



Nordic Council
of Ministers

Low-Carbon Circular Transition in the Nordics:

Actions needed to unleash the potential

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This publication is also available online in a web-accessible version at <https://pub.norden.org/temanord2023-504>.

Executive summary

Key questions

The Nordic region aims to be a forerunner in the transition to circular economy. That transition can facilitate business development and innovation and have positive effects on biodiversity, greenhouse-gas emissions, and the value extracted from those resources that must be consumed. It also supports cleaner air, water, and soil alongside benefits of many other kinds. There are significant opportunities for mutual learning region-wide.

Aimed at generating insight as to the region's related potential and recommending concrete ways of together unlocking this potential, the project Low-Carbon Circular Transition in the Nordics addressed the following questions:

What areas, industries, and sectors are particularly important for the circular transition in the Nordic countries? What kind of potential exists in these?

What will it take to unlock the circularity potential such that this region can become a leading one in the circular economy domain and inspire other regions, globally?

The countries' shared areas of strategic interest

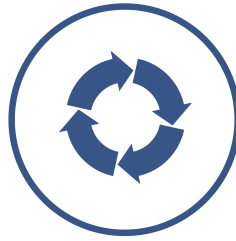
Most of the Nordic countries have developed national strategies, roadmaps, and programmes for promoting transition to circularity or are in the process of doing so.

Detailed study of the national priorities revealed interesting differences but also several themes of common strategic interest. These involve specific **sectors and industries**, alongside important **material flows** and key **transition-drivers** for progress toward circular economy.



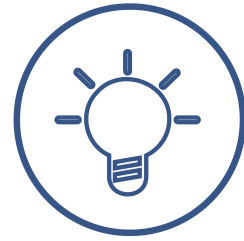
Industries

Real estate and construction
 Mobility, transport and logistics
 The bioeconomy
 The food and beverage industry
 Manufacturing and process industries



Material flows

Textiles
 Plastic
 Packaging
 Minerals and metals

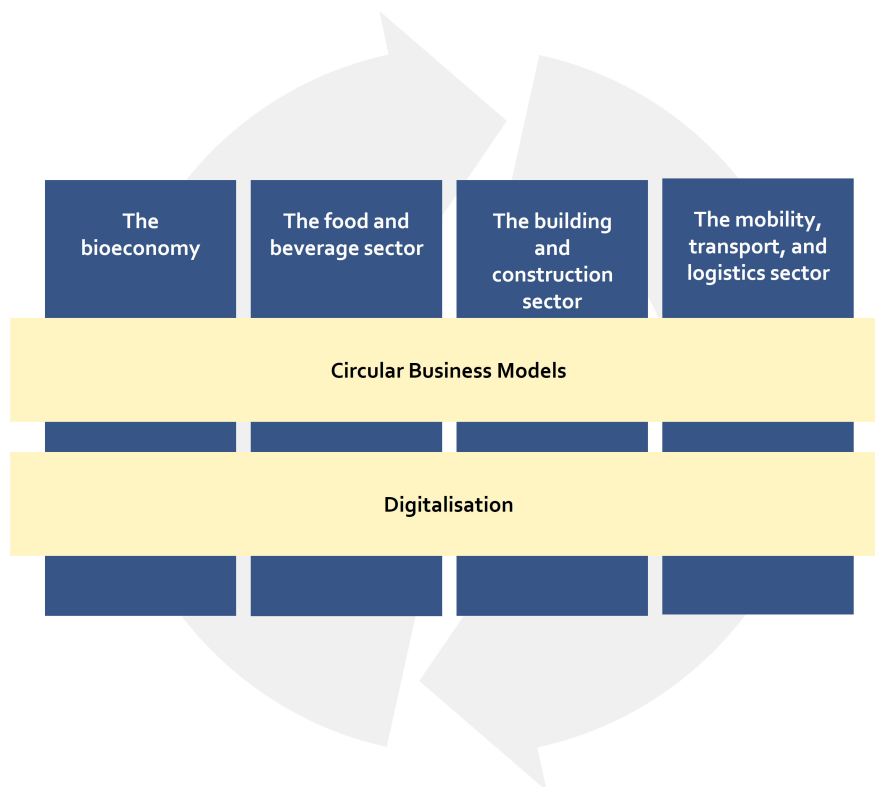


Transition-drivers (enablers)

Digitalisation
 Green procurement / municipalities
 Circular businesses
 Finance
 New consumption patterns

Disruption of traditional industries via new business models and digitalisation

Four key areas of industry and two cross-cutting drivers were selected for detail-level study of circularity impacts. The former – **the bioeconomy, the food and beverage sector, building and construction, and the mobility sector (incl. transport and logistics)** – play a prominent role in the Nordic economies. They are also responsible for significant emissions and waste. The drivers – **applying new circular business models** and **better exploiting data/digitalisation** – can bring systemic change to those economies' use of resources, materials, products, and services, change that holds promise for significant benefits.



Circularity's complex climate and environment impacts, economic effects, and societal reach – and the Nordics' power to reinforce the positive impacts



Climate and environmental impacts are predominantly positive, including benefits from reduced emissions and waste, improving the quality of air, waters and soil, as well as reducing biodiversity loss. Positive impacts realise if circular economy leads to real decrease in the use of virgin resources and does not lead to significant increase of e.g. chemicals or nutrients in the processes. Impacts on biodiversity and natural ecosystems will differ among Nordic regions.



Impacts on innovation and business growth are positive overall. Businesses' adoption of circular practices will require effort in the short term but yield cost savings and greater business opportunities in the long run. Better use of data and digital tools enables resource-efficiency, minimisation of loss, longer retention of value, and support for solid end-of-life management. New circular business models usher in new ways of providing products and services, with servitisation, sharing, looping, and different ownership models (for materials, products, and services).



Circularity's **socio-economic impacts** differ across the Nordics, and changes in industry structures and the employment base can create positive and negative ripples both. In the long run, circular economy can lead to improved economic diversity and to skills development, creating more resilient, innovative, and prosperous regions. Public support for a balanced and just transition is critical for this process.

The study identified dozens of rich opportunities for circular transition in the sectors examined. Eight case studies were chosen to illustrate value chains' transformation and the impacts that it will have.

1. Closed-loop wood-based textile solutions
2. New applications for ocean biomass
3. Predictive management supporting circular food-process solutions
4. New business models and digital platforms for minimisation of food loss
5. Models for increased (re)utilisation of buildings
6. Digital platforms and marketplaces - infrastructure for circular economy
7. Smart and green mobility solutions (Mobility as a Service etc.)
8. Circular transport logistics

The need for policy action to remove barriers to the transition

Alongside the potential, many barriers to releasing it are visible in the Nordics. The study identified these as the most typical manifestations of the critical ones:

Regulatory barriers:



Policies and standards being counterproductive, absent, or malfunctional
National or regional variations in regulation hampering business development and co operation
Decreased will to change, due to lack of (economic) incentives

Technological barriers:



Technology remaining under development and not being functional, available, or affordable for most users
Inability to scale new technologies and models to market needs, on account of lack of knowledge/investments
Circular economy's demand for new value-network structures that require difficult change
Limited availability/usability of digital tools and data

Market barriers:



Underdeveloped markets and infrastructure for circular economy
The costs and risks of value networks' restructuring exceeding the immediate benefits
Virgin materials' and waste-handling's costs being so low that circularity is unprofitable

Cultural barriers:



Linear business operations being held up as the norm
Lack of societal knowledge/awareness of circular business potential
Circular practices coming up against timidity or negative consumer attitudes
Skills, competencies, and expertise not being up-to-date

Recommendations to the Nordic Council of Ministers

The study's results are summed up in a set of recommendations addressing how the Nordic Council of Ministers and region-wide co-operation can help tear down the barriers and support positive impacts of circular transition. Namely, the Nordic Council of Ministers is recommended to take the following actions in an overarching and cross-cutting manner:

1. Facilitate policy dialogue in relevant Nordic committees of senior officials, in pursuit of joint statements and recommendations for the Nordic countries.
2. Co-ordinate the handling of circular economy issues at Nordic Council of Ministers secretariat level, to ensure information-sharing, identify synergies, and avoid overlap and conflicts, while also dedicating resources to this co-ordination and designating clear contact points.
3. Co-ordinate input to those EU policy processes of significance for circular economy in the Nordics. Though the Nordics may not have a joint stand on the topics, dialogue to prepare for EU regulation and its national implementation is always useful and helps the countries concerned understand the impacts of the regulation in question.
4. Support networking between cities, because cities hold power to influence change directly in several of the sectors studied, through public procurement, establishment of local guidelines, and collaboration on practices.
5. Encourage co-operation on public procurement guidelines and practices at national, regional, and local level alike, for guaranteed inclusion of circular economy principles.
6. Continue facilitating the Nordic networking for eco-industrial parks, to develop good models for circular economy activity and industrial symbiosis within and between sectors.
7. Facilitate the creation of Nordic public-private partnerships within key branches of industry, bringing the largest industry players together with leading knowledge institutions, investors, and regional and local governments. Already established co-operation structures (such as the Nordic Circular Hotspot) could serve as a base.
8. Continue supporting joint Nordic RDI that carries knowledge and ideas forward into practice and creates market-viable solutions.
9. Consider using the Nordic region as a testbed for fast-track implementation of certain policies and practices.

Key findings and recommendations specific to the four sectors at the heart of the study are summarised under the sector-specific headings below.

This study, financed by the Nordic Council of Ministers / Nordic Working Group for Circular Economy, was conducted in three parts. In 2020–2021, the first part focused on questions related to which areas of the economy are especially important for the Nordics in the transition and what circularity potential these hold. For instance, could the transition lead to changes that confer competitive advantages or other benefits for the Nordic economies, societies, and environment? The second sub-study, in 2021–2022, examined the impacts of transition in the chosen areas on business development, the climate and environment, and Nordic economies and societies, as well as the barriers to change. In the final part of the study, conducted in 2022, a framework for the Nordic policy action needed was analysed and discussed with stakeholders of the transition, resulting in the set of recommendations for the Nordic Council of Ministers. The work was carried out by a Nordic consortium led by Gaia Consulting (Finland) with partners Environice (Iceland), NORION Consult (Denmark), NORSUS (Norway), and RISE (Sweden).

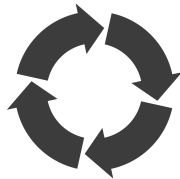
The Bioeconomy



The Nordic countries are rich in bio-based resources and skilled in their management and use. Many parts of the region are heavily dependent on the bioeconomy sector, which employs nearly 1/5 of the Nordics' population.

Climate change, resource scarcity, and biodiversity issues have drawn international attention to the importance of more efficient and sustainable use of bio-based materials. The Nordic countries cannot rely on harvesting more natural resources as a route to further economic growth, so there is mounting pressure to use our resources wisely and preserve our land- and ocean-based ecosystems. Growing global concern about energy supply and food self-sufficiency calls for discussion of how to prioritise the use of biomass for food, animal feed, energy, and higher-value materials and products.

Circular transition in the bioeconomy sector can bring considerable gains throughout the value chain:



Narrowing the loops – resource-efficient use of biomass via digital predictive monitoring, standardisation, and management

Slowing the loops – tracking material flows and optimising side- and waste-stream management accordingly, also prolonging the life of products that use bio-based materials

Closing the loops – making recyclable products and developing treatment processes and systems for collecting the materials for recycling

Some barriers to the transition in this area still must be removed:

Regulatory barriers:



The permit regulations make it slow and difficult to integrate new bio-based components into manufacturing processes

The criteria applied in awarding eco-labels do not reward the use of bio-based or recycled content

Regulation does not provide incentives to recycle bio-based materials (such as bio-based plastics or fibres)

Technological barriers:



Commercially scalable solutions that ensure transparency and traceability of materials are lacking

(Chemical-based) recycling technologies do not exist at scale

Market barriers:



Incentives for investing in chemical-based recycling technologies are absent

Recycled material's cost is high relative to that of virgin materials

There are high risks of duplication and diseconomy of efforts when new solutions are introduced to the market

Cultural barriers:



Enterprises lack expertise in circular practices

Public support for developing circular economy value networks is lacking

Consumer attitudes to new bio-based products vary greatly

To support the circular transition in the bioeconomy domain, the Nordic Council of Ministers can:

1. Support the development of regional innovation ecosystems based on sustainable and circular bioeconomy-related practices.
 - a. Top up national innovation funding for developing these ecosystems with support targeted at Nordic-level networking and exchange of knowledge between ecosystems.
 - b. Enhance Nordic exchange of information via digital platforms and new service-business models, as a means to enhance the use of side streams.
2. Accelerate the development of large-scale circulation of bio-based materials.
 - a. Create a Nordic roadmap that covers how to develop well-functioning recycling schemes and where the countries might be able to draw on cross-border co-operation or joint technology development.
 - b. Launch and co-ordinate national and Nordic pilot programmes for testing

of prospective circular economy facilities.

- c. Facilitate dialogue on regulation for recycling of novel materials.
- 3. Establish dialogue on the Nordic policy level to address blue bioeconomy operations.
 - a. Co-operate on proactive and visually dynamic mapping of ocean resources, including the possible uses and the opportunities for increased value.
 - b. Work toward incentives and requirements' enforcement in all parts of the Nordic region, so that by-products of fishing operations are brought to shore, appropriately.
 - c. Develop policies that support aquaculture rooted in sustainability (incl. with regard to nutrient circulation).
 - d. More fully develop enabling regulation for the use of alternative and novel ingredients in food applications and for other purposes.

The key impacts of these actions should be



...Among the direct impacts, emission reductions through production of less material. With greater reuse and recycling, the need for extraction of virgin materials falls. Circular design can support substitution with more sustainable materials, reduction in waste, and decreased landfilling. Treating hazardous waste, in particular, entails environmental risks.



...Circular design in the construction sector, which could lead to cost savings, larger markets for material streams, and new business models plus business growth related to (digital) marketplaces and logistics. Digitalisation will prove vital. With less new construction, the sector's activity will experience negative business impacts too, creating a need to revisit sustainable business models and ecosystems.



...Potential impacts visible from developing housing, jobs, and business activities in various locations by means of adaptive (re)utilisation of buildings. Skills development will be needed in building and construction, and its overall employment structure may change, with focus shifting toward repair and using digital platforms. Health and safety impacts from buildings and their use may vary.

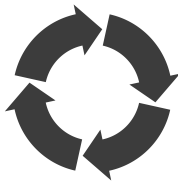
The Food and Beverages Sector



The food and beverage sector comprises key resource flows in the Nordic countries, with considerable turnover and employment figures. Food production is also a necessity for the countries' supply security. Agriculture is the primary producer of resource flows for the food and beverage industry, while in some regions, fishery and aquaculture provide considerable resources.

Reducing food loss and waste is a key sustainability challenge in the Nordic countries. The food and beverage industry generates significant amounts of waste - a third of food produced is lost or wasted along the value chain from primary producers to final consumers. Households generate up to 50–70% of the food waste. For food loss, reliable data is difficult to find. The Nordic countries can take a lead in reducing food loss and waste and circular economy principles can support this effort.

Circular transition in the food and beverage industry can bring considerable gains throughout the value chain:



Narrowing the loops – making strategic choices such that all side streams are used, with no food loss in the fields and seas

Slowing the loops – developing business models for preventing food waste, including digital business-to-business and business-to-consumer services aimed at food being consumed before it goes bad

Closing the loops – circulating food waste for bioenergy (as a last resort)

Some barriers to the transition in this area still must be removed:

Regulatory barriers:



There are no commonly agreed definitions for pre-processing food loss (crops left in the fields, fish material left in the sea, etc.)

Laws limit using side streams from primary production and from food waste

Food-safety regulations and tax laws constrain the options for redistributing food products that are near their expiry date

Technological barriers:



With produce's short life, reducing waste requires fast, efficient processes

The implementation and market penetration of digital tools to monitor food waste remains limited

Market barriers:



Low waste-handling costs in combination with strict food-safety regulations make it more profitable to waste food than to donate it

Better management of waste/loss, by reducing the need for primary production, may conflict with farmers' desire for economic growth

Retail displays a paradoxical relationship between discounts that prevent waste and efforts to sell products at full price

Cultural barriers:



Farmers display knowledge gaps related to the economic and environmental gains that circular practices can bring

Consumers prefer food that looks as good as it tastes, so produce goes to waste for aesthetic reasons

Attitudes to using certain by-products for food create problems, as do issues with consumers differentiating between use-by and best-before dates

To support the circular transition in the food and beverages sector, the Nordic Council of Ministers can:

1. Participate in developing common frameworks for reporting on food loss.
 - a. Define system boundaries, vocabulary, and methods that permit easy sharing and comparison of data on food loss and waste (total and per-capita figures) along the whole food-supply chain.
 - b. Co-ordinate common target-setting for reducing food waste and food loss, for 2025 and 2030.
2. Alongside public authorities take the lead in addressing food waste and ensuring its reduction.
 - a. Develop requirements and incentives for bringing class II vegetables into retail environments and professional kitchens.
 - b. Make public tenders contingent on meeting concrete demands for waste-prevention measures and for reporting of related progress data.
3. Establish a common stance for Nordic policy with regard to EU regulation of food waste and novel foods.
 - a. Develop quality and safety standards to stimulate by-products' and food waste's use for food and its valorisation.
 - b. Develop mandatory food-loss monitoring and reporting obligations EU-wide in line with the existing guidance of the delegated act on that waste's measurement.
4. Encourage food's donation and other redistribution for human consumption, with this use prioritised over animal feed and over reprocessing into non-food products or energy.
 - a. Develop a code of conduct (or similar articulation of principles) for a more secure food hierarchy in times of rising biogas prices.
 - b. Create economic incentives for donation between food value chain stakeholders and the third sector reliant on voluntary schemes when redistributing surplus food.

