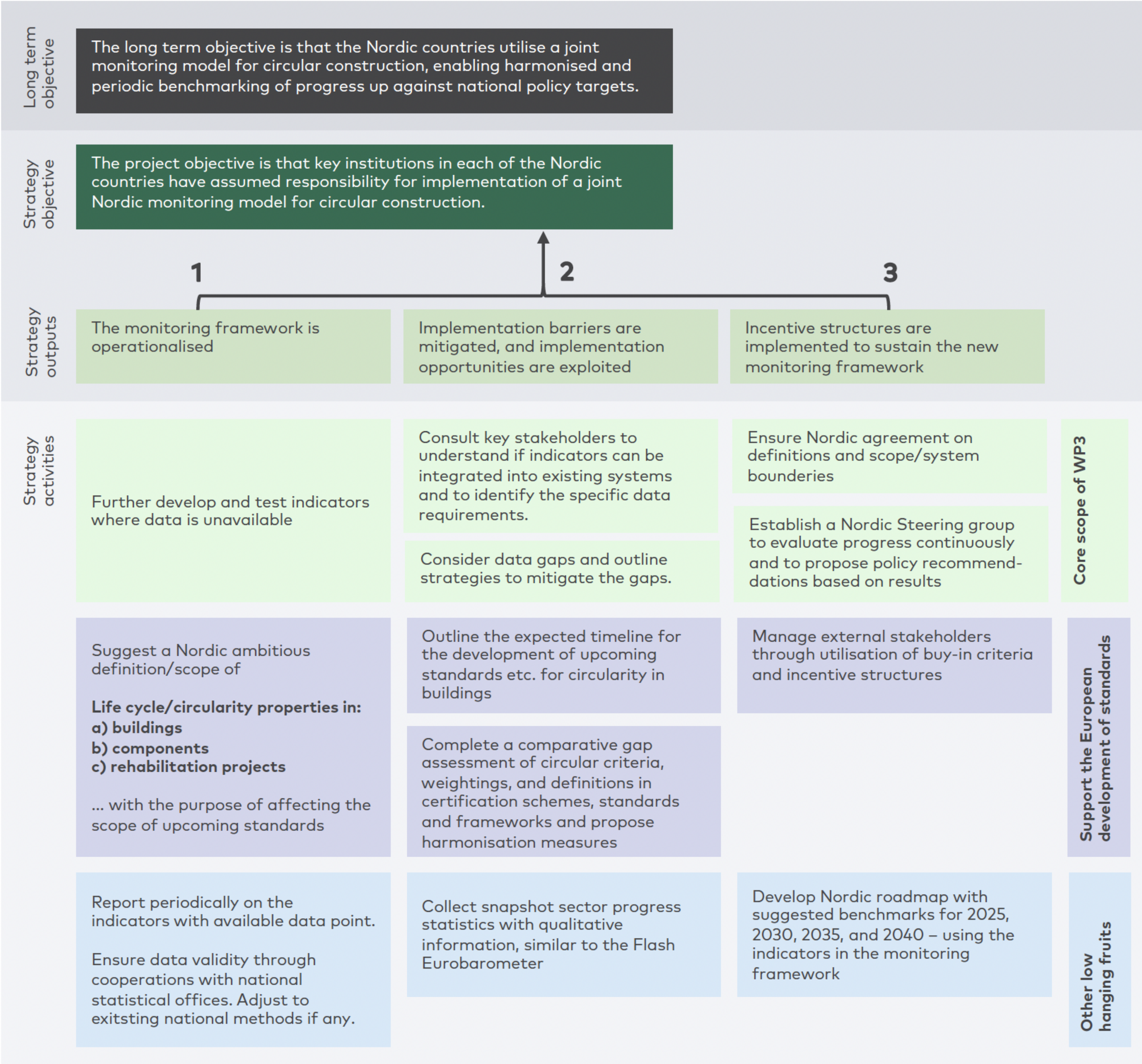

FIGURE 4. THE IMPLEMENTATION STRATEGY

LONG TERM OBJECTIVE

The long-term objective is for the Nordic countries to utilise a joint monitoring model for circular construction, enabling harmonised and periodic benchmarking of progress against national policy targets.

Breaking down the objective reveals aspirations toward aligning methodologies, definitions, and policy benchmarks for policy efforts specifically for material efficiency in the Nordics. This vision is closely related to the Nordic Council of Ministers' vision of becoming the most integrated region in the world.

A vital aspect of the long-term objective is ensuring the actual utilisation of the monitoring model. In other words, the monitoring framework is only a success if used. This underlines the need to allocate responsibility and resources to post-implementation practices such as evaluation, reporting, and maintenance. The long-term objective is reflected in the formulation of the project objective below:

STRATEGY OBJECTIVE

The strategy objective is that key institutions in each Nordic country have assumed responsibility for implementing a joint Nordic monitoring model for circular construction.

The strategy objective establishes that a successful outcome relies on coordination and collaboration between the Nordics. Key institutions include statistical offices, municipalities, ministries, and industry associations. To ensure national implementation and ownership, the implementation must accommodate the differences in the Nordic sectors and policy landscapes.

The monitoring framework will provide reliable and valuable information to policymakers and other relevant stakeholders in the construction sector. This will enable informed decisions, including policy corrections, to ensure the realisation of long-term policy targets for circular construction.

STRATEGY OUTPUTS

The strategy objective will be achieved through the delivery of three outputs:

Output 1 – The monitoring framework is operationalised:

Output 1 aims to prepare and test the monitoring framework in cooperation with national stakeholders, ensuring that the indicators provide relevant and reliable information for key stakeholders.

Output 2 - Implementation barriers are mitigated, and implementation opportunities are exploited:

Output 2 ensures that the implementation strategy is pragmatic towards barriers and opportunities to ensure effective implementation. The WP3 has already assessed such barriers and opportunities.

Output 3 - Incentive structures are implemented to sustain the new monitoring framework:

Output 3 allocates resources to evaluate, maintain, and adapt the monitoring framework to future needs. Output three contributes to building ownership over the framework at relevant institutions.

STRATEGY ACTIVITIES

The three outputs will be delivered based on a series of activities.