The key impacts of these actions should be



...Since food waste accounts for 8–10% of greenhouse gases globally, positive climate effects from preventing it. Resource-efficient primary production improves soil quality and reduces water consumption, nutrients entering the air, water, and soil; and the overall environmental burden.

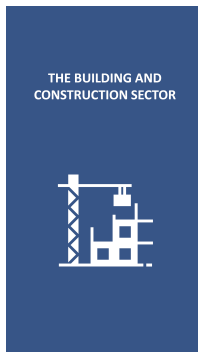


...Better management of food-production chains, which minimises economic losses from food loss and food waste. In addition to cost savings, it creates new business opportunities related to data and digital solutions.



...Resource-efficient primary production. This may reduce the area that must be cultivated and perturb some regions' labour structure, but it may also lead to diversification of the employment base, new skills needs, and potential for better access to affordable produce with health and welfare impacts.

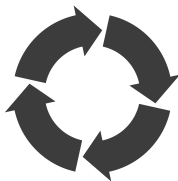
Building and Construction



The building and construction sector represents more than 10% of economic activity in the Nordic countries. It also accounts for a significant proportion of materials' consumption, energy use, and waste generation globally. Half of the earth's raw materials go toward construction, and nearly 40% of all energy consumption arises from the operation of buildings and structures. Of all waste generated within the EU, 30% comes from the construction sector. Therefore, transforming this industry is a vital pillar of circular economy.

The Nordic countries possess advanced expertise in construction. This represents a significant competitive advantage that the region can exploit in export markets also, together with circular-design competencies

Circular transition in the building and construction sector can bring considerable gains throughout the value chain by stimulating rethinking of buildings' entire life cycle.



Narrowing the loops – circular design and choices of materials, avoiding waste/loss by enhancing efficiency

Slowing the loops – keeping existing buildings functional for as long as possible, through renovation and rebuilding but also via optimal use, shared use, reuse, and repurposing

Closing the loops – ensuring reuse in further loops by tackling challenges related to issues such as hazardous materials

Some barriers to the transition in this area still must be removed:

Regulatory barriers:



Variations in building regulations (even between EU Member States) impede trade
Systems for environmental permits vary even country-internally
Classifications and procurement criteria pose challenges – definitions related to end-of-life waste pose issues, for example
Treatment criteria specific to construction and demolition's end-of-life waste remain absent
The regulation is not innovation-friendly, and it is hard to interpret in a circularity-positive way

Technological barriers:



Without technologies for optimising materials' use in buildings, more of them is used than necessary
Technologies and styles change in the course of buildings' long life
Cost-efficient automatic sorting, assessment, and quality assurance mechanisms for materials at the demolition stage do not exist yet
The design of construction elements such as walls, frames, and flooring does not focus on reuse possibilities
It is tricky to keep data up-to-date, reliable, and compatible in today's digital solutions that store details of buildings' components and materials

Market barriers:



The high profitability of building from virgin resources does not create incentives for circular economy
Buildings' long lifetime weakens market incentives to focus on reuse and recirculation of structural components and materials
Value chains for closing the sector's material loops are underdeveloped (incl. organisation among demolition companies, suitable online platforms, processing infrastructure/facilities, and databases covering markets for reused and reusable materials)

Cultural barriers:



Knowledge of what solidly functioning building-information modelling requires remains poor
Quality assurance for reused building materials is lacking
(Digital) marketplaces for material side streams see limited use

To support the circular transition in the building and construction sector, the Nordic Council of Ministers can:

1. Collaborate on Nordic input to EU initiatives.
 - a. Give joint Nordic input on EU-level initiatives within the Green Deal, such as development of the Construction Products Regulation, the union's building-logbook initiative, and its sustainable-carbon-cycles initiative (with support for quantifying the climate benefits of biogenic carbon stores in buildings as the work progresses).
2. Continue and expand the knowledge-building and knowledge-sharing work.
 - a. Continue to support sharing of knowledge about circular public procurement through the relevant authorities and encourage the development of best practice for it, moving from discussion to concrete actions.
 - b. Support building a knowledge base covering the possibilities for repurposing buildings and prolonging their useful life, while also accumulating knowledge about ownership models and concrete actions for shifting ownership in the Nordics.
 - c. Support knowledge-building and R&D related to refurbished components and demolition waste.
3. Consider adopting certain EU policies in advance of their EU rollout.
 - a. Investigate whether some parts of the future EU strategy for circular construction could be applied more swiftly in the Nordic region.
 - b. Pilot joint Nordic initiatives that address how regulation or incentives (carrot or stick mechanisms) could be used to ensure that circular strategies get applied and assessed before any demolition decision.
 - c. Develop common Nordic instructions for pre-demolition audits.
4. Take the lead alongside government authorities in target-setting and for circular public procurement in construction.
 - a. Suggest using existing multi-step principles for public procurement to inform common guidelines for the governments.
 - b. Collaborate on developing more detailed target-setting as a next step, even if specific targets may vary between the countries.

The key impacts of these actions should be



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Digitalisation will prove vital. With less new construction, the sector's activity will experience negative business impacts too, creating a need to revisit sustainable business models and ecosystems.



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Mobility, Transport and logistics

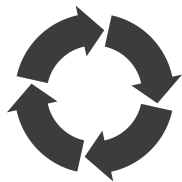


Mobility and transport logistics is both a highly important sector in its own right and an engine for managing the resource flows in a circular economy. Mobility and transport accounts directly for several percentage points of the countries' total GDPs and is a significant source of employment across all of the Nordic countries.

Domestic transport accounts for a significant proportion of CO₂ emissions, and all countries in the region have set targets for reducing their emissions from transport.

A clear need exists to lower emissions, develop efficient transport systems and logistics, and support innovative transport services through circular transition of this sector.

Circular transition in the mobility, transport, and logistics sector can bring considerable gains throughout the value chain:



Narrowing the loops – less need for manufacture of vehicles

Slowing the loops – design of refurbished physical assets and efficient use of existing assets rather than creation of new ones

Closing the loops – recycling and reuse of the constituent raw materials (as the last resort)

Some barriers to the transition in this area still must be removed:

Regulatory barriers:



Deployment of autonomous freight vehicles on public roads is an unsolved challenge
Reverse logistics is subject to especially strong policy and regulatory pressure

Technological barriers:



Highly complex computation work is needed in smart logistics

Market barriers:



Overly diffuse Mobility-as-a-Service competition leads to diseconomy of scale
The market for smart transport logistics is still immature

Cultural barriers:



Shifting from direct ownership/operation of vehicles leads to loss of flexibility and immediacy for end users, so it demands a change in attitudes

To support the circular transition in the mobility, transport, and logistics sector, the Nordic Council of Ministers can:

1. Give co-ordinated Nordic input to relevant EU policy and strategy initiatives.
 - a. Review and, where appropriate, reinforce Nordic input to relevant EU initiatives at ministerial level.
 - b. Ensure appropriate ongoing Nordic representation in relevant EU-level expert groups such as the Digital Transport and Logistics Forum.
 - c. Establish and reinforce contacts that link such groups' experts with relevant Nordic policymakers.
2. Nurture ongoing RDI activities, especially with regard to autonomous vehicles and electrification but also in relation to (fast, real-time) processing and sharing of data.
 - a. Exploit existing structures and programmes (e.g., Nordic Innovation instruments).
 - b. Review funding disbursement and the targeting of funds.
3. Standardise the establishment of personal mobility schemes across individual cities, regions, and countries.

- a. Devise specific guidelines for the associated initiatives.
 - b. Establish regional or national review panels for Mobility-as-a-Service (MaaS) initiatives and other infrastructure plans.
 - c. Take advantage of such existing structures as Smart City Networks for this.
- 4. Consider direct intervention where appropriate so as to harmonise personal mobility or logistics ecosystems and reduce the number of actors involved.
 - a. Identify where operations could be amalgamated or merged to good effect (by reducing counterproductive competition or insulating against economic pressures).
 - b. Investigate and deploy ways to encourage or force such consolidation, via specific incentives or awarding/withholding operation licences, permits, or concessions.
- 5. More fully embed the requirement for smart logistics and (where suitable) for circular personal mobility in public procurement criteria throughout the Nordic region.

The key impacts of these actions should be



...At national level, smart mobility and transport logistics leading to direct emission reductions relative to the levels of today's transport ecosystems.



...A need for innovation and business development for developing green, smart, and circular mobility and transport logistics. This should accelerate R&D in the manufacturing sector, for non-personal transport, and for associated activities. There is potential for long-term economy of scale, cost savings on logistics, reduction in idle/underutilised assets, and new business concepts based on digital solutions and a platform economy.



...Smart mobility leading to the possibility of lower household expenditure on mobility and transport but with inequality of opportunities between regions and between urban and rural areas. Circular transport logistics will create a greater need for skilled labour but possibly reductions in total employment in the logistics sector.

Sammanfattning

Nyckelfrågor

Norden strävar till att vara en föregångare i omställningen till en cirkulär ekonomi. Den cirkulära omställningen kan främja affärsutveckling och innovation, minska påfrestningarna på den biologiska mångfalden, minska växthusgasutsläppen och öka värdet av de resurser som utvinns. Det kan bidra till renare luft, vatten och jordmån samt ha positiva effekter av många andra slag. Möjligheterna till ömsesidigt lärande i den nordiska regionen är omfattande.

Projektet "Low-Carbon Circular Transition in the Nordics" syftade till att skapa insikt om den cirkulära potentialen i Norden samt rekommendera konkreta åtgärder för att frigöra denna potential. Studien behandlade följande frågor:

Vilka områden, industrier och sektorer är särskilt viktiga för den cirkulära omställningen i Norden? Vilken typ av potential finns i dessa?

Vad krävs för att frigöra den cirkulära potentialen så att Norden kan bli en ledande region och global inspiration inom cirkulär ekonomi?

De nordiska länderna delar många strategiska intressen

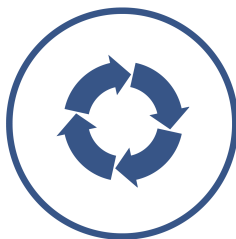
De flesta av de nordiska länderna har under de senaste åren arbetat med att ta fram nationella strategier, färdplaner och strategiska program för att främja övergången till en cirkulär ekonomi.

En detaljerad studie av de nationella prioriteringarna visar på intressanta skillnader men också på flera teman av gemensamt strategiskt intresse. Dessa berör såväl specifika sektorer och industrier som centrala materialflöden samt olika drivkrafter som främjar omställningen till en cirkulär ekonomi.



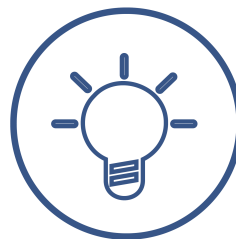
Branscher

Fastighets- och byggverksamhet
Mobilitet, transport och logistik
Bioekonomi
Livsmedels- och dryckesindustri
Tillverknings- och processindustri



Materialflöden

Textiler
Plast
Förpackning
Mineraler och metaller

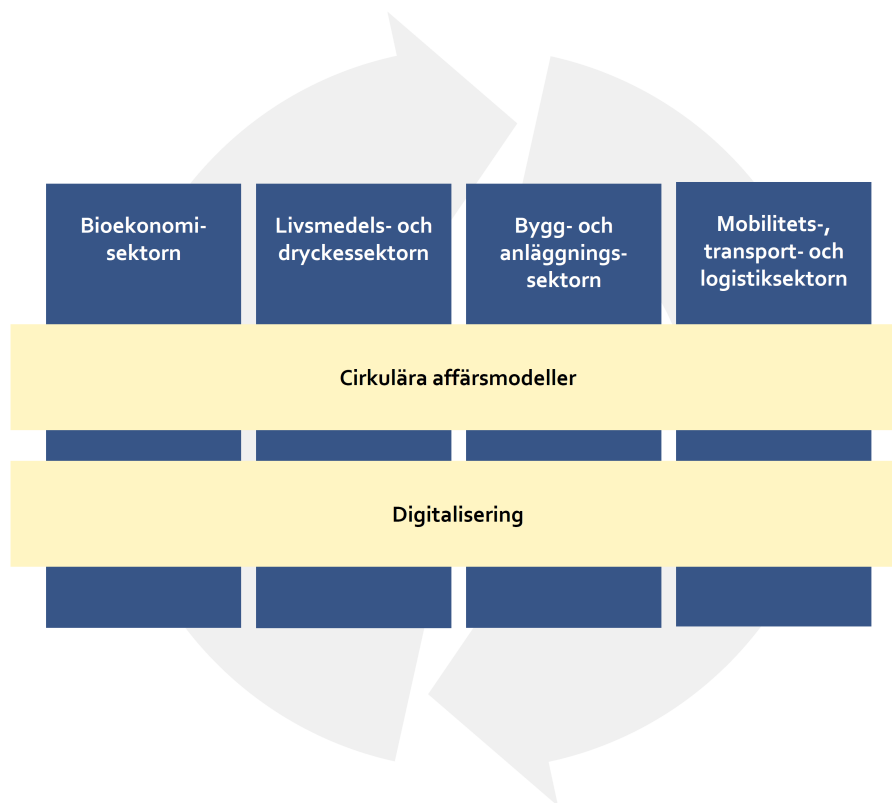


Drivkrafter (verktyg) för omställningen

Digitalisering
Grön offentlig upphandling/kommuner
Cirkulär affärsverksamhet
Finansiering
Nya konsumtionsmönster

Cirkulära affärsmodeller och digitalisering driver på radikal förnyelse av traditionella branscher

Fyra nyckelbranscher inom industrin samt två genomgående drivkrafter valdes för en mer detaljerad studie av effekterna av cirkulär ekonomi. De utvalda branscherna - bioekonomi, livsmedels- och dryckessektorn, byggnads- och anläggningssektorn samt mobilitetssektorn (inkl. transport och logistik) - spelar en framträdande roll i de nordiska ekonomierna. Samtidigt orsakar de också betydande utsläpp och avfall. Tillämpningen av nya cirkulära affärsmodeller och bättre utnyttjande av data/digitalisering är redskap som kan pådriva en systemisk förändring i användningen av resurser, material, produkter och tjänster, och därmed medföra betydande positiva effekter.



Den cirkulära omställningen påverkar klimatet och miljön, ekonomin och våra samhällen på många olika sätt – Nordens förmåga att förstärka de positiva effekterna är av central betydelse



Klimat- och miljökonsekvenserna av en cirkulär omställning är övervägande positiva och omfattar minskade utsläpp och avfall, förbättrad kvalitet på luft, vatten och jordmån samt minskad förlust av biologisk mångfald. Positiva klimat och miljökonsekvenser uppstår om den cirkulära ekonomin leder till minskad utvinning av jungfruliga resurser utan att öka användningen av kemikalier och näringsämnen i processerna i betydande grad. Konsekvenserna för den biologiska mångfalden och de naturliga ekosystemen varierar mellan nordiska regioner.



Effekterna på innovation och företagstillväxt är övervägande positiva. Företagens omställning till cirkulära processer är resurskrävande på kort sikt, men ger kostnadsbesparingar och öppnar för nya affärsmöjligheter på längre sikt. En bättre användning av data och digitala verktyg möjliggör resurseffektivitet, minimering av förluster, längre bevarande av värdet i material och produkter samt bättre hantering av uttjänta produkter. Genom nya cirkulära affärsmodeller skapas nya sätt att tillhandahålla produkter och tjänster såsom tjänstefiering, delning, återvinning och olika ägarmodeller (för material, produkter och tjänster).



De socioekonomiska konsekvenserna av en cirkulär omställning kan vara både positiva och negativa, beroende på de förändringar den medför för industristrukturen och sysselsättningsbasen i olika regioner. På längre sikt kan en cirkulär ekonomi leda till ökad ekonomisk diversifiering och kompetensutveckling, vilket skapar mer resilienta, innovativa och välmående nordiska regioner. Det är av avgörande vikt att den offentliga sektorn stöder en balanserad och rättvis omställning.

Studien identifierade en mångfald av potential för omställning inom de undersökta sektorerna. Åtta fallstudier valdes ut för att illustrera värdekedjornas omvandling och dess effekter.

1. Slutna kretslopp för träbaserade textilier
2. Nya tillämpningar för biomassa från havet
3. Förebyggande förvaltning som stöd för cirkulära lösningar i livsmedelsproduktion
4. Nya affärsmodeller och digitala plattformar för minimering av matsvinn
5. Modeller för ökad (åter)användning av byggnader
6. Digitala plattformar och marknadsplatser för den cirkulära ekonomin
7. Smarta och gröna mobilitetslösningar (såsom mobilitet som tjänst MaaS).
8. Cirkulär transportlogistik

Det behövs politiska åtgärder för att undanröja barriärerna för omställning

Det finns fortsatt många hinder för att frigöra den fulla potentialen i cirkulär ekonomi i Norden. Studien identifierade följande kritiska barriärer.