TABLE 8. KEY ACTIVITIES FOR IMPLEMENTING A NEW VOLUNTARY MONITORING FRAMEWORK FOR CIRCULAR CONSTRUCTION IN THE NORDICS

Output	Activity	Explanation
Output 1: The monitoring framework is operationalised	1.1 Further develop and test indicators where data is unavailable	This activity focuses on refining and operationalising two less widespread indicators: Utilisation rate and Total renovations vs demolition and new buildings. This activity defines which metrics are most helpful and what possible implications new indicators may have. The testing phase includes data collection, cleaning, and interpretation. Finally, the data collection must be implemented in collaboration with municipalities and statistical officers.
	1.2 - Suggest a Nordic ambitious definition/scope of Life cycle/circularity properties in: a) buildings, b) components, and c) rehabilitation projects … to affect the scope of upcoming standards.	Since several working groups (e.g., certification schemes and standardisation organisations) are already working on defining building life cycle properties, implementing new Nordic metrics may not contribute to the overall cause of harmonisation and integrity. Instead, the mandate of the Nordic Council of Ministers is to support these ongoing standardisation processes. By representing society as a whole rather than the industry, the Nordic Council of Ministers has a mandate to improve the level of ambition, e.g., by influencing these processes by suggesting metrics and measuring methodologies that reflect the most significant effect on the environment.
	1.3 Report periodically on the indicators with available data point. Ensure data validity through cooperations with national statistical offices. Adjust to exitsting national methods if any.	This task seeks to improve data quality, coherence, and reliability of Nordic building information on readily available databases such as Eurostat. These databases can then be utilised to provide reports based on a number of the shortlisted indicators.

Output 2: Implementation barriers are mitigated, and implementation opportunities are exploited	2.1 - Consult key stakeholders to understand if indicators can be integrated into existing systems and to identify the specific data requirements.	Task 2.1 ensures collaboration with existing databases and data collectors. Key stakeholders include statistical officers and building permit officers. These are consulted to ensure that existing procedures and data requirements are adhered to. Furthermore, collaboration towards new data collection may be established by engaging in dialogue with such stakeholders.
	2.2 - Consider data gaps and outline strategies to mitigate the gaps.	Task 2.2 establishes mitigating strategies for managing identified data gaps and other implementation barriers. This is especially relevant for the less widespread indicators such as the utilisation rate. Here, metrics may only be available for specific building types, etc.
	2.3 - Outline the expected timeline for developing upcoming standards for circularity in buildings.	Task 2.3 ensures that the timing of subtasks within task 1.2 is appropriate in relation to the ongoing development of new circularity criteria and standards. It outlines critical events and possible pathways of influence.
	2.4 - Complete a comparative gap assessment of circular criteria, weightings, and definitions in certification schemes, standards and frameworks and propose harmonisation measures	Task 2.4 investigates the potential to harmonise circular criteria, weightings and definitions across certification schemes, enabling the sector to identify hotspots for improvements. This activity also serves as a public service by providing a general overview of the sector over the ambition of circularity criteria across available certification schemes. Furthermore, this activity feeds into task 1.2 by providing a foundation for suggesting new criteria.
	2.5 - Collect snapshot sector progress statistics with qualitative information, similar to the Flash Eurobarometer	Task 2.5 represents an alternative reporting approach with the potential to substantiate more in-depth snapshots about the sector. Rather than a dashboard approach with statistical information, there is the option to operate regional surveys on an organisational level. This activity can provide critical information to support official statistics inspired by the European Flash Eurobarometer (EC, 2022a).

Output 3: Incentive structures are implemented to sustain the new monitoring framework.	3.1 - Ensure Nordic agreement on definitions and scope/system boundaries.	Task 3.1 engages in dialogue with Nordic policymakers to ensure a consensus-based approach to implementing the indicators and provide an arena for influencing the monitoring framework. While this is an important feedback mechanism, it is also an essential prerequisite for the uptake of national ownership.
	3.2 - Establish a Nordic Steering group to evaluate progress continuously and to propose policy recommendations based on results.	Task 3.2 established a Nordic Steering group to bridge the monitoring results with policymaking through evaluations, policy recommendations, quarterly sector reports, etc. A steering group with monitoring responsibility serves to help translate the statistical findings into useful findings, thereby improving the utilisation of the framework.
	3.3 - Manage external stakeholders through the utilisation of buy-in criteria and incentive structures.	Task 3.3 continuously engages with sector stakeholders to ensure the framework is current with perceived needs.
	3.4 - Develop a Nordic roadmap with suggested benchmarks for 2025, 2030, 2035, and 2040 - using the indicators in the monitoring framework.	One major benefit of indicators is that they enable policy targets. Task 3.4 establishes ambitious voluntary Nordic benchmarks for each indicator. This can only be achieved through Nordic collaboration.

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ANNEX 1 – STAKEHOLDER INTERESTS

An inclusive stakeholder engagement process was initiated before the implementation strategy was developed. This was to ensure that barriers and enablers were addressed and to adapt the monitoring program most effectively to the construction sector's reality. Over 70 sector experts actively participated in several digital voting, word cloud exercises, and discussion sessions during an online workshop.

Participants were among several questions asked an open-ended question about the overall objective of a new Nordic voluntary monitoring framework. The participants could upvote other participants' responses, as they were visualised in a word cloud. The responses have been grouped and counted, illustrated in the graph below.

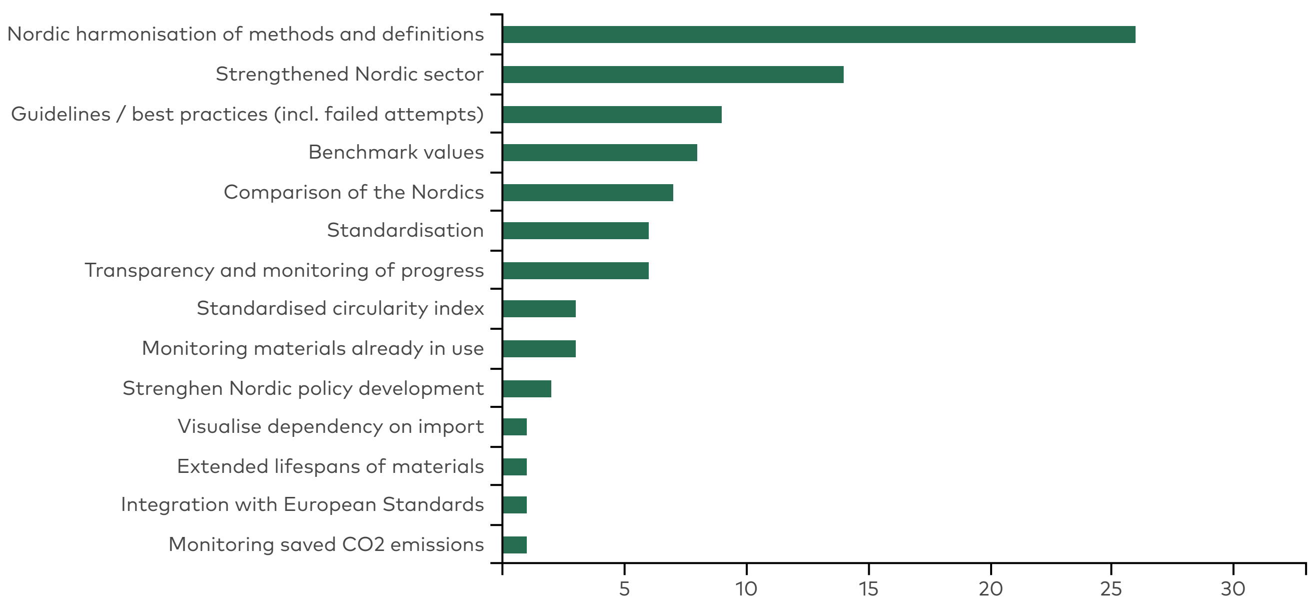

FIGURE 5. STAKEHOLDER RESPONSE TO THE QUESTION: WHAT SHOULD A NEW VOLUNTARY NORDIC FRAMEWORK PROVIDE BEYOND WHAT EXISTING SCHEMES, POLICIES AND FRAMEWORKS ALREADY PROVIDE? WHAT IS THE ADDED VALUE?