Regulatoriska barriärer



Lagar, regler och standarder som är kontraproduktiva, saknas eller fungerar dåligt.

Nationella eller regionala variationer i lagstiftningen som hindrar affärsutveckling och samarbete.

Brist på (ekonomiska) incitament för förändring.

Tekniska barriärer



Teknik som fortfarande är under utveckling och som inte är fullt ut fungerande, tillgänglig eller överkomlig för de flesta användare.

Bristande kunskap eller investeringar som hindrar skalning av ny teknik och nya lösningar att möta efterfrågan på marknaden.
Den cirkulära ekonomins behöver nya strukturer som kräver utmanande förändringar i värdenätverken.
Begränsad tillgång till användbara digitala verktyg och data.

Marknadsrelaterade barriärer



Underutvecklade marknader och infrastruktur för cirkulär ekonomi.
Kostnaderna och riskerna förknippade med en omstrukturering av värdenätverken överstiger de omedelbara fördelarna.
Låga kostnader för råmaterial och avfallshantering gör cirkulär ekonomi olönsamt.

Kulturella barriärer



Den linjära ekonomin betraktas fortsatt som norm inom företagen.
Bristande medvetenhet i samhället om den cirkulära ekonomins potential.
Försiktiga eller negativa konsumentattityder gentemot cirkulär ekonomi.
Det råder brist på arbetskraft med uppdaterade kunskaper och färdigheter inom cirkulär ekonomi.

Rekommendationer till Nordiska ministerrådet

Studiens resultat sammanfattas i en rad rekommendationer till Nordiska ministerrådet gällande på vilket sätt det nordiska samarbetet kan bidra till att undanröja hindren och stödja de positiva effekterna av en cirkulär omställning. På ett övergripande och tvärgående plan rekommenderas Nordiska ministerrådet att vidta följande åtgärder:

1. Främja dialog i relevanta ministerråd och ämbetsmannakommittéer med syftet att ta fram gemensamma utlåtanden och rekommendationer för de nordiska länderna.
2. Samordna hanteringen av frågor gällande cirkulär ekonomi på Nordiska ministerrådets sekretariat för att utväxla information, identifiera synergier och undvika överlappningar och intressekonflikter mellan sektorerna; avsätta resurser och utse kontaktpunkter för samordningen.
3. Samordna ländernas bidrag till de politiska processer inom EU:s regi som är betydande för utvecklingen av cirkulär ekonomi i Norden. Även om de nordiska länderna kanske inte har någon gemensam ståndpunkt i frågorna, kan en dialog i förberedandet av EU-reglering och dess nationella implementering hjälpa länderna att bättre förutse effekterna av regleringen i fråga.
4. Stödja nätverkandet mellan städer, eftersom städerna har makt att direkt påverka förändringar inom flera av de studerade sektorerna genom offentlig upphandling, framtagandet av riktlinjer och samarbete om praxis.

5. Uppmuntra samarbetet om riktlinjer och praxis för offentlig upphandling på både nationell, regional och lokal nivå, med målet att säkerställa att principer för cirkulär ekonomi inkluderas.
6. Fortsatt stöda nordiskt nätverkande mellan ekoindustriella parker med målet att utveckla goda modeller för verksamhet inom cirkulär ekonomi och industriell symbios inom och mellan sektorer.
7. Underlätta skapandet av nordiska partnerskap mellan offentlig och privat sektor inom viktiga branscher som sammanför de största industriaktörerna med ledande kunskapsinstitutioner, investerare samt regionala och lokala myndigheter. Redan etablerade samarbetsstrukturer (såsom Nordic Circular Hotspot) kan utgöra en startpunkt.
8. Fortsatt understöda gemensam nordisk forskning, utveckling och innovation med målet att ta fram och föra kunskap och idéer vidare till praktiken och skapa marknadsmässiga lösningar.
9. Undersöka möjligheterna att utnyttja Norden som testbädd för försöksbaserad utveckling och snabb implementering av utvalda politikåtgärder och praxis.

Sektorspecifika fynd och rekommendationer sammanfattas under de sektorspecifika rubrikerna nedan.

Denna tredelade studie finansierades av Nordiska ministerrådet/den nordiska arbetsgruppen för cirkulär ekonomi. Den första delstudien (genomförd 2020–2021) fokuserade på att identifiera områden av särskild betydelse för den cirkulära omställningen i Norden och vilken potential dessa har. Kan den cirkulära omställningen till exempel leda till förändringar som ger konkurrensfördelar eller har andra positiva konsekvenser för de nordiska ekonomierna, samhällena och miljön? I den andra delstudien (genomförd 2021–2022), undersöktes vilka effekter omställningen inom de valda områdena har på företagsutveckling, klimat och miljö samt på de nordiska ekonomierna och samhällena, samt vad som hindrar omställningen. I den sista delen av studien (som genomfördes 2022), analyserades och diskuterades nordiska politikåtgärder för en cirkulär omställning vilket resulterade i en uppsättning rekommendationer till Nordiska ministerrådet. Studien genomfördes av ett nordiskt konsortium under ledning av Gaia Consulting (Finland) med deltagare från Environice (Island), Norion Consult (Danmark), NORSUS (Norge) och RISE (Sverige).

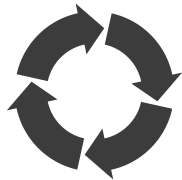
Bioekonomi



De nordiska länderna är rika på biobaserade resurser och skickliga på att förvalta och använda dem. Många regioner i Norden är starkt beroende av bioekonomisektorn, som sysselsätter nästan 1/5 av Nordens befolkning.

Klimatförändringen, resursbrist och hotet mot biologisk mångfald har riktat internationell uppmärksamhet mot behovet att utveckla effektivare och hållbarare användning av biobaserade material. Inte heller de nordiska länderna kan bygga sin ekonomiska tillväxt på utnyttjandet av mer naturresurser, vi måste fokusera på att använda våra resurser klokt och bevara våra land- och havsbaserade ekosystem. Den växande globala utmaningen med energiförsörjning och självförsörjning av livsmedel kräver en diskussion om hur man kan prioritera användningen av biomassa för livsmedel, djurfoder, energi och förädling av material och produkter med högre värde.

En cirkulär omställning av bioekonomisektorn kan ge betydande vinster genom hela värdekedjan:



Minska resursflödet genom resurseffektiv användning av biomassa med hjälp av digital förebyggande övervakning, standardisering och förvaltning.

Sakta ner resursflödet genom bättre spårning av materialflöden, utnyttjande av sidoströmmar och bättre avfallshantering samt förlängning av livslängden för produkter som gjorts av biobaserade material.

Sluta cirkeln genom att tillverka återvinningsbara produkter och utveckla behandlingsprocesser och system för insamling av återvinnbart material.

Vissa hinder för omställningen måste fortfarande undanröjas.

Regulatoriska barriärer



Tillståndsbestämmelserna gör det långsamt och svårt att integrera nya biobaserade komponenter i tillverkningsprocesserna.

De kriterier som tillämpas vid tilldelning av miljömärken belönar inte användningen av biobaserat eller återvunnet innehåll.

Nuvarande regulering saknar incitament för att återvinna biobaserade material (t.ex. biobaserade plaster eller fibrer).

Tekniska barriärer



Det saknas kommersiellt skalbara lösningar för transparens och spårbarhet för material.

(Kemiskt baserad) återvinningsteknik saknas i stor skala.

Marknadsrelaterade barriärer



Det saknas incitament för investeringar i kemikaliebaserad återvinningsteknik.

Kostnaden för återvunnet material är hög i förhållande till kostnaden för jungfruliga material.

Risken för dubbelarbete och ekonomiskt olönsamma insatser är stor när nya lösningar introduceras på marknaden.

Kulturella barriärer



Företagen saknar sakkunskap om cirkulära metoder.

Det saknas offentligt stöd för att utveckla värdenätverk för cirkulär ekonomi.

Konsumenternas attityder till nya biobaserade produkter varierar kraftigt.

För att stödja den cirkulära övergången inom bioekonomin kan Nordiska ministerrådet:

1. Stödja utvecklingen av regionala innovationsekosystem baserade på hållbara och cirkulära modeller för bioekonomi.
 - a. Toppa upp existerande nationell innovationsfinansiering riktad till att utveckla sådana ekosystem med stöd för nätverksbyggande på nordisk nivå och kunskapsutbyte mellan ekosystem.
 - b. Öka det nordiska informationsutbytet mellan digitala plattformar och nya affärsmodeller för tjänster, som ett sätt att öka användningen av sidosrömmar.
2. Påskynda utvecklingen av storskalig cirkulation av biobaserade material.
 - a. Skapa en nordisk färdplan med mål att utveckla välfungerande

- återvinningssystem där länderna kan dra nytta av gränsöverskridande samarbete eller gemensam teknikutveckling.
- b. Starta och samordna nationella och nordiska pilotprogram för att testa framtida anläggningar för cirkulär ekonomi.
 - c. Facilitera dialog om fungerande reglering för återvinning av nya material.
3. Upprätta dialog på nordisk politisk nivå för att främja verksamhet inom blå bioekonomi.
- a. Samarbeta om en proaktiv och visuellt dynamisk kartläggning av havets resurser, som omfattar möjliga användningsområden och visar på möjligheter till ökat värde.
 - b. Arbeta för att uppnå målet att biprodukter från fiskeverksamheten ska föras i land på lämpligt sätt, genom att införa incitament samt krav i alla delar av Norden.
 - c. Utarbeta strategier som stöder hållbart vattenbruk (bland annat gällande cirkulation av näringsämnen).
 - d. Utveckla mer omfattande lagstiftning för att möjliggöra användningen av alternativa och nya ingredienser i livsmedel och andra produkter.

De huvudsakliga effekterna förväntas vara:



...En cirkulär bioekonomi med potential att minska behovet av icke-förnybara resurser och jungfruliga material, minska koldioxidutsläppen samt tillhandahålla kolsänkor. Samtidigt måste man se till att undvika förlust av biologisk mångfald till följd av avskogning/överfiske och andra negativa effekter på naturens ekosystem.



...En stärkt roll för de nordiska länderna som förändringsaktörer i spetsen för cirkulär bioekonomi och innovation. En expansion och uppskalning av cirkulära processer och tekniker, tillsammans med utvecklingen av nya materialflöden, möjligheter och marknader kan bidra till betydande nya affärsmöjligheter.



...En cirkulär bioekonomi som bygger på starka regionala innovationsnätverk baserade på industriell symbios och samarbete och en diversifierad sysselsättningsbas i regionerna.

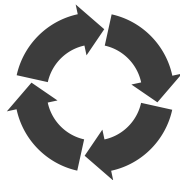
Livsmedels- och dryckessektorn



Livsmedels- och dryckessektorn omfattar viktiga resursflöden i de nordiska länderna, med betydande omsättning och sysselsättningssiffror. Livsmedelsproduktionen är också en nödvändighet för ländernas försörjningstrygghet. Jordbruket är den främsta producenten av resursflöden för livsmedels- och dryckesindustrin, medan fiske och vattenbruk i vissa regioner står för betydande resurser.

Att minska matsvinnet är en viktig hållbarhetsutmaning i de nordiska länderna. Livsmedels- och dryckesindustrin genererar betydande mängder avfall - en tredjedel av den producerade maten går förlorad eller slängs längs värdekedjan från primärproducenter till slutkonsumenter. Hushållen genererar upp till 50–70 procent av matavfallet. När det gäller livsmedelsförluster i värdekedjans tidigare skeden är det svårt att hitta tillförlitliga uppgifter. De nordiska länderna kan ta ledningen när det gäller att minska matsvinnet och principerna för cirkulär ekonomi kan stödja detta arbete.

En cirkulär omställning inom livsmedels- och dryckesindustrin kan ge betydande vinster i hela värdekedjan:



Minska resursflödet genom strategiska val så att alla sidoströmmar används, utan att livsmedel går förlorade på åkrar och i hav.

Sakta ner resursflödet genom att utveckla affärsmodeller som förhindrar matsvinn och avfall, bland annat digitala tjänster från företag till företag och från företag till konsument som syftar till att få maten konsumerad innan den blir skämd.

Sluta cirkeln genom att cirkulera matavfall som bioenergi (som en sista utväg).

Vissa hinder för omställningen måste fortfarande undanröjas.

Regulatoriska barriärer



Det finns inga gemensamt överenskomna definitioner för matsvinn i primärproduktionen (grödor som lämnas kvar på åkrarna, fiskmaterial som lämnas kvar i havet osv.)

Lagar begränsar användningen av sidoströmmar från primärproduktion och matavfall.

Bestämmelser om livsmedelssäkerhet och skattelagstiftning begränsar möjligheterna att omfördela livsmedelsprodukter som är nära sitt utgångsdatum.

Tekniska barriärer



Med tanke på produkternas korta livslängd krävs snabba och effektiva processer för att minska avfallet.

Införandet och marknadspenetrationen av digitala verktyg för att bättre monitorera matsvinn är fortfarande begränsat.

Marknadsrelaterade barriärer



Låga kostnader för avfallshantering i kombination med stränga bestämmelser om livsmedelssäkerhet gör det mer lönsamt att slänga livsmedel än att skänka bort dem.

Bättre hantering av svinn kan på längre sikt minska behovet av primärproduktion, vilket kan stå i konflikt med jordbrukarnas önskan om ekonomisk tillväxt.

Detaljhandeln uppvisar ett paradoxalt förhållande mellan rabatter som förhindrar slöseri och önskan att sälja produkter till fullt pris.

Kulturella barriärer



Jordbrukarna har bristande kunskaper om de ekonomiska och miljömässiga vinster som cirkulära metoder kan ge.

Konsumenterna föredrar mat som ser lika bra ut som den smakar, så produkter går till spillo av estetiska skäl.

Attityder mot vissa biprodukter som livsmedel skapar problem, liksom konsumenterna svårigheter med att uppfatta skillnaden mellan sista användningsdatum och bäst före-datum.

För att stödja den cirkulära omställningen inom livsmedels- och dryckessektorn kan Nordiska ministerrådet:

1. Delta i utvecklingen av gemensamma ramverk för rapportering av livsmedelssvinn.
 - a. Definiera systemgränser, vokabulär och metoder som gör det möjligt att enkelt dela och jämföra data om livsmedelsförluster och -avfall (totala siffror och per capita) längs hela livsmedelskedjan.
 - b. Samordna gemensamma mål för att minska matsvinn och livsmedelsförluster för 2025 och 2030.
2. Tillsammans med offentliga myndigheter ta ledningen när det gäller att ta itu med matsvinnet och se till att det minskar.
 - a. Utveckla krav och incitament för att föra in grönsaker av klass II i detaljhandelsmiljöer och professionella kök.
 - b. Införa konkreta krav i offentliga upphandlingar på avfallsförebyggande åtgärder och datarapportering om framsteg.
3. Nå ett gemensamt ställningstagande för den nordiska politiken när det gäller EU:s reglering av matavfall och nya livsmedel.
 - a. Utveckla kvalitets- och säkerhetsnormer för att stimulera användandet och värdeökningen av livsmedelsbiprodukter och matavfall.
 - b. Utveckla obligatoriska skyldigheter för övervakning och rapportering av matsvinn i hela EU i linje med den befintliga vägledningen i det delegerade beslutet om mätning och rapportering av matsvinn.
4. Uppmuntra donering och annan omfördelning av livsmedel för mänsklig konsumtion, så att denna användning prioriteras framför djurfoder och framför bearbetning till icke-livsmedelsprodukter eller energi.
 - a. Utarbeta en uppförandekod (eller liknande klart uttalande av principer) för en säkrare livsmedelshierarki i tider av stigande biogaspriser.
 - b. Skapa ekonomiska incitament för livsmedelsdonationer mellan aktörer i livsmedelsvärdekedjan och den tredje sektorn som är beroende av frivilliga system vid omfördelning av livsmedelsöverskott.

De huvudsakliga effekterna förväntas vara:



... Betydande positiva climateffekter, eftersom matavfallet står för 8–10 % av växthusgaserna globalt. En resurseffektiv primärproduktion har positiv inverkan på jordmånens kvalitet och minskar vattenförbruket och mängden näringsämnen som kommer ut i luft, vatten och jordmån samt den totala miljöbelastningen.



...En bättre förvaltning av livsmedelsproduktionskedjorna som minimerar de ekonomiska förlusterna från matsvinn. Förutom kostnadsbesparingar skapas nya affärsmöjligheter relaterade till användningen av data och digitala lösningar.



...En resurseffektiv primärproduktion som kan minska behovet av odlingsareal och påverka sysselsättningsstrukturen i en del regioner, men också leda till diversifiering av sysselsättningsbasen, nya kompetensbehov och förbättra tillgången till förmånliga livsmedel vilket i sin tur kan ha positiva effekter på hälsa och välfärd.

Bygg- och anläggningssektorn

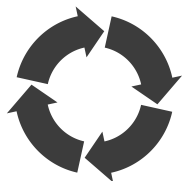


Bygg- och anläggningssektorn står för mer än 10 % av den ekonomiska aktiviteten i de nordiska länderna. Den står också för en betydande del av materialförbrukningen, energianvändningen och avfallsproduktionen globalt sett. Hälften av jordens råvaror används inom byggande och nästan 40 % av all energiförbrukning härrör från driften av byggnader och konstruktioner. Av allt avfall som genereras inom EU kommer 30 % från byggsektorn. En omställning av denna industri är därför en viktig pelare i den cirkulära ekonomin.

De nordiska länderna har avancerad expertis inom byggbranschen. Detta utgör en betydande konkurrensfördel som regionen kan utnyttja även på exportmarknaderna kombinerat med kompetens inom cirkulär design.

En cirkulär omställning inom bygg- och anläggningssektorn kan ge betydande vinster i hela värdekedjan genom ett nytänkande kring byggnadens hela livscykel.

Minska resursflödet genom cirkulär utformning och materialval, undvikande av avfall/förluster genom ökad effektivitet.



Sakta ner resursflödet genom att hålla befintliga byggnader i funktion så länge som möjligt med hjälp av renovering och ombyggnad men också genom optimal användning, delad användning, återanvändning och återanpassning (för annat bruk).

Sluta cirkeln genom att säkerställa återanvändning av komponenter och material i ytterligare kretslopp genom att ta itu med problem som rör t.ex. farliga material.

Vissa hinder för omställningen måste fortfarande undanröjas.

Regulatoriska barriärer



Skilnader i byggregler (även mellan EU:s medlemsstater) hindrar handeln. Systemen för miljötillstånd varierar till och med inom länder. Klassificeringar och upphandlingskriterier innebär utmaningar bland annat när det gäller definitioner av avfall i slutet av livscykeln. Materialspecifika behandlingskriterier för uttjänt bygg- och rivningsavfall saknas fortfarande. Lagstiftningen är inte innovationsfrämjande och den är svår att tolka på ett sätt som stöder cirkulär ekonomi.

Tekniska barriärer



Avsaknaden av teknik för att optimera materialanvändningen i byggnader leder till slösandet av mer material än nödvändigt. Teknik och stilar förändras under byggnaders långa livslängd. Det finns ännu inga kostnadseffektiva mekanismer för automatisk sortering, bedömning och kvalitetssäkring av material i rivningsskedet. Utformningen av konstruktionselement som väggar, ramar och golv fokuserar inte på återanvändningsmöjligheter. Dagens digitala lösningar för lagring av uppgifter om byggnadskomponenter och material är suboptimala och det är svårt att hålla uppgifterna i dem uppdaterade, tillförlitliga och kompatibla.

Marknadsrelaterade barriärer



Det finns inte tillräckliga incitament för cirkulär ekonomi eftersom det är (för) lönsamt att bygga med nyproducerade resurser. Byggnaders långa livslängd försvagar marknadsincitamenten att satsa på återanvändningsbara konstruktionsdelar och material. Värdekedjorna för slutna kretslopp inom byggbranschen är underutvecklade. Detta gäller bland annat organisationen av rivningsföretag, lämpliga digitala plattformar, infrastruktur/anläggningar för bearbetning och databaser som täcker marknader för återanvända och återanvändbara material.

Kulturella barriärer



Kunskapen om vad som krävs för en väl fungerande byggnadsinformationsmodellering är fortfarande bristfällig. Kvalitetssäkring av återanvända byggnadsmaterial saknas. (Digitala) marknadsplatser för sidoströmmar av material används i begränsad omfattning.

För att stödja den cirkulära omställningen inom bygg- och anläggningssektorn kan Nordiska ministerrådet:

1. Samarbeta om input från de nordiska länderna till EU-initiativ.
 - a. Ta fram gemensam input till initiativ inom EU:s gröna giv där det är relevant, t.ex. utvecklingen av byggproduktförordningen, initiativet om byggnadsintyg och initiativet om hållbara kretslopp för koldioxid (med stöd för kvantifiering av klimatfördelarna med biogena koldioxidförråd i byggnader allteftersom arbetet fortskrider).
2. Fortsätta och utvidga arbetet med kunskapsuppbyggnad och kunskapsdelning.
 - a. Fortsätta att stödja kunskapsdelning om cirkulär offentlig upphandling mellan berörda myndigheter och uppmuntra till utveckling av god praxis, ta steget från diskussion till konkreta åtgärder.
 - b. Stödja uppbyggnaden av en kunskapsbas om möjligheterna att återanvända byggnader för nya syften och därmed förlänga deras livslängd, samtidigt som man samlar kunskap om ägarskapsmodeller i Norden och konkreta åtgärder för att ändra på dem.
 - c. Stödja kunskapsuppbyggnad och forskning och utveckling gällande renoverade komponenter och rivningsavfall.
3. Överväga att anta vissa politikåtgärder från EU-nivå innan de införs i hela unionen.
 - a. Undersök om vissa delar av EU:s framtida strategi för cirkulärt byggande skulle kunna tillämpas snabbare i Norden.
 - b. Pilotprojekt för gemensamma nordiska initiativ som tar upp hur reglering eller incitament ("piska eller morot") skulle kunna användas för att se till att cirkulära strategier tillämpas och utvärderas innan rivningsbeslut fattas.
 - c. Utveckla gemensamma nordiska instruktioner för granskningar före rivning.
4. Ta ledningen tillsammans med statliga myndigheter för målstyrning och cirkulär offentlig upphandling inom byggbranschen.
 - a. Föreslå att man tar hjälp av befintliga flerstegsprinciper för offentlig upphandling för att utveckla gemensamma riktlinjer för regeringarna.
 - b. Samarbeta om utvecklingen av mer detaljerad målstyrning som ett nästa steg, även om de specifika målen kan variera mellan länderna.

De huvudsakliga effekterna förväntas vara:



... Utsläppsminskningar genom produktion av mindre material. Med ökad återanvändning och återvinning minskar behovet av ny materialutvinning. Cirkulär formgivning kan leda till att material ersätts med mer hållbara alternativ och att mängden deponerat avfall minskar. Samtidigt medför behandlingen av farligt avfall miljörisker.



...Cirkulär design inom byggsektorn, vilket kan leda till kostnadsbesparingar, större marknader för materialflöden och nya affärsmodeller samt affärstillväxt relaterat till digitala marknadsplatser och logistik. Digitaliseringen har en avgörande roll. Med mindre nybyggnation kommer sektorns verksamhet också att få negativa affärseffekter, vilket skapar ett behov av att se över hållbara affärsmodeller och företagsekosystem.



...Potentiella effekter på utvecklingen av bostadsmiljöer, arbetstillfällen och affärsverksamhet på olika orter genom anpassningsbar (åter)användning av byggnader. Kompetensutveckling kommer att behövas inom bygg- och anläggningsbranschen och dess övergripande sysselsättningsstruktur kan förändras, med större fokus på renoverings- och reparationsbyggnad samt användning av digitala plattformar. Hälso- och säkerhetskONSEKVENSERNA av byggnader och deras användning kan variera.

Mobilitet, transport och logistik



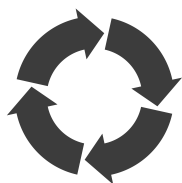
Mobilitet, transport och logistik utgör mycket viktiga sektorer i sin egen rätt men också väsentliga förutsättningar för en cirkulär ekonomi och dess resursflöden. Mobilitets- och transportsektorerna utgör flera procent av ländernas totala BNP och är betydande källor till sysselsättning i alla de nordiska länderna.

Inrikestrafik och -transport står för en betydande del av koldioxidutsläppen och alla nordiska länder har satt upp mål för att minska sina utsläpp.

Det finns ett tydligt behov av att utveckla koldioxidsnåla effektiva transportsystem och logistik samt stödja innovativa transporttjänster genom cirkulär omställning av sektorn.

En cirkulär omställning inom mobilitets-, transport- och logistiksektorn kan ge betydande vinster i hela värdekedjan:

Minska resursflödet genom cirkulär utformning och materialval, undvikande av avfall/förluster genom ökad effektivitet.



Sakta ner resursflödet genom att hålla befintliga byggnader i funktion så länge som möjligt med hjälp av renovering och ombyggnad men också genom optimal användning, delad användning, återanvändning och återanpassning (för annat bruk).

Sluta cirkeln genom att säkerställa återanvändning av komponenter och material i ytterligare kretslopp genom att ta itu med problem som rör t.ex. farliga material.

Vissa hinder för omställningen måste fortfarande undanröjas.

Regulatoriska barriärer



Utnyttjandet av autonoma fraktfordon på allmänna vägar innehåller utmaningar som behöver lösas. Omvänd logistik är föremål för ett särskilt starkt politiskt och lagstiftningsmässigt tryck.

Tekniska barriärer



Smart logistik kräver omfattande och komplexa beräkningar.

Marknadsrelaterade barriärer



En alltför diversifierad konkurrens när det gäller MaaS-lösningar hindrar uppbyggandet av stordriftsfördelar. Marknaden för smart transportlogistik är fortfarande omogen.

Kulturella barriärer



En övergång från direkt ägande/drift av fordon leder till förlorad flexibilitet och omedelbarhet för slutanvändarna, vilket kräver en attitydförändring.

För att stödja den cirkulära övergången inom mobilitet, transport och logistik kan Nordiska ministerrådet:

1. Samordna ländernas bidrag till relevanta politiska och strategiska initiativ från EU.
 - a. Se över och vid behov förstärka det nordiska bidraget till relevanta EU-initiativ på ministernivå.
 - b. Säkerställa fortlöpande nordisk representation i relevanta expertgrupper på EU-nivå, t.ex. forumet för digital transport och logistik.
 - c. Upprätta och förstärka kontakter som kopplar samman experterna i sådana grupper med relevanta nordiska beslutsfattare.
2. Understödja pågående FoU-aktiviteter särskilt gällande autonoma fordon och elektrifiering, men också (snabb, realtids) bearbetning och delning av data.
 - a. Utnyttja befintliga strukturer och program (såsom program i regi av Nordic Innovation).
 - b. Se över befintliga stödmedel och finansieringens inriktning.
3. Standardisera systemen för personmobilitet mellan enskilda städer, regioner och länder.
 - a. Utarbeta särskilda riktlinjer för mobilitetsinitiativ (såsom olika MaaS-ordningar).

- b. Inrätta regionala eller nationella granskningspaneler för MaaS-initiativ och andra infrastrukturplaner.
 - c. Dra nytta av befintliga strukturer som Smart City - nätverk.
- 4. Överväga direkta interventioner där det är lämpligt för att harmonisera ekosystemen för personmobilitet och logistik och minska antalet inblandade aktörer.
 - a. Identifiera var verksamheter kan slås samman eller fusioneras med god effekt (genom att minska kontraproduktiv konkurrens eller isolera mot ekonomiska påtryckningar).
 - b. Undersöka och använda metoder för att uppmuntra eller tvinga fram konsolidering, genom särskilda incitament eller genom att bevilja eller hålla tillbaka verksamhetslicenser, tillstånd eller koncessioner.
- 5. I högre grad förankra kravet på smart logistik och (där det är lämpligt) på cirkulär personmobilitet i kriterierna för offentlig upphandling i hela Norden.

De huvudsakliga effekterna förväntas vara:



...På nationell nivå, smart mobilitet och transportlogistik som leder till direkta utsläppsminskningar i förhållande till nivåerna i dagens transportekosystem. Mobilitetslösningar ger de nordiska hushållen en möjlighet att minska sitt klimatavtryck, men med vissa variationer mellan länder och regioner. På lång sikt kan en minskning av den mark som mobilitet kräver och resursanvändningen från tillverkningen av privata fordon ha effekter på den biologiska mångfalden samt andra positiva miljökonsekvenser.



...Ett behov av innovation och affärsutveckling för att utveckla grön, smart och cirkulär personmobilitet och transportlogistik. Detta bör påskynda FoU inom tillverkningssektorn för icke-personlig transport och för närliggande verksamheter. Det finns potential för långsiktiga stordriftsfördelar, kostnadsbesparingar för logistik, minskning av outnyttjade/underutnyttjade tillgångar och nya affärskoncept baserade på digitala lösningar och en plattformsekonomi.



...Smart rörlighet som leder till lägre hushållsutgifter för rörlighet och transport, men med ojämlika möjligheter mellan regioner och mellan stads- och landsbygdsområden. Cirkulär transportlogistik kommer att skapa ett större behov av kvalificerad arbetskraft, men möjligen en minskning av den totala sysselsättningen inom logistiksektorn.

1. Introduction

1.1 Project background

Access to natural resources is among the most significant factors defining the landscape where today's societies and companies operate and create well-being. Population growth and climate change are creating rising pressure related to the use of natural resources¹, and they call for smart and efficient allocation, use, and conservation of our valuable resources.

Resource scarcity represents not only a source of risk and concern but also, through circular economy, a significant opportunity for the Nordic region. The goal behind circular-economy activities is to obtain greater value from our resource use and render our production and consumption more sustainable by transforming linear resource flows into loops.

Through this circular form², value is created in three ways: 1) closing resource loops via reuse and recycling of materials, 2) slowing resources' flow through those loops by designing long-life goods and extending products' service life, and 3) narrowing the resource flows via resource efficiency³.

Circular economy is high on the political agenda of the Nordic countries, as it is for the European Union. The European Commission's Circular Economy Action Plan with its 35 actions is one of the main building blocks of the European Green Deal, Europe's agenda for sustainable growth⁴. Denmark, Finland, Norway, and Sweden have already developed national strategies, roadmaps, and programmes for promoting transition to circularity, and Iceland has recently published its plans to fund circular economy projects⁵.

The circular transition is supported by many key actors. Individual businesses act on ambitions for implementing circularity-based business models via, for instance, co-operation that involves industrial symbiosis. Industry and business in the Nordic region are interconnected in many ways, and they face some of the same challenges, with industrial associations playing an especially important role in supporting development on local/regional, national, and Nordic level.

The circular transition ties in also with sector-specific policies both nationally and regionally, particularly waste management; sustainable consumption; and innovation, product, and industrial policy. National and sub-national policymakers and especially municipalities support circular development within these sectors. At the same time, the role of individuals and households should not be overlooked.

The Nordic region aims to be a forerunner in the transition to circular economy⁶. This transition holds potential to facilitate business development and innovation, reductions in greenhouse-gas emissions, positive effects on biodiversity, a cleaner

1. IPCC 2019.
2. Bocken et al. 2016.
3. Bocken et al. 2016.
4. European Commission 2022c.
5. Polar Journal 2022.
6. Nordic Council of Ministers 2021.

environment (air, water, and soil), increased utilisation per unit of material, and numerous other positive outcomes⁷⁸.

Among the opportunities that Nordic collaboration represents for strengthening circular economy are learning from each other and gaining fuller awareness of the broader context of circular economy in the Nordic region. Solid shared understanding enables deeper insight related to the opportunities and challenges connected with promoting the region's transformation into a world-leading force for circular-economy inspiration, in line with the ambitious Nordic vision for 2030.

Box 1: How low-carbon circular transition is defined for this assessment

A circular economy designs out waste and pollution, keeps products and materials in use, and regenerates natural systems⁹. It possesses potential to change how we use resources, thereby leading to in-depth systemic change in our economy and society. In the ideal scenario, this systemic shift can build long-term resilience, generate business opportunities, and provide environmental and societal benefits. Among those benefits are greater resource-efficiency, positive effects on biodiversity, and lower levels of greenhouse-gas emissions. A shift to circularity can support a low-carbon society via reduced consumption of energy and resources, thus contributing to reduction in emissions of carbon dioxide. However, promoting circular economy is not always obviously consistent with the decarbonisation targets set.

Our project has taken a broad-based approach to the circular transition by putting emphasis on a systemic understanding of circular strategies for managing materials and products, alongside systems and circular creation of value. In addition, the assessment employed a forward-looking approach in efforts to anticipate where new potential can be expected even beyond established industrial classifications and perspectives. The research team's extensive experience has contributed to an understanding of the complex dynamics of circular economy that encompasses the dynamics of emerging business areas and those of activities taking place at interfaces between and across traditional industry boundaries.

1.2 The project's aims

The Nordic region aims to be a pioneer in the circular-economy domain. There are significant opportunities for mutual learning between its countries. Transition to circular economy can facilitate business development and innovation, reductions in greenhouse-gas (GHG) emissions, a positive influence on biodiversity, progress toward a cleaner environment (our air, water, and soil), fuller utilisation of the resources exploited, and creation of numerous positive effects in several other areas.

7. Ellen MacArthur Foundation 2017.

8. Linder et al. 2020.

9. Ellen MacArthur Foundation 2017.

Our study was aimed at generating insight related to the potential of circular economy in the Nordic region and providing recommendations for unlocking this potential.

The study addressed several key research questions¹⁰ and subsidiary questions:

1. **What areas, industries, and sectors are particularly important for the circular transition in the Nordic countries? What kind of potential exists in these?**
 - a. Which sectors are especially important for the Nordics?
 - b. Can the transition to circular economy lead to changes in key sectors that give the Nordics competitive advantages or other economic benefits?
Which sectors are these?
 - c. What does circular transition mean for the use of resources in our region?
What impacts could the transition have on, for example, the availability of biomass for other uses?
 - d. Is there potential for innovation and industrial symbiosis?
 - e. How does the circular transition affect climate-relevant emissions throughout the life cycle in key sectors?
 - f. What impact could the transition be expected to have on biodiversity?
 - g. What does a transition to circular economy mean for our oceans and other waters, soil, and air?