A variety of aspects were highlighted. However, one point was the most mentioned: the added value of Nordic harmonisation of methods and definitions, supporting a common Nordic understanding. It was echoed several times during the breakout discussions that there is a lack of knowledge, shared understanding and methods to measure the circular economy in the Nordics.

The participants were also asked to choose which of the fifteen identified Nordic circularity goals/targets they considered the most important in implementing a new monitoring framework.

FIGURE 6. EXISTING POLICY TARGETS AND STAKEHOLDER PRIORITIES COMPARED

An interesting finding was how the exercise demonstrated a notable discrepancy between the priorities of the stakeholders and existing policy targets. The lack of voting towards some objectives does not mean that these were not considered necessary, given that each participant had only one vote, but that these were not considered the main objective. Most participants (37.5%) voted that they found resource efficiency as the most critical policy objective to monitor progress towards in a new Voluntary Monitoring Framework. Other popular objectives were 1) the increased use of existing building mass, 2) improved knowledge and knowledge sharing, and 3) increased reuse of CDW.

The workshop also allowed the participants to provide feedback on scoping the new voluntary framework conceptualised through the project taxonomy.

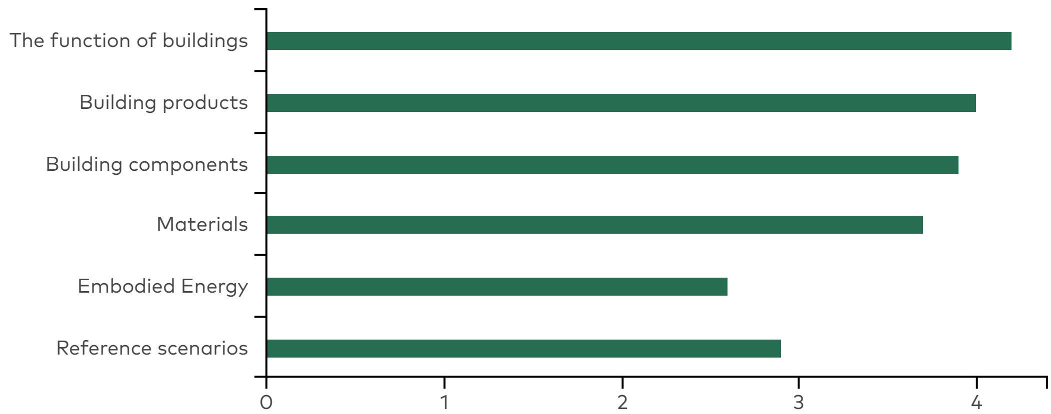

FIGURE 7. FEEDBACK TO THE SCOPING OF A NEW VOLUNTARY MONITORING FRAMEWORK: STAKEHOLDER RESPONSE TO THE QUESTION: "*WHICH ASPECTS OF THE CIRCULAR ECONOMY STRATEGIES ARE MOST IMPORTANT TO INCLUDE IN A NEW NORDIC MONITORING FRAMEWORK?*"

The workshop participants indicated that circular strategies relating to the function of buildings (refuse, rethink and reduce) are the most essential strategies to monitor in a new Nordic Voluntary Framework. However, strategies related to building products/buildings (reuse, repair, refurbish, remanufacture), building components (reuse, repurpose), and materials (recycle) were also considered of high importance. These results can be explained by the fact that the less upvoted options are already well established in both current monitoring systems and policy goals, while the upvoted options are only emerging in very recent policies.

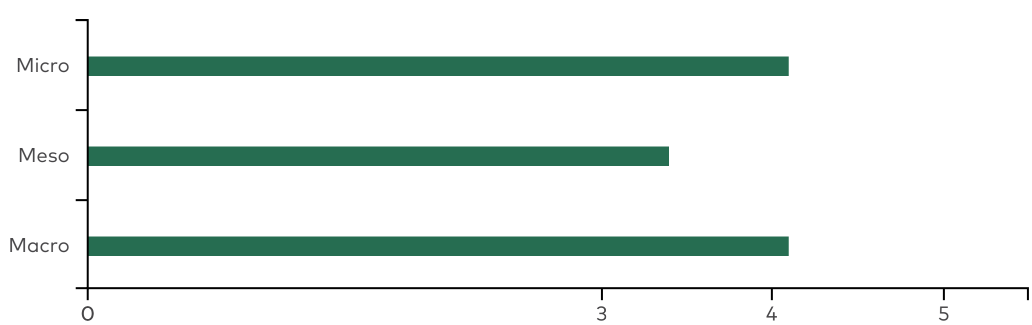

FIGURE 8. FEEDBACK TO THE SCOPING OF A NEW VOLUNTARY MONITORING FRAMEWORK: STAKEHOLDER RESPONSE TO THE QUESTION: *WHICH LEVELS OF IMPLEMENTATION ARE MOST IMPORTANT TO INCLUDE IN A NEW NORDIC MONITORING FRAMEWORK?*

When asked about which levels of implementation that are most important to monitor, the micro and macro levels were considered equally important, whereas the meso (regional) level was considered less important.

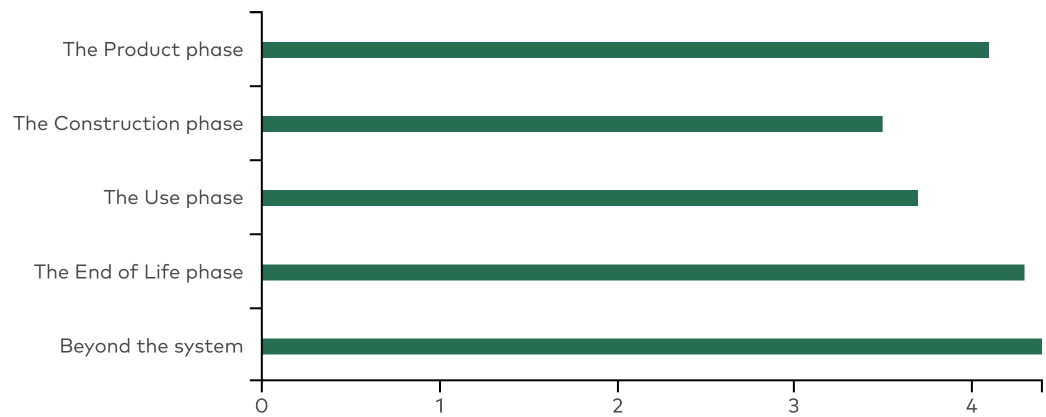

FIGURE 9. FEEDBACK TO THE SCOPING OF A NEW VOLUNTARY MONITORING FRAMEWORK: STAKEHOLDER RESPONSE TO THE QUESTION: *WHICH LIFE CYCLE PHASES ARE MOST IMPORTANT TO INCLUDE IN A NEW NORDIC MONITORING FRAMEWORK?*

Finally, when asked to prioritise the construction phases, phase D (beyond the system) was considered the most important, followed by phases C1-C4 (the end-of-life phase) and A1-A3 (the product phase). Surprisingly, phases A4-A5 (the construction phase) and B1-B5 (the use phase) were considered relatively low importance. The discussions added that the design phase is an important lifecycle aspect missing from the LCA approach.