2. **What will it take to unlock the circularity potential such that the Nordic region can become a leading region in the circular-economy domain and an inspiration for other regions globally?**
 - h. What main conditions are in place that could help us succeed?
 - i. What are the main barriers to releasing some of the related (or other) potential?
 - j. What specific challenges does the Nordic region face with regard to such issues as the geographical distribution of populations, travel distances, and varied terrain?
 - i. Might the transition prove especially challenging for some parts of the region, in light of these challenges?
 - ii. On the other hand, do some areas present conditions that support success especially well?
 - k. What kinds of actions and policy instruments are needed to release the potential?
 - i. How does the picture look for the short, medium, and long term?
 - ii. What is the breakdown of these conditions by sector, industry, and region?
 - iii. How can they be characterised at the various levels (local, national, and regional)?
 - l. In what areas might it be easier to identify concrete actions and policy instruments?
 - i. What areas show conflict in specific respects?

10. Terms of Reference, from 29.5.2019 (translated from Norwegian).

2. The framework and methodology of the study

2.1 Notes on the approach and methodology

Throughout the two-year study, the main emphasis has been on a holistic perspective – approaching the move toward circular economy as a systemic change. This transition involves a variety of levels: national, cross-border, regional, and local ecosystems; the broader base of business ecosystems such as symbiosis across and between entire industries; and everything down to individual households and citizens. Clearly, such transition does not honour national borders and is tightly bound up with global value chains. Many types of interconnection are visible at the Nordic level in particular, with the various industries and business facing some of the same challenges, though the various branches of industry from one Nordic country to the next display remarkable differences that need to be taken into account.

Our endeavour is rooted in the belief that the Nordic countries can gain from taking a joint approach in exploring areas with potential for circular economy and in learning from each other to actualise that potential. Also, there are good reasons to believe that several areas of shared potential can be identified and that possibilities exist for common policy stances that aid in promoting this region's transformation into a leading circular-economy player and global inspiration, as articulated in the ambitious Nordic vision for 2030¹¹.

2.2 Identifying the Nordics' circularity potential and necessary action

Finding areas with specific circularity potential

The first part of the study (10/2020–4/2021) was aimed at generating more general insight surrounding the potential of circular economy in the Nordic region and providing recommendations for unlocking it. That work focused on mapping those of the region's industries, sectors, and geographical areas that the available information points to as holding potential related to the circular transition.

The main sources examined for the mapping were relevant national strategies, roadmaps, and other literature on circular-economy commitments that pinpoints fields and themes identified as national priorities¹². When this study commenced, several of the Nordic countries were engaged in processes for development of national strategies, programmes, and roadmaps aimed at circular economy. With our choice of approach, we sought to investigate how Nordic co-operation could support the countries in their work, rather than build processes that overlap with or reinvent these national efforts. Simultaneously, emphasising the direct link between

11. Nordic Council of Ministers 2021.

12. See Table 1.

national and Nordic priorities assisted in establishing valuable stakeholder engagement early on, in the first phase of our work. In consequence, fairly well-attended national workshops informed later stages.

Through a systematic survey of nation-specific documentation, the team created extensive lists of potential areas of significance for each country (with specific attention also to the self-governing areas of the Faroe Islands, Greenland, and Åland). Then, those 'areas' (significant themes) identified as particularly important for the circular transition in the individual Nordic countries were further analysed with regard to existing activities and initiatives, potential opportunities and benefits, enablers and challenges, and circular-transition potential. The preliminary assessment produced on this basis was supplemented by a presentation of the areas' associated turnover figures, employment numbers, the CO₂ emissions produced, and waste quantities.

The resulting picture of national results was validated through the nation-specific stakeholder workshops and, for Åland, the Faroe Islands, and Greenland, interviews, with preliminary discussion of the potential role of Nordic co-operation. With input from the dialogue with stakeholders, the results from the national sub-studies were aggregated and analysed at regional level in terms of such factors as turnover, employment, emissions, and the waste generated. The aggregate analysis was directed toward developing a sound general understanding of the various areas' potential role in moving the Nordic countries toward being circular-economy societies. Such understanding creates a solid foundation for impact analysis, the next step.

Table 1: Key data sources used for identifying areas with significant circularity potential, by country

Denmark	• The national action plan for circular economy • Green Procurement for a Green Future – Strategy for Green Public Procurement • A detailed waste plan that served as input to government planning • The climate plan for the waste sector • The government strategy for circular economy • Advisory board recommendations (input to government strategy) • A report from the Danish Business Association on circular business • A case-study-based 'tool box' for circular economy
Finland	• The national strategic programme to promote circular economy • The Finnish roadmap for circular economy for 2016–2025 • Bio and Circular Finland programme materials, 2019–2022

Iceland	• An NGO report on circular economy and the construction sector • Materials from the national waste-prevention programme • The national waste-management plan
Norway	• The national roadmap for circular economy and benefits for society • The national roadmap for Europe-level circular economy • Results from a study of the building sector by a national group of experts • 'Study for a National Strategy for Circular Economy' materials • The Circularity Gap Report of Norway
Sweden	• Sweden's national circular-economy strategy • The report 'Circular Economy for a Competitive and Sustainable Business Community' • The results from an investigation looking into current material flows • An industry report on circularity • A report from a panel of circularity experts • A report from the MISTRA-funded project Resource-Efficient and Effective Solutions • A report on circular procurement in the public sector
Faroe Islands	• The official Web site giving an overview of the sustainability policies
Greenland	• Greenland's waste action plan • Agricultural Strategy 2021–2030 • The national Web site for the UN Sustainable Development Goals
Åland	• The development and sustainability agenda for Åland

Box 2: Notes on the availability and quality of circular-economy data

Any assessment of the impacts of circular transition depends partly on the availability of high-quality data. While the Standard Industrial Classification (SIC) provides reliable basic figures for predefined industries, the numbers say little about the industries' circular nature. Likewise, the statistics available do not facilitate analysis of activities that take place at interfaces between traditional industries or in cross-sector business ecosystems.

In the first stage of the work, key industry data were gathered at national level for the industries and sectors identified. Among these figures, which also were among the input to the next parts of the project, are turnover, employment, and CO₂ emissions.

When compiling the data, the study team had to contend with the possibility of variations between countries in the data categories' definitions. Some calibration was performed, to ensure the data's comparability for the industries selected. The calibration decisions included considering national factors, for appropriate delimitation of the areas.

Quantitative key indicators were not compiled for the material flows or cross-cutting enablers identified in the study, as these have no direct links to the SIC scheme and since no comprehensive studies with reliable data for the whole Nordic region were found. To avoid significantly overlapping or mutually incompatible data, the analysis of these areas has been confined to qualitative assessment.

Measuring the impacts

The **second part of the study (4/2021–2/2022)** focused on identifying, describing, and assessing the impacts of circular transition. It took its point of departure from the potential areas of circular economy that had been identified in the first part of the study.

Our working hypothesis was that potential that holds specific relevance with regard to circular transition can be cultivated at the nexus of these areas through circular mechanisms that entail broader impacts within and across the sectors in question. Accordingly, we chose an approach of building strong cases that represent an illustrative sample of these mechanisms and of their potential impacts on the areas of industry highlighted in part I of the study (the foundation-creating work).

The circular-economy opportunities chosen as subjects for the case studies¹³ showcased a range of mechanisms that drive transition within the areas of

13. The opportunities were chosen so as to represent diverse branches of industry, the various stages in circular loops' development, and different levels of activity. They differ in scope, content, and maturity. This methodological choice was aimed at emphasising the diversity and complexity of the transformation while simultaneously supplying very concrete examples of drivers of change that can release the potential for economic transformation and renewal across a broad industrial landscape. A set of criteria was created to facilitate choosing the most suitable circular-economy opportunities for the case studies, encompassing relevance for the Nordic region, significance in the circular transition, Nordic collaboration potential, climate and environmental impacts for the Nordic region, and the business potential for the region.

industry focused upon. The purpose for examining these cases was to afford interesting and valuable insight highlighting the dynamism of the circular-economy transition in the Nordics, by pointing to various sorts of mechanisms for realising the transformation.

Employing a multistage approach to choosing the cases, the project team elaborated on the various circular-economy opportunities that had been brought to their attention in the first phase of the study. The opportunities were rated and prioritised for their potential to narrow, slow, or close circular loops and to optimise value over the life span of materials and products through business potential of various types; their potential impacts on the climate, environment, economy, and Nordic societies; and their relevance for the Nordic region. This involved examining relevance from several distinct angles, with an element regarded as relevant if having a) high relevance for several countries (in light of national priorities), b) a significant role in Nordic national or regional economies, c) a vital part in addressing challenges that are significant for many Nordic areas, and/or d) strategic relevance in terms of scalability of models or transferability and potential application in other sectors or contexts. In the case studies, the team described individual features by means of a desk study, with supplementing interviews with experts where needed. For each of the case studies, the current state of affairs in the Nordics was described, future potential identified, and impacts assessed. For measurement purposes, impacts were divided into the rough categories of

- impacts on business development and growth in the Nordic region;
- impacts on the climate and environment in the Nordic region, including biodiversity; and
- impacts on Nordic economies and societies, inclusive of possible variations between Nordic locations.

While predominantly qualitative, the impact assessment was designed to yield information on the impacts' 'direction' (positive/negative effect), 'pathway' (direct/indirect emergence), volume (high/medium/low magnitude), significance (high/medium/low weight), and duration (a short-term/long-term/permanent nature).

Considering the data available, the team then examined the case studies in aggregate to shed light on circular economy's impacts on the selected industries, sectors, and areas. In light of a broad definition for circular economy that encompasses, in addition to direct material flows, new ownership models in a platform-based sharing economy, it was deemed neither feasible nor relevant to attempt quantitative modelling of total impacts on each sector within the scope of this study – the models required for this would have included so many variables, with accompanying uncertainty, that the ultimate value would have been compromised. 'Proper', comprehensive impact modelling would necessitate deeper, more detailed analysis of industries and economies at regional level, for several specific parts of the Nordic region. Instead, the case studies concentrated on phenomena and mechanisms connected with circular economy that the Nordic countries should support if wishing to unlock strong potential for a sustainable and well-integrated Nordic region.

Identifying barriers

The case studies also informed identification of key barriers to unleashing the potential represented by the circularity opportunities. Here, a barrier was defined as any major factor that hinders releasing the circular-economy potential identified and actualising its impacts.

The barriers were systematically analysed along the lines of the broad categories of

- **regulatory barriers**, stemming both from lack of laws/regulations and from instruments that pose a hindrance, along with contradictions among regulatory instruments between sectors or countries (this category encompasses all legislative and regulatory development, from EU and national to regional and local level);
- **technological barriers**, connected with any factors related to the technological possibilities, among them lack of such components as data, demonstration projects, and circular design;
- **market barriers**, a category including economic difficulties of scaling the activities to commercially viable level and also possible barriers between markets that are not of a regulatory or technological nature; and
- **cultural barriers**, whether connected with company/producer culture and business environments or with consumer behaviour, societal attitudes, etc.

In addition, key barriers were categorised with respect to the level on which they occur (global, EU, Nordic, national, regional/local, or organisation level), for finding the most suitable mechanisms of influence for Nordic Council of Ministers attention.

Barriers were analysed in qualitative terms and prioritised by the criticality of their elimination. The findings then formed the basis for our analysis of the actions needed.

Defining the action needed

The third part of the study (3/2022–9/2022) focused on identifying and assessing those actions required for unlocking the circularity potential and removing barriers in the thematic areas specified in the first two parts of the study (e.g., actions promoting the use of side streams through such means as industrial symbiosis). In this context, 'actions' refers to concrete activities, projects, etc. that should be implemented for the purposes of practical realisation of a necessary result (construction of processing plants, co-operation wherein companies use each other's surplus energy or side streams, transition from fossil to emission-free fuels, etc.). Potential actions were identified through work by the project team's experts, proceeding from the case analysis completed in the second part of the study, and discussed further in dialogue with the various sectors' stakeholders. The process for stakeholder involvement, which featured the above-mentioned interviews and workshops, is described in Annex 3.

The team based the analysis and prioritisation of the required actions on the impacts and barriers identified in the case-study output from part II of the project, and the experts identified various categories of actions with possible ability to release the circularity potential. These were articulated in relation to the impacts

identified in the second sub-study and the barriers pinpointed: actions for overcoming technological barriers, regulatory barriers, market barriers, and cultural barriers. The actions were further discussed and prioritised in collaboration with key stakeholders from each country and members of Nordic networks, through one-on-one and group interviews.

Analysing policy instruments

In the final part of the study, the necessary actions thus pinpointed were further concretised, into policy-instrument recommendations describing what authorities can do to support the actions identified and, thereby, release the potential. Attention was given to instruments that can be brought into real-world use and that enable the actions needed. These might take the form of regulations, producer-responsibility schemes, fees, or other mechanisms. Instruments can be assessed at several levels (local, national, and regional).

To systematise the multiple kinds of policy instruments available in a manner that affords easy understanding, the study borrowed from the framework for national policy instruments that has been presented by Circle Economy, adapting it specifically to Nordic co-operation.

The analysis of policy instruments and development of policy recommendations was carried out in dialogue with stakeholders involved in the relevant national and Nordic-level actions. Actions were prioritised and assessed in light of their importance and feasibility both, with the team elaborating on the costs and benefits of each. This process gave focus to actions wherein Nordic co-operation could play a role through the various types of policy instruments analysed. The framework facilitated systematic conceptualisation of the actions identified. Using this framework made it easy to pinpoint where Nordic actions are already under way and where opportunities lie dormant.

Prioritising actions and creating recommendations

Conclusions and recommendations emerging in the study were discussed with stakeholders and further analysed within the project team. The policy recommendations that are outcomes of this project are commensurate with the project team's expertise and understanding of the Nordic Council of Ministers mandate for action. They are aligned with what the project revealed to be the most crucial actions. The recommendations are not assigned an order of precedence, and they are not mutually compared for their urgency/importance, since they pertain to multiple working groups and actors within the Council of Ministers, whose work is not to be prioritised by the project's consultants.

General qualitative analysis of the Nordic-level socio-economic impacts of the transition envisioned was conducted for selected areas, with regional differences factored in where relevant. The analysis assessed the prerequisites for the suggested actions on the basis of what the Nordic countries are already doing together, any new investments needed, and said action's priority. With such a broad scope of areas chosen for examination, it was infeasible to perform quantitative socio-economic analysis of the benefits and costs to society from releasing the potential for circular

transition in relevant industries, sectors, and areas. Neither could the socio-economic impacts be neatly aligned with the system boundary chosen (the Nordic region), totalled at country level, analysed over the full lifetime of all relevant entities, or quantified in an all-inclusive manner beyond the borders of Nordic geography. However, information on the consequences of not acting was sought where relevant.

The study's results are presented in a manner intended to provide a solid overview of the shift toward circular societies that the Nordic countries are undergoing, to shed light on what that development means in some specific critical sectors and of the vast untapped potential for further development in this transition, and to offer inspiration and recommendations with regard to the next steps that the countries and all involved in Nordic co-operation could take to accelerate that transition.

2.3 Key methods used

The main methods employed are outlined in Table 2, which also presents a summary of their timeline, condensed from the discussion in the previous subsection.

Table 2: Key methods

Project phase	Method	Data sources	Timeline
Identifying areas with specific circularity potential	Desk study and expert analysis	National road-maps, programmes, and other documentation; reports on relevant studies of the subject	Late 2020 – spring 2021
	National stakeholder workshops and interviews		Early 2021
Measuring impacts	Desk study and expert analysis	Reports from relevant studies; interviews with experts	Spring 2021
	Interviews with experts		Spring 2021
	A Nordic stakeholder workshop		Late 2021
Identifying barriers	Expert analysis	Reports from relevant studies	Late 2021 – early 2022
Ascertaining the action needed	Expert analysis	Reports from relevant studies; interviews with experts	Spring–autumn 2022
	Interviews (group and one-on-one)		Spring 2022
Analysing policy instruments	Desk study and expert analysis	Reports from relevant studies; the Circle Economy framework	Spring–summer 2022
Prioritising among actions and creating recommendations	Expert analysis		Summer–autumn 2022
	A Nordic stakeholder workshop		Autumn 2022
Disseminating the results and communicating	Presentations at relevant fora	Nordic Circular Summit 2021; the 2022 Nordic Circular Economy Conference	Throughout the project process, 2020–2022
	Dialogue with key stakeholders		Throughout the project, 2020–2022

This study was carried out for the Nordic Council of Ministers by Gaia Consulting Ltd, PlanMiljø (now Norion Consult), the Norwegian Institute for Sustainability Research (NORSUS), Research Institutes of Sweden (RISE), and Environice.

The members of the research team, who authored the TemaNord report, are Susanna Sepponen, Mari Hjelt, Matleena Moisio, Tuuli Saukkonen, and Minna Jyrälä for Gaia Consulting Ltd; Mads Werge with Norion Consult (former PlanMiljø); John Baxter of NORSUS; Josefina Sallén with RISE; and Environice's Stefán Gíslason.

Among the other output from the project was the publication of two working papers. The following additional authors participated in the work for these: Päivi Luoma, Ringa Sirppiniemi, and Jenni Nurmi, all at Gaia Consulting Ltd; Bjørn Bauer, David McKinnon, Kia Egebæk, and Elvira Borgman, with PlanMiljø (now Norion Consult), Ole Jørgen Hansen, at NORSUS; and Katherine Whalen, at RISE.