IMPLEMENTATION BARRIERS FOR A NEW VOLUNTARY FRAMEWORK

The following summary of identified implementation barriers is based on Nordic country profile reports produced within WP3 and notes from stakeholder workshops, interviews, and questionnaires.

Low company relevance

If the indicators are mainly reported as macro indicators at the country or county level, companies may not see the relevance, hindering implementation at a micro level.

Competitive interests and knowledge sharing

Competitive interests within the sector might hinder knowledge sharing across the sector. This, again, creates a barrier to collaboration and learning. Many companies also lack knowledge about the circular economy to incorporate the indicators into their business model.

Low understanding of the indicators

The absence of standardised terminology and translations might make aligning stakeholders' understanding of the metrics and data across countries and companies challenging. It also represents a barrier to efficient and correct reporting of the indicators.

Lack of regulatory incentives

There is a lack of regulatory incentives in current and future planned legislation, which can hinder the effective implementation of new indicators. Current policies and regulations are insufficient in monitoring CE indicators. In addition, current legislation does not require companies to achieve clear minimum targets on the indicators, which can also be a barrier to implementing the indicators.

Additional reporting platforms

This adds complexity to reporting processes and introduces a challenge to operationalising the indicators' implementation.

Culture and current business practices

A strong tradition for linear practices and thinking presents a challenge as many stakeholders may resist adapting new practices without the right incentives.

Lack of best practices and forerunners

Small- and medium-sized businesses may lack guidance on implementing the indicators due to a shortcoming of forerunners who are quick to implement the indicators.

Limited data availability

There is a scarcity of available statistics necessary to report on the indicators. This means that companies are not reporting the necessary data for the indicators today, requiring the establishment of new routines for identifying, collecting, and reporting the data.

ANNEX 2 – LINKAGES BETWEEN CIRCULAR ECONOMY, BIODIVERSITY, ECOSYSTEMS, AND CHEMICALS

There are high expectations that the circular economy (CE) can halt biodiversity loss; for instance, the EU's Biodiversity Strategy considers CE as one solution for using natural resources and investments (European Commission, 2020). The Circular Economy Action Plan aims to implement a growth model that gives more back to the planet than it takes (European Commission, 2020). However, this literature study finds little research investigating the *direct* link between specific CE strategies, biodiversity, and ecosystem services. Another under-investigated research area is the trade-offs related to the use of chemicals in relation to the circular economy. A literature review was conducted to shed light on these themes.

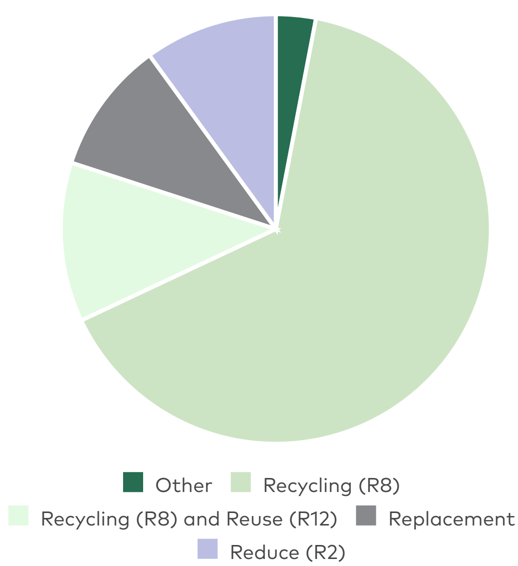

FIGURE 10. DISTRIBUTION OF RESEARCH PAPERS

While articles reviewed in the project predominantly point to the potential of mitigating pressure on the environment via recycling building materials, a vast research gap still needs further systematic investigation before we can understand the full implications of the impact on ecosystem services and biodiversity.

BIODIVERSITY AND ECOSYSTEMS

Throughout their lifecycle, buildings in Europe are responsible for half of all extracted materials, half of the total energy production, a third of the total water consumption, and a third of the total waste generation (EC, 2022b). The construction and real estate sectors put significant pressure on ecosystems and biodiversity (Hyvärinen et al., 2019) through the decrease and fragmentation of natural habitats (Auvinen et al., 2020). The Global Assessment Report on Biodiversity and Ecosystem Services (Díaz et al., 2019) states that the current deterioration of biodiversity and ecosystem services is unprecedented. According to the International Resource Panel (Díaz et al., 2019), natural resource use and processing are linked with 90 % of biodiversity loss worldwide. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services points to five key drivers of the biodiversity crisis and nature loss: land use and sea use, climate change, pollution, direct exploitation of natural resources, and invasive species (Díaz et al., 2019).

Biodiversity is undoubtedly impacted negatively by changes in land use if the use of natural resources leads to degradation, loss, or fragmentation of ecosystems (Haines-Young, 2009). The impacts of construction on biodiversity arise especially through the extent and intensity of land use, including direct land use, indirect land use from the extraction of raw materials and fuels, and the land use associated with the treatment and disposal of CDW (Ruokamo et al., 2023). Highways and roads often have a high fragmentation impact (Bennett, 2017). While global economic growth is primarily based on extracting and processing virgin raw materials into goods, the increased use of natural resources puts pressure on biodiversity and ecosystem services (Allwood et al., 2011; International Resource Panel, 2019). The building material industry also significantly impacts biodiversity within the habitats in which it operates.

While the direct linkages on mitigating harmful impacts from construction on ecosystem services and biodiversity have not yet been widely and systematically investigated in peer-reviewed articles, some articles cover the indirect linkages between CE in the construction sector and the mitigation of biodiversity loss and ecosystem degradation. Attention is paid to reducing carbon emissions, resource extraction and landfill depletion as areas of concern, mainly covering only one aspect of the CE, namely recycling. While carbon emissions, resource extraction, anthropocentric land use, and landfills do, without a doubt, harm ecosystem services and biodiversity, CE can help mitigate this significant pressure from the construction sector. To what degree CE strategies can mitigate pressure depends on many variables within the local context, including the land cover and functional redundancy of the species and habitats being affected.

The complexity and broad scope of CE, combined with the locality-specific nature of ecosystem services and biodiversity and the fact that impacts from construction are both direct and indirect, make it challenging to develop a single conversion factor that assigns a score to CE strategies from a biodiversity perspective. However, some possible indicators may serve to monitor and quantify changes from CE strategies on the impact of construction; these are the *Raw material requirement (RMR), Land use, and Biodiversity loss index*. Global warming potential - land use and land use change (luluc) is another more conventional methodology where climate emissions related to land use change are used as a proxy for biodiversity.

The review indicates that CE often focuses on material efficiency rather than nature conservation. From the perspective of ecosystem service preservation and biodiversity, one must, therefore, consider the risk of the rebound effect[4] if CE strategies are only implemented to support and legitimise the growth paradigm through the relative decoupling of growth from raw material extraction and land use. In other words, if recycling strategies are implemented, but overall material usage continues to grow while current raw material extraction practices are not sustainably managed, then there is little chance that the biodiversity crisis will halt. In the case of substituting non-renewable resources with renewable resources, it is critical to consider that, e.g., the existing forestry industry is already putting significant pressure on ecosystems in the Nordics. These resources must be managed sustainably for the overall environmental benefits to outweigh the negative impact on biodiversity and ecosystems. Some articles, however, suggest that the bio-economy or circular bioeconomy has better restorative potential for sustainable management of natural habitats and ecosystem services than the circular economy principles.

CHEMICALS

When examining the benefits of CE strategies, it is essential to recognise the importance of limiting the introduction and recirculation of hazardous chemicals. In the construction sector, legacy substances threaten the circular transition. Therefore, it is essential to determine how to be resource-efficient without looping chemicals that can negatively affect biodiversity, ecosystem services, and overall human well-being.

Chemicals in building materials have numerous valuable functions. However, hazardous chemicals in building materials risk contaminating waste streams and water streams, which may later influence humans, biodiversity, and ecosystem services if not appropriately managed (e.g., Bodar et al., 2018; Aurisano et al., 2021;

4. The rebound effect refers to the offsetting of resource savings resulting from efficiency improvements through increased resource use. Studies show that the material efficiency is also likely to enable the superlative rebound effects (Skelton et al., 2020).

Freige et al., 2018). In the case of implementing CE strategies, the chemicals in these secondary resources may hinder reuse and recycling, and there is a risk that dangerous chemicals cross-contaminate recycled and reused building products.

Reuse and recycling of construction materials can be hindered by the extensive contamination of preservatives, paints and glue, cross-contamination due to lack of selective demolition, legislation, and increased need for manual preparation for reuse (Vis et al., 2016). This highlights the need for material and context-specific risk assessment studies, as some recycled materials may contaminate the built environment. In some cases, hazardous substances from other industries are recycled into construction materials, e.g., ray tubes substituting sand in concrete production containing lead. Using ray tubes in concrete is considered safe because the lead will not release from the concrete. However, consequently, this will triple the amount of hazardous waste in the future, as concrete containing lead cannot currently be recycled (Bodar et al., 2018). Hazardous chemicals also challenge the reuse of building materials because few systems provide the necessary traceability for construction materials. According to Egebæk et al. (2019), the lack of traceability combined with the uncertainty of the chemical content is one of the leading barriers to the increased reuse of building components.

According to Bodar et al. (2018), the linear legislation on the use of chemicals problematises the transition to a circular economy. Currently, the REACH directive primarily hinders using hazardous chemicals in new products. However, it does not concern the waste management of products containing harmful chemicals, as this is a part of the Waste Framework Directive. A critical category (especially within the construction sector) is 'legacy substances', which are prohibited by law but are still a part of products currently in use. For instance, asbestos is not permitted in new building materials but is a part of many existing buildings (Bodar et al., 2018). These chemicals may reoccur in the end-of-life phase, when construction waste is deposited or recycled, representing a potential environmental risk for human health and the environment.

As the CE is gaining momentum, the need to reuse and recycle resources is demanded from governmental and non-governmental stakeholders. However, according to Bodar et al. (2019), these demands must balance resource efficiency targets, environmental safety, and public health targets. A more balanced approach could ensure the benefits of the CE and limit the negative consequences of, e.g., legacy substances.

When examining the linkage between CE and chemicals, green chemistry and the principles of green chemistry are reappearing concepts. According to Chen et al. (2020), integrating CE strategies within the principles of green chemistry would contribute to achieving the circular transition, as this would lessen the use and impact of hazardous chemicals. According to Silvestri et al. (2021), using Green Chemistry would contribute to more materials being reused and recycled.

ANNEX 3 – LONGLIST OF INDICATORS

The following statistics describe the overall distribution of the indicators.