2.4 Delimitation of scope and topics for further study

This study was aimed at grasping key developments and needs connected with circular economy in the Nordics. Therefore, its theme is extremely broad, with regard to both the sectors, industries, and areas considered and the relevant geographical and societal aspects. It has not been easy to balance an entity whose suggestions should hold relevance across the entire spectrum of economic activity, from primary production to manufacturing industries to waste management, or for the diverse Nordic lands, from the vast expanses of sparsely populated rural areas to densely populated capitals. We have sought to find a balance that can bring inspiration responding to the highly varied needs and challenges involved. This has necessitated delimiting the focus and making choices – which means that a few aspects, sometimes just as important, have been left out.

The study was conducted at a time of rapid development in the circular-economy operating environment in the Nordic countries and in understandings of circular economy. These years (2020–2022) also have witnessed continued evolution in business models and markets involving circular products and services. In particular, popular awareness is growing, with today's consumer attitudes to circular economy being generally positive¹⁴.

Policy development too is seeing evident progress. In 2020, the European Commission adopted a new circular-economy action plan, replacing the one from 2015. Later that year, the Commission undertook its first initiative under the new action plan when it adopted the proposal for a new regulation on sustainable batteries. The following year saw establishment of the Global Alliance on Circular Economy and Resource Efficiency (GACERE), and several further proposals were adopted. In 2022, the Commission has adopted a package of measures proposed under the circular-economy action plan, including a proposal for a revised Construction Products Regulation and the EU strategy for sustainable and circular textiles. Changes to the policy and regulative landscape on the EU level are definitely occurring apace (the eco-design directive, and measures related to the green transition etc.). This too has implications for the Nordic countries.

14. DNV 2022.

In consequence of developments such as the numerous initiatives launched by the Nordic countries and the Nordic Council of Ministers to support healthy development, the landscape analysis performed in the first phase of the study (in late 2020 to early 2021) is already outdated in some respects, and the case studies carried out in its second part (in autumn 2021) do not cover all of the recent interesting initiatives in their entirety. With a project of this length and such rapid change, continuously updating the results with new decisions and examples is not feasible. Rather, the study's output gives a snapshot of the time when it was created while also remaining amply valid as a source for inspiration. With regard to the regulatory environment, it should accurately reflect the situation in autumn 2022, when the last updates were made.

An important part of this study has been in seeking stakeholder engagement and building connections to the knowledge developed in parallel Nordic initiatives. This said, it is important to emphasize that the authors of this study are solely responsible for the conclusions and recommendations forwarded.

3. Areas with significant circular transition potential

3.1 Circular economy's development in the Nordic countries

Denmark has been implementing its 2018–2022 strategy for circular economy in aims of reducing its use of virgin resources and increasing the competitiveness and productivity of Danish businesses. The areas of focus are the circular transition for small and medium-sized businesses (SMEs), circular design, circular consumption through circular public procurement, a market for waste and secondary resources, and greater value from biomass and buildings. The Circular Economy Action Plan 2020–2032, which entered the consultation phase in late 2020, describes Danish policy and associated concrete efforts focused on striving for a circular value chain, which range from design and consumption mechanisms to waste management, from which natural resources are to be returned for new products and materials. The action plan covers, in total, 129 initiatives, many of which fall under the nation's climate plan for a green waste sector and circular economy (2020), its Strategy for Green Public Procurement (2020), the National Strategy for a Sustainable Built Environment (2021), Denmark's strategy for circular economy (2018), and the Action Plan on Plastics (2018).

Finland was the first country in the world to publish a national roadmap to circular economy, doing so in 2016. In 2020, its new strategic programme to promote circular economy was developed. Adopted in 2021, this sets forth objectives and indicators, specifies measures, and allocates the resources deemed necessary for promoting circular economy and bringing about systemic change. Also, the transition to circular economy constitutes a step toward reaching the government's target of carbon neutrality by 2035. At the time of preparation of this report, the implementation of the strategic programme is still in progress, with, for example, the circular-economy knowledge network Kiertotalous-Suomi (KiSu) scheduled to begin operations in autumn 2022.

In **Iceland**, there is not yet an explicit national strategy for circular economy. However, the national waste-management plan published in June 2021 under the title 'Towards Circular Economy' can be regarded as an effort in this direction, even though it is limited to waste prevention and waste management. The government's five-year state budget plan earmarks some ISK 1.7 billion (roughly 10.5 million euros) for circular-economy initiatives. Almost a third of the total amount was allocated in the budget for 2021. The main foci of the budget plan are on responsible production and consumption, waste prevention, increased recycling, and more recovery, with the overall objective of sustaining a circular flow of resources for as long as possible.

In 2021, **Norway** adopted a national strategy identifying those sectors found to have the greatest potential for improving circularity, alongside incentives and barriers that could influence introduction of circular-economy operations in Norway. The introduction of this strategy was followed by a change in national government. The new coalition's framework document (Hurdalsplattformen)¹⁵ outlines consequent

15. Government of Norway 2021.

changes and developments at national government level. Among these are an updated strategy and action plan focused on circular economy, specific emission-reduction targets for particular sectors and industries, and increased consideration of climate/environment factors in public procurement. Special attention is paid to all sectors and areas of business receiving focus in our study, including several relevant pledges related to specific aspects of the circular transition. The document sets out priorities for supporting the transition in the bioeconomy domain, specific promises for research into business-driven digitalisation, and an increase in the central government's contribution to supporting local transport initiatives.

Sweden introduced its national circular economy strategy in July 2020. The strategy is intended to contribute to reaching Sweden's environmental and climate goals, among them the goal of having zero net emissions of greenhouse gases by 2045. A follow-up action plan was released at the end of January 2021. This focuses on the four key areas outlined in the 2020 national strategy and describes more than 100 measures that either have already been chosen or are to be decided upon by the government.

With 2022 came further developments. In April, all parties in Sweden's national politics expressed support for a suggestion to the government on consumption-based climate targets. June brought a Swedish government announcement that a committee is to be formed for investigating means of economic control that can promote transition to circular economy. The committee tasked with this investigation will focus on areas in which incentives could have a crucial impact on major environmental or climate effects by promoting such a transition.

The overarching policy document for the **Faroe Islands** is the government's coalition agreement from 2019. Circular economy is not mentioned as such, but the agreement does include goals for sustainability of fishery operations, aquaculture, agriculture, the food industry, and waste and pollution management that can be interpreted as encompassing circular-economy principles. The inter-municipality waste and recycling company IRF, owned and managed by the Faroese municipalities, works toward spreading its vision of circular economy in the Faroe Islands. Furthermore, there are grassroots efforts: Faroese businesses have created a network called the Faroese Sustainable Business Initiative.

While **Greenland** makes no explicit mention of circular economy in its government's coalition agreement, it has developed an action plan for the waste sector for 2020–2031 that covers the entire territory. This specifies general guidelines for the nation's waste policy and an agriculture strategy through to 2030. As of 2022, a new fisheries law is under preparation, and Greenland is engaged in work responding to the UN Sustainable Development Goals.

Åland's Development and Sustainability Agenda has grown from relatively early beginnings. It was established in 2014–2015 within the framework of *Bärkraft.ax*, a network created for all citizens, authorities, companies, and other organisations on the islands. The agenda comprises a vision and seven strategic goals for 2030, addressing both environmental and social sustainability. Goal 7, for sustainable and mindful patterns of consumption and production, entails following several action plans of relevance for circular economy. These pertain to industrial supply chains, waste, production, transport and logistics, packaging, and waste. Further action plans are in the pipeline for the construction sector, a sustainable food value chain, circular services, and the sharing economy.

3.2 Circular economy priorities in each country

This section of the chapter presents the areas that the national studies identified as holding potential. Pinpointed preliminarily from the national strategies in 2020, these were elaborated upon in the stakeholder workshops and through the interviews. The first working paper from this project¹⁶ documents the national studies in detail, with references to all sources.

Denmark

The sub-study looking at Danish priorities culminated in pinpointing of six key areas in which potential needs to be unlocked and of four enablers considered vital for the ongoing transition to circular economy in Denmark.

Biomass is one of the key areas of focus identified in Denmark's current circular-economy action plan. Biorefinery-based methods, development of bioproduction techniques, and recycling of nutrients from organic waste to runoff from agricultural land constitute opportunities for circular transition in the biomass sector. The potential was found to be considerable, and technological development and political will point toward ongoing transition in this sector.

The potential for circular transition in **the Danish real-estate and construction sector** was identified as substantial. While recycling rates are already high, room remains for improvement with regard to high-quality recycling. Several associated activities and initiatives have taken root, and there is great interest in adoption of circular methods in this field. Work that is in progress for further development of standards and building methods should accelerate the transition in the coming years.

Food and beverage production and consumption is a key resource flow and one that generates significant amounts of waste along the value chain between primary producers and end consumers. Many opportunities exist in development of suitable technology and adoption of sustainable production methods, and efforts in both of these areas are moving forward at a fast pace. In addition, there is huge economic and environmental potential in minimisation of food loss and food waste from farm to fork. Barriers to improvements may be found with regard to policy and regulations, shared practices, and culture and behaviour.

Danish industry was found to possess vast untapped potential, especially in that much of the technology needed has already been developed and is waiting to be implemented. The country's SMEs in particular need special support if they are to overcome the obstacles and challenges, they face. Ensuring that these and other enterprises can access the knowledge and capital required for investing in circular transition is a vital component of the shift toward circular economy in Denmark.

Plastics play an important role behind much of what we consider the modern world, but plastic products (including packaging) are seldom designed with the end-of-use stage in mind. Ensuring that plastic products retain value (as either material or products) after their first use life is a key goal and a huge source of potential. Developments in technology and logistics will be necessary, as will design for their end of life, which is currently lacking. A solid combination of regulation and co-operation is going to be required for harvesting the potential and thus ensuring that

16. Luoma et al. 2021.

plastic becomes integral to circular economy rather than a useful material that brings with it a large environmental burden.

The textile industry in Denmark is small when compared to the country's other sectors; although there is a significant textile-design industry, very little textile production takes place in Denmark. Yet this country's figure for per-capita consumption of textiles is among the highest in the world, making Denmark one of the largest generators of textile waste per person. Reducing the generation of textile waste and making better use of the waste that does get produced are the two areas with greatest circularity potential. These demand broad-based, complexity-aware efforts to influence designers, importers, and – not least – consumers while simultaneously spurring the development of technology that can hold value in used textiles longer.

As for **circular business models**, widespread transition of business practices to help maintain products' and materials' value, minimise waste, and support sustainable sourcing holds massive potential for Danish businesses – in terms of not only reduced environmental impacts but also lower financial costs and better returns. Step-by-step improvements can go a long way toward shifting businesses in the right direction and opening new opportunities for collaboration and efficiency gains.

Green procurement is high on the agenda in Denmark, and this is seen as one of the main tools through which the public sector can push for genuine circularity transition. In fact, the public sector could function as one of the main drivers of transition to circular economy by exercising its purchasing power to support circular solutions – with products, services, and product–service systems alike – and creating a market that benefits from economies of scale.

In Denmark, more and better use of **data and digitalisation** is viewed as a pillar for all of the other enabling areas and for, thereby, actualising the potential in each of them. Broad and deep digitalisation is a vital component of making sound decisions that lead toward circular economy. Here, Danish companies could benefit from developing a better understanding of their sourcing, processes, and products; consumers gain fuller insight into which of the products and services are sustainable, how individuals can reap the greatest benefit from their disposable income, and ways of optimising one's consumption; and waste-management operators can achieve better control of the materials they collect, hence contributing to higher-quality reuse and recycling.

Minimising loss along value chains represents great potential that can be harvested in many settings through increased efficiency and better co-ordination. The efficiency and co-ordination mechanisms are especially relevant for those value chains mostly internal to Denmark, with the construction and food industry being prime examples, but the principle applies just as well to all industries operating in the country.

Finland

The project's study of Finnish priorities produced the following outline of nine key areas among its conclusions.

Bio-based solutions, with forest-based loops especially, emerged as a strong area of expertise in circular-economy approaches in Finland. Scarcity of resources has made bio-based materials a topic of international interest, and Finland is at the forefront of work on them as an innovator. Opportunities exist in relation to new materials and products, replacement of fossil-based raw materials, sustainable bio-based solutions, and side-stream cycles, alongside, on the consumption side, reducing materials' consumption and increasing recycling by means of circular design.

Real estate and construction have a highly significant role in the flows of steel, concrete, wood, and plastics both in Finland and globally, and this sector is a substantial generator of emissions. The construction sector is Finland's largest individual consumer of raw materials by volume, and it is the country's second-largest producer of waste. Circular economy is hence garnering increasing interest – it presents opportunities for improving real estate's utilisation rate, enhancing exploitation of materials freed in the end-of-life phase (including use of recycled materials in construction), and utilising smart building solutions to extend service lives and reduce resource consumption.

Actors in Finland have identified **a sustainable food system** as an area in which the country already possesses strong expertise, yet extensive potential remains for developing an even more sustainable overall system. Two factors in the food value chain are especially crucial for circular economy: how well raw materials are utilised (whether for their primary purpose or as production side streams) and the way in which nutrients are reintroduced to the nutrient cycle. Among the sources of circularity opportunities identified are organic recycled nutrients, minimisation of food waste, and support for biogas and other renewable energy in agriculture.

Good transport and good logistics are a prerequisite for circular economy, enabling, for example, reverse resource flows. It is necessary to decrease emissions, develop efficient transport systems and corresponding logistics, and support innovative transport services. Circularity opportunities are visible with regard to sharing the transport resources and combining several transport possibilities, mobility-as-a-service (MaaS) activities, the sharing economy, optimisation of transport, sustainable liquid biofuels, and transport technologies. The potential for circular transport is considerable.

Packaging represents a material flow of interest in terms of reuse, recycling, and waste-management opportunities but also with respect to introducing new renewable packaging materials. There are links to many of the sectors discussed above. Finland's packaging waste reaches approximately 800 t each year, and the amount of packaging used is only growing.

Textiles are another material flow that manifests interesting reuse, recycling, and waste-management opportunities, and it too holds promise for introduction of new renewable materials (e.g., wood-based textiles). Finland has strong expertise in wood-based value chains that could lead to opportunities for the textile production of the future, and new textile-waste-management options and value chains are

already emerging. Finland accounts for 700 t of textile purchases per year, and roughly the same amount is disposed of annually, yet the country's utilisation of textile waste remains minimal.

Circular economy disrupts value chains and seizes opportunities for **new business models** and value creation. There are new models emerging that involve servitisation, sharing, and loop-based changes (connected with, for example, the ownership of materials and products). Sharing-economy and platform-economy opportunities may hold great promise, and they display interesting possibilities.

Digitalisation and data together hold power for enabling and driving circular economy. They can aid in narrowing, slowing, and closing up material flows through such effects as extending products' useful lifetime. Related activities could serve various functions: circular design, supply-chain management, material flows' management, system optimisation, etc. Both availability and high quality are crucial for the source data, and so are efficient management and sharing of data in value networks and ecosystems.

Municipalities play a significant role in enabling, promoting, and designing the vital infrastructure, platforms, and services for circular economy. Urban planning is among the key instruments at municipalities' disposal for promoting it. Every year, they spend significant amounts on public procurement, where considerable room remains for services and solutions that better address issues of energy, water, nutrient cycles, use of waste and side streams, mobility, and information and communications technology. Co-operation between the private and public sector presents further opportunities.

Iceland

The sub-study examining Icelandic priorities led to identification of 12 areas, which are tightly interwoven.

The bioeconomy, with fisheries as the largest contributor, is a sector with major importance for Iceland. Fisheries have formed a basic industry for the country for centuries, with **food processing** as the biggest application. Valuable fishing grounds are available, and their utilisation has long had a significant multiplication effect – e.g., through employment in various service-based industries, including food processing, transportation, maintenance, and development of specific technical solutions. Recent years have witnessed rising use of by-products from fishing-related industries as raw materials for valuable innovative products (connected with pharmaceuticals, cosmetics, etc.).

The building sector is a large player in the national economy of Iceland and, since construction waste accounts for a significant percentage of the total waste generated, is one of the six areas given focus in the national strategy for waste prevention. The sector has great potential for improvement from a sustainability perspective. Certification of building and renovation work is on the rise in Iceland. This phenomenon reflects increasing interest in circular solutions within the sector.

Iceland's landscape of **energy-intensive industries** features a handful of aluminium smelters and other heavy-industry entities established to harness the country's relatively accessible renewable energy. A few companies in this sector together

consume the bulk of the electricity produced in Iceland, and these generate some 40% of the country's greenhouse gas emissions (GHGs). Thus far, technical limitations have stood in the way of reducing this sector's carbon-intensity. At present, almost all production is channelled to raw-material exports. This situation should entail some potential for increased use of by-products, more extensive recycling, use of waste heat, etc.

Transport and logistics activities are a substantial contributor to the Icelandic economy and an important source of GHG emissions. At the same time, a well-functioning transport system is a prerequisite for circular economy. Smart, service-based transport systems based on renewable energy may hold great potential in this regard. Iceland is among the leaders in electrification of personal transport. Transport of goods, on the other hand, is lagging behind. In light of Iceland's rich supply of renewable energy, there should be a large amount of potential here. Imports and combustion of fossil fuel is most likely the main obstacle on the path to circular economy in Iceland.