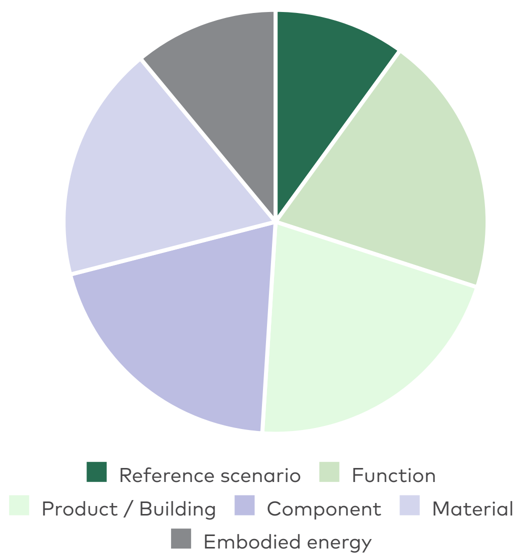

FIGURE 11. THE DISTRIBUTION OF IDENTIFIED INDICATORS ACROSS THE CIRCULAR ECONOMY STRATEGIES

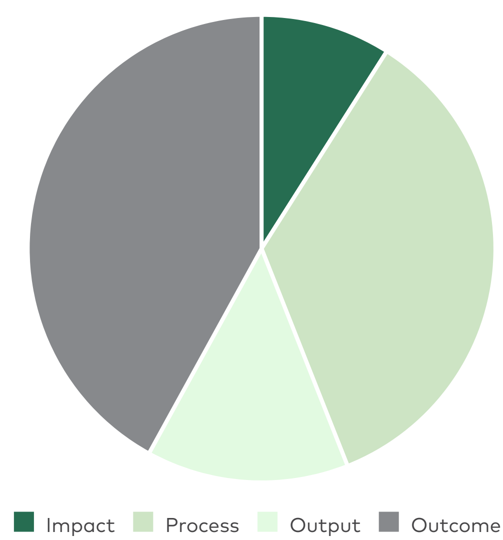

FIGURE 12. THE DISTRIBUTION OF IDENTIFIED INDICATORS ACROSS TIME/ CAUSALITY DIMENSIONS

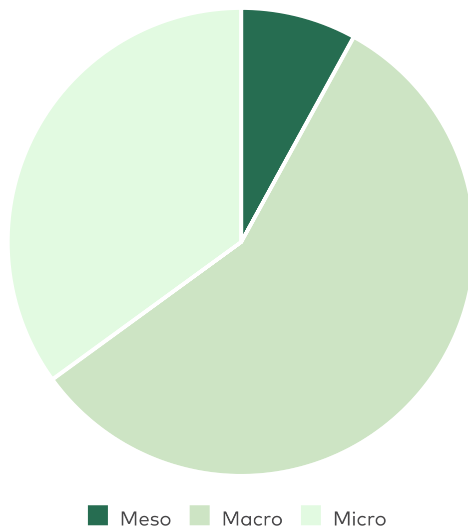

FIGURE 13. THE DISTRIBUTION OF IDENTIFIED INDICATORS ACROSS THE IMPLEMENTATION SCALE

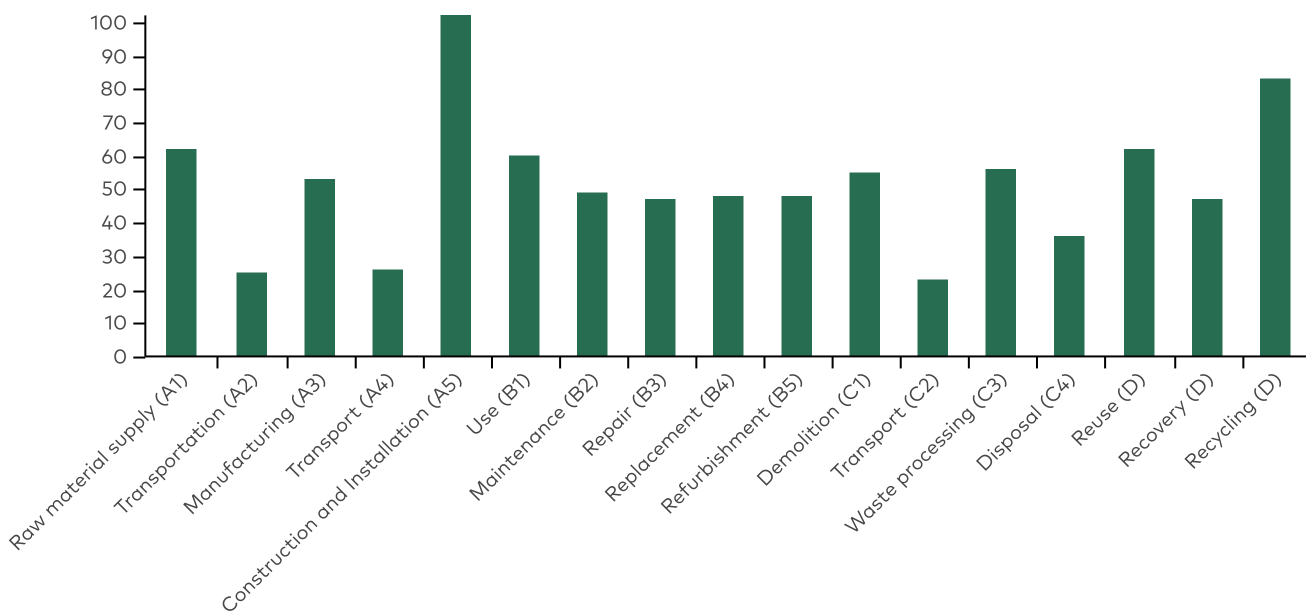

FIGURE 14. THE DISTRIBUTION OF IDENTIFIED INDICATORS ACROSS THE LIFE CYCLE PHASES OF CONSTRUCTION

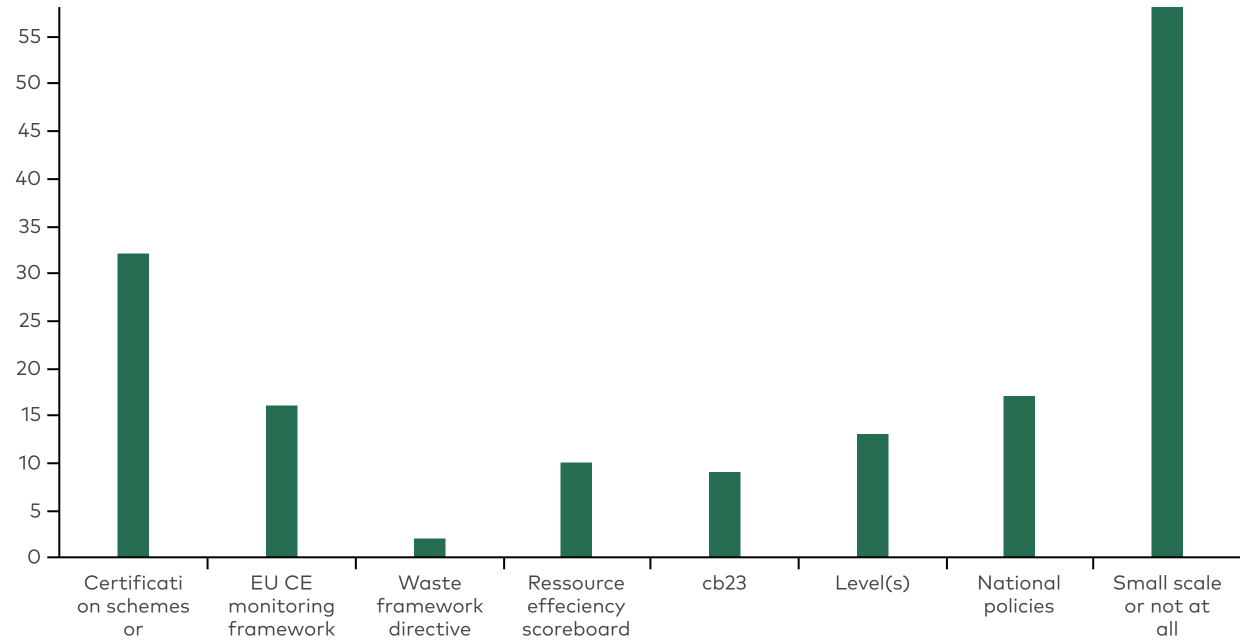

FIGURE 15. THE CURRENT STAGE OF IMPLEMENTATION FOR THE IDENTIFIED INDICATORS

LONG LIST OF INDICATORS

- Academic Laboratories involved with research on CE (or sustainability in regard to CE) in the C&D sector. (e.g., research in building design for CE, research on innovative building materials).
- Accessibility for recycling.
- Adaptability and flexibility in new buildings.
- Adoption of circular business models.
- Amount of unrecoverable CDW.
- Amount of waste that is recycled as the same material (TR6).
- Amount of waste treated for energy recovery.
- Architecture companies/bureaux designing/working with re-usable building components.
- Ashes from energy recovery treatment are recycled as a building material. (TR26)
- Awareness level of CE among the public.
- Bill of quantities, materials and lifespans.
- Biodiversity.
- Building materials with EPDs available.
- Building materials with Material Passport.
- Buildings in use certified by selected certification schemes.
- Buildings where the potential for reuse in construction projects is analysed is higher than 90%.
- Buildings, where building materials are screened before demolition.
- Built-up area.
- Business engagement in waste prevention and reuse.
- Businesses with a certified environmental.
- C&D SME investment per year in resource efficiency activities.
- C2C Material Health Assessment Methodology.
- Capacities developed and trained in CE for CDW management.
- Carbon footprint in the construction sector.
- Chemical material connections.
- Chemically hazardous materials.
- Circular challenges and other initiatives from the public sector.
- Circular material use rate: The circular material use (CMUR) is defined as the ratio of the circular use of materials to the overall material use.
- Circularity properties of buildings.
- Circularity properties of components and materials.

- Circularity properties of rehabilitation projects.
- Co-creation and co-production (i.e. participatory design).
- Collaboration with other industries.
- Collected household waste used as construction material. (TR31).
- Components sized to suit the means of handling.
- Construction and demolition waste / GDP in the construction sector.
- Construction and demolition waste and treatment.
- Construction industries involved in industrial symbiosis.
- Construction industries receiving financial support towards BCDW circularity.
- Construction waste recycled by fractions.
- Contribution of recycled material to raw materials demand.
- Courses available on CE in the universities.
- CPI (Circular economy Performance Indicator.
- Design for adaptability and renovation.
- Design for deconstruction, reuse and recycling.
- Design for disassembly.
- Design for material reuse/durability (reusability or resource-efficiency).
- Design support tools availability.
- Designed for attachment and trust.
- Designed for minimum resource input Designed for emissions minimisation.
- Designed for minimum waste generation.
- Designed for recovery (i.e. material or components).
- Designed for upgrade.
- Development programs put in place for CE in the construction sector.
- Disassembly Effort Index.
- Disassembly requires only common tools and equipment.
- Domestic extraction of resources + Import (measured in Raw Material Equivalents)".
- Domestic extraction of resources + Import (measured in RME) – Export (measured in RME) = DMI – Export (measured in RME)".
- Domestic Material Consumption (DMC): Domestic extraction of resources + Import – Export.
- Domestic Material Input (DMI): Domestic extraction of resources + Import .
- Durability and quality of new buildings.
- Ease of maintenance and cleaning in new buildings.
- Eco-innovation index.

- Economic value of the resources used and the value at the time they are reintroduced into the system.
- Efficient use of water resources.
- Embodied Carbon.
- Embodied Energy.
- Employees in CE-oriented organisations.
- End-of-life management/end-of-life recycling input rates.
- End-of-life recycling input rate (EOL-RIR): The indicator measures, for a given raw material, how much of its input into the production system comes from recycling of "old scrap", i.e. scrap from end-of-life products. The EOL-RIR does not take into account scrap that originates from manufacturing processes ("new scrap").
- End-of-life recycling input rates (EOL-RIR) (percentage).