Waste and recycling represent central issues addressed in government plans for circular economy. From an Icelandic perspective, the main focus should be on domestic supply chains (supply chains in which the major links in the life cycle are internal to Iceland). Food is the number-one material for attention here, as the majority of its production, distribution, consumption, and reuse/recycling/regeneration/disposal takes place within Iceland. Indeed, **food** is among the areas given focus in the national waste-prevention programme.

Plastics is another of the six areas of focus articulated in the national strategy for waste prevention. While no primary production of plastics takes place in Iceland, the use and end-of-use phases have been accorded high priority on the government agenda for the last couple of years. Likewise, the input from the national stakeholder workshop in February 2021 stressed the importance of plastic waste from agriculture (primarily hay baling), as a company now gaining prominence in Iceland has set a goal of recycling all of this waste, alongside plastic waste from other domestic sources.

Green financing is becoming a central issue for all of Iceland's largest banks. This creates an opportunity for efficiently impelling transition to circular economy.

Municipalities and local authorities can contribute to circular economy through their zoning and space-use planning. Particularly for detail planning, certain rules could influence choices of materials, and a well-defined framework could well enrich urban agriculture and local access to shops and service centres.

Green public procurement (GPP) is another important enabler, especially with regard to tender criteria. A revised national strategy for GPP was published in January 2021.

Norway

Studying Norwegian priorities pinpointed six main sectors and two key enablers.

The bioeconomy (agriculture, forestry, and fishery operations) was found to be of considerable importance irrespective of this sector's relatively small share of Norway's GDP, because it is a significant contributor to GHG emissions. The study revealed strong circularity potential represented by the use of renewable natural resources. With many opportunities for (more) circular resource production and use, this context shows relatively high circularity potential even though the sector is comparatively small. If downstream elements related to this sector (mainly the food industry as a whole, inclusive of its consumption and waste) are taken into consideration, the potential is immense.

Operations involving **food and beverages** are the focus of a sizeable sector in Norway, particularly in GDP terms. They exhibit high circularity potential, in most cases related to reduction in waste and to more thorough or efficient use of the natural and renewable resources utilised. These operations represent a large sector possessing great potential for progress along numerous technical and non-technical (market-based and consumer-driven) avenues to greater circularity.

The manufacturing and process-industry sector was found to be of considerable significance for the circular transition in terms of output, employment, and GHG emissions. This sector's high circularity potential stems from resource and energy use, across the manufacturing and process industry as a whole. Several kinds of large-scale activity in this sector show great potential for more resource and energy circularity.

The **oil and gas** sector shows quite limited circularity potential but, nonetheless, is very important because of the sector's size, particularly with respect to GDP and GHGs. Hence, even only marginal circularity improvements in the industry could result in significant outcomes overall. While this sector holds some intrinsic potential, the primary circular transition opportunities related to it lie in shifts away from the oil and gas sector completely, in favour of other sectors (involving renewable energy and alternative circular/renewable resource stocks).

The national studies indicate consensus that activities related to **real estate and construction** possess very high circularity potential, which has increased recently. This sector is very important for GDP and employment, less so in terms of GHG emissions. Many studies have identified it as a priority, and indeed it possesses massive potential. This is partly because the resource consumption and waste volumes remain high in the country's (largely linear) economy as it stands while also showing a connection with the extensive scope for change.

The **transport and logistics** sector is hugely important in GHG terms: it is by far the biggest discrete sector in this regard, and there are very significant opportunities for improved circularity. The circularity potential here was found to be enormous, owing to the tremendous importance of transport for today's economy (particularly with respect to GHGs) and myriad transformation possibilities connected with transport demands, more sustainable/renewable fuels, lighter and more efficient vehicles, and other network- or logistics-related efficiency improvements.

Data and digitalisation together constitute a crucial factor in that, while facilitating utilisation of data could be a strong circularity driver, the quality and availability of

relevant data have proved patchy in many respects. This factor severely inhibits circular procurement, resource use, and consumption improvements at present. Enhanced digitalisation is a key driver for improved circularity economy-wide, with potential applications in each and every field of business.

Markets for circular products and services are crucial. The relevant marketplaces for goods and services must always be included among the circularity considerations, throughout any sector. In some cases, specific markets for secondary raw materials can be identified almost immediately (for example, with reference to the EU's 27 materials defined as critical). Some circularity improvements, such as those involving shifts in resource use, energy use, or waste, rarely (if ever) occur without specific connections to the pertinent marketplaces. In practice, economic instruments for influencing markets (shifting tax burdens, increasing the tax applied to certain activities, and granting tax advantages for others) are considered very effective for inspiring innovation and more circular behaviour of consumers and businesses alike. Almost every field of industry or commerce could be influenced through more, stronger markets for circular products and services. The sea of potential is vast and of extensive breadth.

Sweden

The work studying Swedish priorities found 11 key areas for circular-economy transition.

One of these is **the bioeconomy**. Sweden is rich in natural resources and skilled in refinement/recycling of raw materials. That includes activities involving biomass. Moving toward a circular-style bio-based economy offers Sweden an opportunity to 1) replace non-renewable technical materials with renewable biomaterials, 2) ensure the reuse of bio-based materials/products, and 3) improve the end-of-life handling of bio-based materials (by such means as increased recycling of solutions based on them). Sweden's largest market for bio-based solutions is connected with biomass in transport and energy applications and with replacing the chemical and petrochemical sectors' current raw materials with biomaterial-based products.

The building and construction sector in Sweden makes use of numerous material flows, which cover a wide spectrum, and a building's full life cycle presents a plethora of opportunities to reduce the need for virgin resources and improve resource-efficiency by applying circular-economy strategies. The Swedish Circular Economy Strategy stresses opportunities to reduce this sector's emissions, not least those from buildings' use.

Food and beverage operations hold considerable potential. Although most of the country's food waste is connected with household consumption, opportunities for circular solutions exist along the entire food value chain. Focus should be placed on reducing and reusing both 'inevitable food waste' (what humans cannot reuse) and 'unnecessary' food waste (food that could have been used by humans but goes unused).

Circular production ties in with many of the material flows identified in connection with **manufacturing and process-industry work**, thereby presenting significant opportunities for reducing resource and energy use. This sector engages in large-scale operations with considerable room for greater circularity. Its links with many

substantial flows and its strong potential for better use of resources and energy deserve attention.

Mobility, transport, and logistics operations too merit attention. Genuine circular economy hinges on transportation that incorporates 'reverse logistics'. Much of the positive effect possible arises through helping extend the useful life of products and materials. Moreover, transport accounts for a considerable percentage of Sweden's CO₂ emissions. The need to reduce emissions from domestic transport by 70% by 2030 draws further attention to the need to seize the significant opportunity for a circular transition for mobility. Numerous opportunities for circular mobility solutions exist, related both to usage (in such areas as service-based solutions that raise products' use value, help extend product lifetimes, and decrease carbon emissions) and to end of life (connected with, for instance, materials' fuller recovery and reuse). Greater recovery of steel, aluminium, and plastic from end-of-life vehicles represents one particularly clear opportunity – this value chain is among those from which Sweden often fails to recapture value.

In the **textiles** field, opportunities are visible on both the production and the consumption side. The Swedish Circular Economy Strategy emphasises 1) designing textiles for reuse and materials' recycling, 2) new business models that encourage optimal usage and reuse of textiles, and 3) more extensive and cost-effective methods of textile recycling.

Increased circularity of material flows for **minerals and metals** is important for Sweden, where better handling of metals (steel and aluminium among them) promises significant economic and environmental benefits. Recovering critical materials has been recognised as a priority, and Sweden is positioned relatively well for this. The country has a relatively extensive system in place for collection of electrical and electronic waste, and, though recovery rates are showing a downward trend, potential for further expansion still exists, especially with regard to small electronic devices.

Sweden has opportunities to reduce the generation of **plastic waste and packaging** and to recycle what is produced, for reduction of negative economic and environmental impacts. By current estimates, only 10–20% of all plastic that enters the Swedish market gets recycled into new raw material. Overcoming the many challenges related to recycling of plastics is one specific matter already highlighted for future attention.

Digitalisation is a powerful enabler. It can aid in rendering some circular material flows and business models possible in the first place. Its great potential in the circular transition stems from affording the optimisation of knowledge, and of its sharing, along the value chain.

Sweden's experts see **finance** as a crucial link in supporting the transition and enabling new circular business models. Because all circularity-transition-related projects and ventures – in industry and in the public sector both – require financing and capital, this area holds strong potential for influencing circularity.

Public procurement accounts for a significant proportion of Sweden's GDP. There is vast potential to stimulate circularity solutions and contribute to resource-efficiency, recycling, and circular business models by means of public procurement. The opportunities are especially evident with regard to Sweden's carbon emissions. Activities connected with land and buildings are the largest contributor to the

country's overall GHG emission figures, followed by equipment and materials; however, what is procured varies with the level of government, so this too must be considered.

The Faroe Islands

The sub-study focused on the Faroe Islands identified the following areas as priorities for circular transition.

The bioeconomy (fisheries, aquaculture, and agriculture): The fishery industry produces around 90% of the exports of the Faroe Islands, with aquaculture being a substantial component of the territory's bio-based industries. At the same time, land-based agriculture is important, with most meat consumption being satisfied by local sources. Also, the territory shows particular interest in greater self-sufficiency, and technological development of the agricultural sector could support reaching this goal.

Renewable energy: Energy production in the Faroe Islands already is handled to a remarkable extent through renewable energy, and production of energy via wind turbines is expected to expand even further. In addition, experiments with tidal turbines are underway, indicating that technological development may serve as an enabler of circular transition in this field.

Waste streams and recycling: The waste-handling system in the Faroe Islands could be tuned further, to prevent losses of energy and materials. Recycling facilities have recently become available for more categories of material, and a project focused on organic waste gave citizens the tools necessary for composting this material at home.

Circular business: A business network has been established with the intention of devising a common sustainability strategy. The tourism sector, which is growing in the Faroe Islands, is placing increasing focus on sustainable practices intended for minimising the burden on the environment and natural resources.

Greenland

The project's study of Greenland's priorities produced the following outline of areas for the circular transition.

The bioeconomy (fishing and agriculture): The fishery sector is of great economic importance for Greenland, accounting for the majority of Greenland's exports and a large share of employment. There are initiatives for supporting the fisheries' energy-efficiency, protecting fish stocks, and putting by-products to use for other types of agricultural production. Land-based agriculture is another sector identified as relevant, especially with regard to production of animals, primarily sheep. Efforts are being directed toward encouraging local production of fodder, as a substitute for imported fodder.

Renewable energy: Though 70% of Greenland's public energy supply already comes from energy with renewable sources, renewable-energy potential is still high. A goal has been set for public supply to be as renewable as possible in 2030; with establishment of new hydropower plants, the share is forecast to be 90% by then.

Furthermore, renewable energy is seen as offering Greenland export options, since it can support power-to-X activities or be used at data centres that require large quantities of energy.

Waste and recycling: Goal 3 in Greenland's waste-treatment strategy is related to circular economy and waste prevention. The aim is to reduce the amounts of waste produced, with special focus on waste from the public sector and industry and on more extensive reuse and recycling. Several initiatives are to be undertaken to support reaching this goal. These target increased sorting of waste, activities for direct reuse, dialogue with relevant stakeholders about packaging, and development of GPP methods.

Packaging: One of the flows given focus in Greenland's Waste Action Plan is the flow of packaging and its materials.

Biodegradable waste: The main flow of biodegradable waste comes from fisheries. This waste flow holds circularity-stimulation opportunities related to, for instance, reducing by-catch (and thereby lowering the amount of discarded fish) and bringing about higher-quality utilisation of the nutrients from the biomass involved.

Sustainable procurement: Dependence on imported products, the long-distance transport of these products, and a small population distributed over a large land area constitute challenges to sustainable procurement in Greenland. Co-operation and agreements that support local procurement, resource-efficient transport, and procurement of sustainable products could support activities for circular transition in this sector.

Circularity-related innovation: Innovation and establishment of new technology constitutes another enabler for circular transition in Greenland. This has links to the renewable-energy sector, in which new technologies could provide for more efficient energy storage; the waste sector, for which innovations could stimulate better use of the materials; and agriculture, wherein technological innovations could contribute to higher productivity and better nutrient cycles.

Åland

In the examination of Åland's priorities, the following key areas emerged.

The bioeconomy and a sustainable food system hold great promise: a large proportion of industrial production in Åland is connected to primary industries and food production – specifically, agriculture and fishing/fishery operations. Some circular solutions have been piloted in this area, but great untapped potential remains.

The construction sector has been identified as the biggest industrial waste-producer. On the development and sustainability agenda, the action plan for industry includes actions related to the following matters for the construction industry: wood-based construction, minimisation of waste, and energy-efficiency. Potential for an action plan specific to a sustainable construction industry has been identified too.

The transport and logistics sector is of great importance for Åland. This sector brings with it emission challenges and great potential both. For operations involving biofuels, electric vehicles, and resource-efficiency gains cultivated via digital solutions and marketing-related opportunities, Åland could serve as a test bed for

digitalised transport and other solutions.

One of the targets on the development and sustainability agenda is **turning waste into resources**, and several actions are in progress to that end. Åland's **plastics-industry operations** provide motivation for pursuing circular-economy activities that pay heed to plastics factors, and **packaging (specifically plastics) and textiles** are among the targets specified in Åland's articulation of sustainable consumption and production patterns as a strategic development goal.

Digitalisation and open data could be exploited to minimise transport needs.

Åland-level discussion has examined, in addition, digital platforms for the sharing of resources linked to material flows and industry symbiosis.

The need for **circular innovations** is accentuated in relation to such endeavours as transforming waste into resources and developing new, innovative circular service models. Accordingly, a network for large-scale industry and one for SMEs have been established for discussion of novel sustainability solutions.

Sustainable circularity-oriented consumption patterns have been identified as a key priority and a source of substantial potential. **Sustainable public procurement** related to such advances as a sustainable food-process chain and energy procurement for real-estate and other operations is another designated priority that represents potential.

3.3 Areas of shared strategic Nordic interest

The Nordic countries share several strategic interests cohering around areas that hold potential for the circular transition.

It should be stressed that the circular transition constitutes systemic change spanning many sectors and that the resulting economy emerges in diverse ecosystems, value chains, and networks wherein materials and value flow through various actors and across traditional industry boundaries. Therefore, the potential for circular transition is not confined to economic activity generated within any specific sector.

Of the sectors identified in the circular-economy strategies and strategic programmes specific to each country, at least the following elements were stressed in most of the countries if not all of them: the bioeconomy; the food and beverage industry; real estate and construction; and transport, logistics, and mobility.

Some country-linked differences in what the various industries involve should be noted. While the circular-economy potential in, for example, the building and construction industry shows extensive similarity region-wide, some variations were visible in the transport, logistics, and mobility sector, with even more distinct differences evident in the – partly overlapping – food-and-beverage-sector and bioeconomy-related operations.

The countries' bioeconomy priorities naturally reflect the natural resources available. For example, the bioeconomy-related priorities in Finland are largely clustered around the forest sector, while agriculture and fishery work are regarded as part of the food and beverage industry. In contrast, agriculture forms the core of the bioeconomy in Denmark, and the grouping of industries there reflects that: it is not

addressed under food and beverages. For Iceland (along with the Faroe Islands and Greenland), the bioeconomy sector comprises mainly fishery activities, while Norway and Sweden (with Åland) have taken a broader approach, including agriculture, forestry, and fisheries among their bio-based priorities.

In addition, most of the countries' national strategies emphasise particular facets of manufacturing and process-industry operations. These overlap somewhat with bio-based and other loops (as in the case of forest-based bioeconomy activities in Finland) and with the food and beverage sector. The focus of the manufacturing and process industries too and what they include differ from one Nordic country to the next.

The national strategies of a few of the countries express the importance of some material flows in particular – namely, packaging, plastics, textiles, and minerals and metals. These flows display overlaps with particular branches of industry; for instance, some strategies put emphasis on biomaterials and the bioeconomy in parallel.

Additionally, the national circular-economy strategies and programmes call attention to different kinds of cross-cutting perspective with regard to promoting circular-economy activities. These are what we have chosen to call enablers of circular economy.

Table 3 presents the areas identified in multiple countries and shortlisted for Nordic attention. For the table, some of the narrower topics have been combined.¹⁷ In this presentation, use of brackets around the 'x' denotes an area that, while not articulated as an explicit priority, was emphasised in some respects in the national strategy.

17. Within the bioeconomy area, we address Finland's bio-based industries and agriculture, along with its forest-based loops; the fishing and fishery operations in Greenland and the Faroe Islands; agriculture and fishery operations, alongside forestry, in Åland; Denmark's biomass operations; and Sweden's activities related to renewable and bio-based materials (including paper products and biomass). Regarding the food and beverage industry, we focused on a sustainable food system (in Finland and Åland). For manufacturing- and process-industry operations, we included energy-intensive industries in Iceland, both energy- and material-intensive industry operations in Finland, industry overall in Denmark, and the manufacturing and process industry of Norway. Real estate and construction includes the building sector (especially important in Åland) and building and construction (a key factor in Iceland and Sweden). Among the circular consumption patterns examined is the use of new consumption models in Denmark. Examination of digitalisation paid particular attention to data phenomena in Denmark. The analysis of green procurement / municipal operations examined sustainable procurement (in Greenland), public procurement (in Iceland, Sweden, and Åland), specifically green public procurement (in Denmark), and the operations of municipalities and regions (in Finland).