- End-of-life recycling input rates (EOL-RIR), aluminium.
- Energy usage from the total life cycle.
- Environmental costs (costs of exhaustion, water pollution, CO_2 emissions, toxicity, and land use).
- Environmental friendly design: The ratio of products and services being eco-labelled with the Nordic Swan.
- Environmental friendly design: The revenue from the eco-label, the Swan.
- Environmental tax revenues as a share of total revenues from taxes and social contributions.
- EVR (Eco-cost value ratio).
- Exhibitions or projects held concretely demonstrating CE strategies in the built environment (e.g., reuse in building construction, architecture/design with reused elements).
- Existing value lost (output).
- Expansion material inputs.
- Expected building lifetime (new buildings).
- Expected impact of industrial symbiosis and sharing economy.
- Expected lifespan of utilised products, compared to the average life span of status-quo products in the same application.
- Few hazardous materials.
- Fines on landfilling.
- Flexibility of technical solutions in new buildings.
- Frequency of recycling and quantity of CDW recycled.
- Frequency of reuse and quantity of CDW reused.
- Freshwater abstraction by source and sector.

- Fully devalued (waste) materials produced after each use cycle (lower is better).
- Generation of municipal waste per capita.
- Google Search popularity of terms such as "circular economy", "circular construction", "sustainable construction" and similar.
- Green deals.
- Green Public Procurement: Circular economy criteria in GPP.
- Green Public Procurement: The share of public tenders (being subject to EU procurement law), which include environmental elements.
- Green suppliers.
- Gross additions to stock (GAS).
- Gross investments in tangible goods (percentage of GDP at current prices).
- Hazardous waste in the construction sector.
- High-value recycling.
- Impact on the environment.
- Imports in raw material equivalents.
- Initial investment costs.
- Initial value (input) of materials.
- Innovative schemes for CE developed by the government for CDW management.
- Investments: In material goods (in circular sectors) defined as investments in all material goods (in circular indicators) as a share of GDP in the year of reference.
- Investors/real estate project owners or investments in circular buildings or circular real estate projects.
- Joints and materials withstand repeated use (durability).
- Land use change, index.
- Land-use: Share of preserved areas versus industrial purposes.
- Leadership development programs set in place to raise greater awareness among individuals involved with the construction process and develop individuals (in relation to CE).
- Life cycle Global Warming Potential.
- Lifetime of the material in the anthroposphere.
- Lightweight materials.
- Longevity of buildings and components.
- Maintenance material inputs.
- Management systems adapted within building sector companies, e.g. EMAS / ISO".
- Material Circularity Indicator (MCI).

- Material circularity indicator CIRC (actual cumulative service in per cent of maximal service).
- Material efficiency score: SMEs, resource efficiency and green markets.
- Material outputs from stock.
- Material rejected for material recycling used for energy recovery.
- Material stocks (MS)of non-metallic minerals.
- Material stocks (MS)of non-metallic minerals.
- Materials available for the next cycle (output).
- Materials collected and resold by retailers.
- Materials lost (output).
- Materials restored and their quality: Contamination, Tramp element content.
- Materials used (in-put).
- Materials with local high-value recycling potential after each use cycle (lower is better).
- Metals recycled from waste ashes from energy recovery treatment.
- Mineral depletion indicator.
- Minimisation of waste on construction sites.
- Modular design.
- Municipalities with circularity goals regarding municipal buildings.
- National standards under CEN / TC 350/SC.
- Net additions to stock (NAS).
- New buildings certified within a sustainability system (DGNB, Svanemærket, etc.).
- New construction projects applying Building Information Modelling (BIM) for the assessment of materials flows.
- Number of EPDs for "circular" materials.
- Number of EU Taxonomy-aligned buildings.
- Often divided into fossil energy, non-metallic minerals, metallic minerals, biomass, others.
- Open buildings system.
- Origins of the materials used.
- Patents related to recycling and secondary materials.
- Per capita stock expansion.
- Platforms for exchange/sales of reused building materials.
- Platforms: (Extra) utilisation of (public) buildings monitored via platforms.
- Platforms: Activity or frequency level of products/materials reuse platforms (number of times people visit the platform page, number of times people offer reusable products, number of times architects/designers buy from these reuse platforms).

- Platforms: Material efficiency audit data collected through digital platform.
- Platforms: Online social collaboration platforms that bring together CE organisations and members of those organisations worldwide, enabling more collaboration, sharing, and overall communication.
- Platforms: Utilisation of secondary resources through 3rd party platforms.
- Platforms: Variability of reusable elements collected, offered on reuse platforms and available for designers to choose from Reverse logistics and take back schemes set in place.
- Position in the waste hierarchy. Total waste generation is multiplied by a step value for each step in the waste hierarchy to produce a score value of the position of a given waste system in the waste hierarchy.
- Private investments, jobs, and gross value added related to circular economy sectors.
- Product-Level Circularity Indicator.
- Product, components, and material retention rate.
- Products and components collected for reuse by the municipality or NGOs at recycling stations or reuse areas.
- Provision for 'realistic' tolerances for assembly and disassembly.
- PSS solutions within the sector (market share).
- Quality in new buildings.
- Raw Material Consumption (RMC).
- Raw Material Input (RMI).
- Recirculated economic value from EoL components over total product value.
- Recovery rate of construction and demolition waste.
- Recyclability of component.
- Recycled content in buildings.
- Recycled material value/resale value.
- Recycled materials as part of the total amount of raw materials for construction.
- Recycling efficiency rate.
- Recycling rate of all waste, excluding major mineral waste: (Recycled waste / treated waste).
- Recycling rate of municipal waste: The share of municipal waste being recycled of the total waste amount.
- Recycling rate within the C&D sector for a range of fractions, including overall packaging, plastic packaging, packaging based on wood, electronic waste, biowaste and construction and demolition.
- Refurbishment rate.
- Rehabilitation projects with reuse of buildings at least 20%.

- Rejected material for material recycling sent to landfill.
- Repairability (availability of repair manuals or spare parts or products designed for maintenance).
- Resource productivity in construction.
- Resource security: kg resources extracted per kg DMI.
- Resource- and carbon footprints.
- Reuse generated by reuse operators or households.
- Reuse in public works.
- Reuse potential assessed through digital material passport of buildings.
- Reuse potential indicator (RPI) assesses based on current technologies if a material is seen as material or waste.
- Reused material of total C&D waste.
- Reversible mechanical connections.
- Roadmaps for CDW management availability.
- Robustness of new buildings.
- Running and replacement costs.
- Scientific articles on CE in buildings.
- Self-sufficiency for raw material.
- Self-sufficiency for raw materials, aluminium.
- Self-sufficiency in renewable energy.
- Separated in many different types of waste from construction, including all types of hazardous waste."
- Service generated by material consumption.
- Servitisation (i.e. product service system).
- Share of certified building projects.
- Simplicity in construction: The number of connections (lower is better).
- Simplicity in construction: The number of different material types (lower is better).
- Simplicity in construction: The numbers different types of connections (lower is better).
- Sorting of waste at construction sites.
- Structured Facility Management documentation in new buildings.
- Students applying for CE-related studies at university.
- Supply chain footprint of regenerative flows.
- Targets in place regarding public buildings (e.g. repurpose).
- Taxes on landfilling (amount/ton of waste).
- TCA in new buildings.

- The degree to which CE infrastructures are in place.
- The impact of extraction of raw materials.
- The ratio of virgin materials to recycled, re-used or rapidly renewable materials.
- The use of renewable, recycled and sustainable raw materials in new buildings.
- Times of Use of a Material (NTUM).
- Total renovations vs demolition and new buildings.
- Trade in recyclable raw materials: Between EU-states.
- Trade in recyclable raw materials: Export of recyclable raw materials from non-EU countries.
- Trade in recyclable raw materials: Import of recyclable raw materials from non-EU countries.
- Trained environment- and resource-coordinators.
- Treatment of hazardousness mineral waste from construction by waste management option.
- Treatment of waste by waste category, hazardousness and waste management operations.
- Turnover from reused construction- and demolition materials sold by retailer.
- Urban waste management costs.
- Use of cement per m^2 created.
- Use stage energy performance.
- Utilisation rate of existing building stock.
- Value available for the next cycle (output).
- Value-based resource efficiency (VRE).
- Virgin mineral materials produced and used in the building sector.
- Voluntary collaboration towards CE for CDW.
- Waste amounts treated as landfill, including waste rejected from other fractions.
- Waste amounts treated by energy recovery, including waste rejected from other fractions.
- Waste amounts treated by material recovery, including waste rejected from other fractions.
- Waste amounts used as construction material, including waste rejected from other fractions.
- Waste and resource management.
- Waste being deposited.
- Waste being generated from the construction sector.
- Waste from building site.

- Waste from construction, renovation and demolition activities.
- Waste material used in the production of new materials (roofing felt, concrete, gypsum, wood chipboards, Rockwool).
- Waste materials being recycled. Separated in a large number of different types of waste from construction, including all types of hazardous waste.
- Waste materials ratio to reusable and/or recyclable materials generated when a building is refurbished or demolished.
- Waste materials treated for energy recovery from the construction sector. Separated into many different types of waste from construction, including all types of hazardous waste.
- Waste produced in the city.
- Waste that is recycled as construction material, backfill and landfill cover.
- Waste volumes from the construction sector in relation to value-added, goods procurement, production and turnover within the same sector.
- Water productivity.
- Water usage in the use phase.
- Water use: Amount of used water in relation to accessible water.
- Water, land, material footprints, or a combination thereof (footprint dashboard).
- Workshops and exhibitions: Visitors at exhibitions and workshops regarding circular construction.
- Workshops: Different partners from the construction industry/built environment sector addressed by CE workshops brought together, attending, and addressed by CE workshops.

ABOUT THIS PUBLICATION

NORDIC NETWORK FOR CIRCULAR

Simon Claësson Kaarsgaard, Project manager, Norion Consult
Bjørn Bauer, Project Director, Norion Consult
Leonardo Rosado, Chalmers University
Tuuli Kassi, Ethica
Maria Ekblad, TRE Rådgivende Ingeniører og Biologer
Regina Skattenborg, Norsus

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Nordic co-operation

Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland and Åland.

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The Nordic Council of Ministers
Nordens Hus
Ved Stranden 18
DK-1061 Copenhagen
www.norden.org

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