Table 3: An overview of the potential-showing areas that the country-specific studies identified via the national strategies

Branch of industry	Denmark	Finland	Iceland	Norway	Sweden	Faroe Islands	Greenland	Åland
The bioeconomy	x	x	x	x	x	x	x	x
The food and beverage industry	x	x	x	x	x			x
Manufacturing and process-based industry	x	(x)	x	x	x			
Real estate and construction	x	x	x	x	x			x
Transport, logistics, and mobility		x	x	x	x			x
Material flows	Denmark	Finland	Iceland	Norway	Sweden	Faroe Islands	Greenland	Åland
Textiles	x	x			x			x
Plastics	x				x			x
Packaging	(x)	x						x
Enablers	Denmark	Finland	Iceland	Norway	Sweden	Faroe Islands	Greenland	Åland
Circular business models*	x	x		x				
Circular consumption patterns	x	(x)						x
Digitalisation	x	x		x	x			x
Finance			x	(x)	x			
Green procurement / municipal operations	x	x		(x)	x			(x)

*Including various perspectives: Servitisation (Finland), markets for circular products and services (Norway).

Several further key sectors and areas were shortlisted in the national-level analyses. Because these were not explicit in circular-economy strategies across the Nordic region, they are not presented in the table. These are mining, oil, and gas (in Norway); minerals and metals (in Sweden); renewable energy (for the Faroe Islands and Greenland); waste streams and recycling in general (for Iceland, the Faroe Islands, and Åland); clear responsibilities for waste management (in Norway);

minimisation of loss along value chains (Denmark); biodegradable waste (in Greenland); and enhanced producer-responsibility schemes, well-identified national goals and indicators, and knowledge and competence development (for Norway). While not directly reflected in the table, these areas constitute important aspects of the Nordic circular transition.



Figure 1. The industries, material flows, and transition-drivers identified.

3.4 Identified areas with specific potential in the transition to a circular economy

The study team chose an approach that considers several key branches of industry in combination with important drivers of change (see Figure 2).

The choice of areas was informed by the magnitude of the material flows, waste volumes, and circular transition opportunities identified in the analysis. The areas selected are the bioeconomy; the food and beverage industry; real estate and construction; and transport, logistics, and mobility. It should be pointed out that the consideration of these was not restricted to the corresponding Standard Industrial Classification (SIC) categories and encompassed significant parts of the manufacturing industries.

For sharper focus, this selection was complemented by two significant drivers of change: digitalisation and new circular business models. The incorporation of these transition-driving elements was motivated by their evident role in providing tools for transformative ways of developing circular economy.

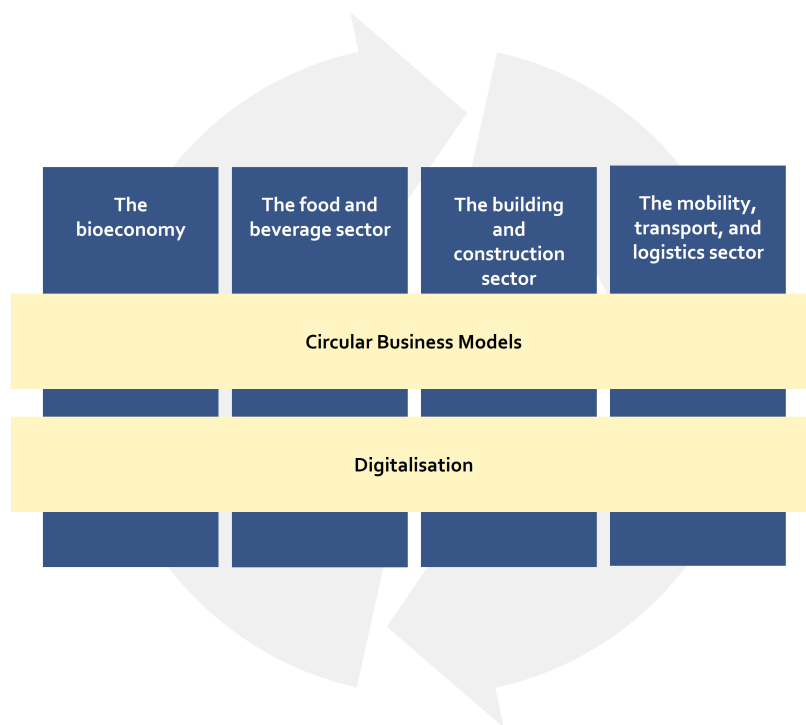


Figure 2: The sectors and transition-drivers identified.

Giving special attention to the value that might be cultivated in these areas to contribute to transition to carbon-free circular economy in the Nordic region, the selection process emphasised the potential of the areas chosen with specific regard to the transition to circular economy (e.g., yielding greater circular value via a focus on 'inner loops' that involve a longer service life and reuse), potential to reduce negative environmental impacts significantly (through resource savings, CO₂ reductions, etc.), possible positive socio-economic impacts (e.g., in terms of business-volume growth and employment effects), and the potential for region-level synergy among areas/sectors/industries that display similarities and either manifest high circular potential or present solid opportunities for learning across boundaries – between areas and across national borders. We concluded in addition that the set of areas chosen represents fields where additional measures may hold more potential than in others (e.g., through unrealised routes to circularity that are accessible via means that entail relatively little investment of resources).

Branches of industry: The bioeconomy

When broadly defined, the bioeconomy covers those primary-production activities and those parts of the economy and industrial landscape that are based on the use, production, or processing of biological resources from agriculture, forestry, fishery/ fishing activities, and aquaculture. Since most of this production is for food, there is some overlap with the food and beverage sector.

This area was selected because the Nordic countries are rich in bio-based resources and skilled in their management and use. Discussion of climate change, scarcity of vital resources, and biodiversity has drawn international attention to bio-based materials, and the Nordic countries are change-makers and at the forefront of innovation in this regard.

At the same time, the countries' bioeconomy priorities naturally reflect the resources available. As noted above, the bioeconomy-related priorities in Finland are clustered to a considerable extent around the forest sector, and agriculture and fisheries are seen as falling within the food and beverage industry, while agriculture forms the core of the bioeconomy from Denmark's perspective, and the grouping of industries there reflects that rather than a position under food and beverages. Likewise, again, Iceland, the Faroe Islands, and Greenland regard the bioeconomy sector as consisting mainly of fishery-related activities, while Norway, Sweden, and Åland demonstrate a broader approach by counting agriculture, forestry, and fishery activities among their bio-based priorities.

Branches of industry: The food and beverage sector

The food and beverage sector, when simply defined, consists of the production and sale of food and beverages. It inherently overlaps with the bioeconomy sector considerably.

The reason behind choosing this area lies in its position in the Nordic countries' value chains: it constitutes a crucial flow of resources and one that generates significant amounts of waste along the long value chain from primary production to final consumption.

Branches of industry: The building and construction sector

The building and construction sector includes rental, buying, and selling activities associated with land, buildings, and housing, coupled with the construction, alteration or renovation, and repair of buildings and other structures.

The reason for choosing this area is that it accounts for such a large proportion of economic activity and also of energy use, overall consumption of materials, and waste generation that its transformation must form a central component of the shift toward circular economy. In addition, the Nordic countries are a centre of advanced construction expertise and home to related markets that transcend national boundaries and encompass significant export activities.

Branches of industry: The mobility, transport, and logistics sector

The final sector given specific focus includes the production, buying, sale, operation, and end-of-life activities associated with all forms of transportation of humans and goods, also in mobility and logistics activities.

The reason for singling out this area is that transport and logistics operations constitute a prerequisite for circular economy, enabling such vital components of it as reverse resource flows. At the same time, domestic transport in the Nordic countries accounts for a significant share of emissions and all countries have set

targets for reducing emissions from transport. A clear need exists to lower emissions, develop efficient transport systems and logistics, and support innovative transport services.

Drivers of transition: Circular business models

The circular transition requires new ways of providing products and services – techniques that maintain value longer and facilitate better end-of-life management. Opportunities for new business models can be found in, for example, servitisation, sharing, looping, and changing the ownership models for materials and products. The reason for choosing this area is that businesses are at the heart of the transition to circular economy, and the change necessitates new business models that draw on new ways of creating value throughout the life cycles involved. These also must incorporate circularity-based thinking into the design of products and services, thereby affording long service lives and products' repairability. Those outcomes, in turn, enable application of new models of consumption that still facilitate a satisfying response to user and customer demands.

Drivers of transition: Digitalisation

Digitalisation and proper, scaled availability and use of data are key enablers of circular economy. These support circularity by affording such activities as predictive maintenance, sharing-economy flows, and optimisation of side and waste streams' handling. Among the relevant digital technologies are the Internet of Things (IoT), artificial intelligence (machine learning etc.), and blockchain technology. The reason for choosing this area is that more and better use of data and digitalisation can be viewed as a core element supporting actions in all of the other areas and, thereby, facilitating unlocking of the potential in each of them. Digitalisation influences numerous functions – circular design, supply-chain management, material flows' management, system optimisation, etc. Data's ready availability and quality are crucial, as is the efficient management and sharing of data in value networks and ecosystems.

4. Potential impacts of circular transition in selected areas

4.1 Lessons learned from in-depth study of circular opportunities

Making informed policy decisions requires an understanding of the various impacts of one's decision. Sustainable-development literature speaks of the interconnectedness of the pillars of sustainable development and of the need to recognise the need for trade-offs but also highlights opportunities for 'co-synergies' that carry sustainable development further. In the trade-offs considered in the context of this study, the circular transition may have a wide range of positive impacts but can also bring negative consequences if not executed in a fair manner, with those consequences possibly varying across the Nordic region. What are called co-synergies occur when an action leads to positive impacts on both the environment and, for instance, business development.

To describe the impacts of circular transition and possible relations between impacts, we conducted eight in-depth case studies (see Figure 3). The case-study method was chosen to afford interesting, valuable insight highlighting the dynamism of the circular economy transition in the Nordics, by pointing to various sorts of mechanisms for realising the transformation. The cases are outlined in boxes in the section specific to each sector. For a more detailed description of the cases, please see Working Paper 2¹⁸.

At the nexus of traditional branches of industry, there is special potential for circular mechanisms that lead to broader impacts within and across sectors. The case studies selected for attention here incorporate a wide range of mechanisms that drive the circular transition within important areas of the economy and industrial operations. The cases were chosen so as to represent different branches of industry, different stages in circular loops' development, and different levels of activity. They vary in their scope, content, and maturity. This methodological choice was aimed at emphasising the diversity and complexity of the transformation while simultaneously supplying very concrete examples of drivers of change that can release the potential for economic transformation and renewal across a broad industrial landscape.

The case studies showcase multiple areas of demand for circular economy solutions and numerous benefits, over the full life cycle of the industrial processes described. There is a clear need to obtain greater value from resource use and develop more sustainable production and consumption patterns by transforming linear resource flows into loops.

The main trends advancing this development encompass the following factors:

- The market demand for circular economy solutions is rising as prices of virgin materials increase in tandem with those of waste-handling. Hence, circular economy solutions should become more business-viable over time.
- Regulatory actions in various sectors and branches of industry are boosting the

18. Hjelt et al. 2022.

circular transition. An important example is the EU ban on landfill disposal of residual waste from 2025 onward and the EU Green Deal's Ecodesign Directive.

- Technological development enables new solutions and makes new business models viable. Digitalisation is a major driver in this development.

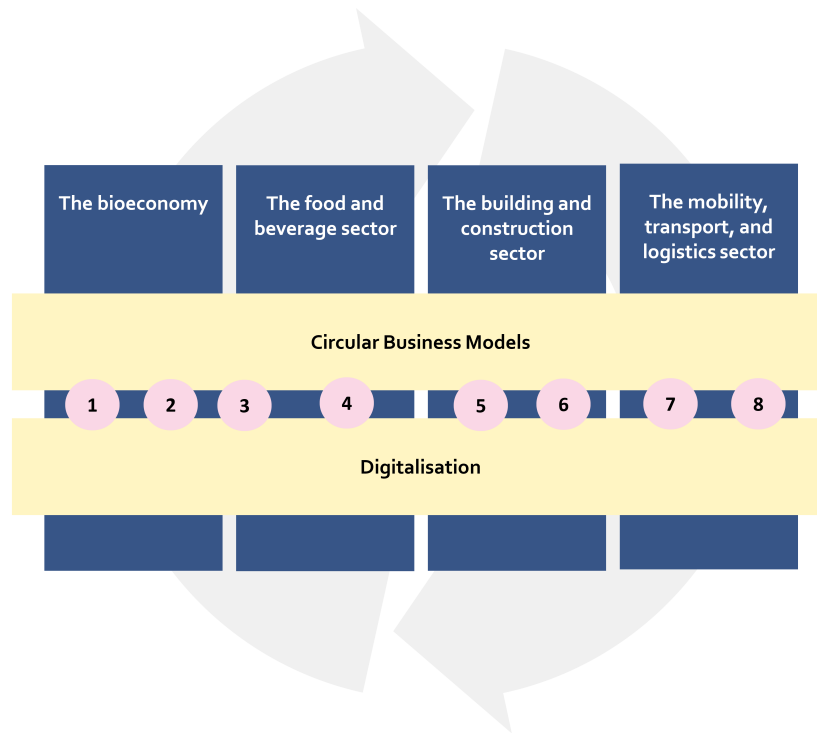


Figure 3: The opportunities for circularity in the areas of significance for the Nordic circular transition: 1) closed-loop wood-based textile solutions, 2) new applications for ocean biomass, 3) predictive management supporting circular food-chain solutions, 4) digital platforms for minimisation of food waste, 5) models for increased (re)utilisation of buildings, 6) digital platforms supporting circular economy, 7) smart mobility solutions, 8) and circular transport logistics.

The discussion below presents some general-level conclusions pertaining to the potential, impacts, and barriers connected with Nordic transition to circularity.

In the big picture, circular economy solutions prove their immense potential to facilitate business development and innovation, reduce greenhouse gas (GHG) emissions, have positive biodiversity effects, and support a cleaner environment (air, water, and soil). In addition, the solutions have various socio-economic implications. Importantly, these differ across Nordic locations, which must be considered as circular economy becomes a key tool in a process of green and just transition.

Creating circular economy would generally involve reducing the amount of land, water, and fossil fuel used in production. Replacing virgin and synthetic materials with recycled materials could reduce the emissions associated with fossil fuels' use. Also, research has found that circular economy strategies could cut global

greenhouse-gas emissions by 39% by reducing the use of resources. Circular economy practices can have large impacts in fighting biodiversity loss too.¹⁹ These practices help protect human health, ultimately, through the decrease in negative impacts on the climate and nature.

Circularity of end-of-life handling of products has immense positive impacts. Keeping products and their materials in use longer results in less waste getting created. The flow of plastic waste to the oceans could be reduced by 80% by 2040 were plastics to be replaced with other materials, plastic content designed for easier recycling, and the recycling process scaled up. Currently, plastic pollution brings \$13 billion in economic losses yearly.²⁰

It has been stated that circular economy globally offers a \$4.5 trillion economic opportunity by creating employment, stimulating innovation in circular-economy-based new business models, and reducing waste. The economic benefits are long-term ones so may require short-term incentives. Furthermore, transitioning to circular economy globally could create six million new jobs by 2030. Meanwhile, jobs in linear business are bound to be lost. The new jobs demand new skills, so taking fair transition practices into account is crucial.²¹

At the same time, there is still a wide range of barriers to the transition. These can be broadly categorised into regulatory, technology-related, market, and cultural (including consumer-behaviour) barriers.

Regulatory barriers are visible in lack of regulation, prevailing standards and regulation that prohibit or complicate circular economy solutions, and shortcomings such as conflicting/counterproductive policies and regulation. Regulatory barriers act at multiple levels, and the growing role of EU regulation may exert an especially strong effect on the ways in which Nordic co-operation can influence policy development and regulation.

Among the **technology-related barriers** are hurdles connected with new value-chain structures and new ways of collaborating, especially related to critical steps in getting circular economy solutions based on new technologies to work at industrial scale after their piloting and demonstration phase. Digitalisation is one of the main drivers for circular economy, while the key challenges in this regard are related to such factors as continuing lack of harmonised data standards, low quality of data, and limited data access.

Market barriers arise mainly in relation to underdeveloped markets for circular economy solutions – solutions that are not yet business-viable for reason of low market volumes, business-as-usual solutions' low costs relative to the new solutions, and absence of the necessary infrastructure. Also, low costs of virgin materials and issues of waste-handling are blocking the implementation of circular economy solutions. As the circular transition requires new models for co-operation and restructuring of existing value networks, business turbulence and higher risks are expected over an extended time, with some of the barriers linked to modern industries' low readiness to change their structures and business models accordingly.

The **cultural barriers** are related primarily to the practices followed in business operations, practices, knowledge and awareness, and attitudes. Both potential users and customers are used to the linear practices applied in a 'business as usual' mode.

19. World Resources Institute 2021.

20. World Resources Institute 2021.

21. World Resources Institute 2021.

Companies may have doubts about the business potential while customers could find it challenging to alter their own behaviour. End users' attitudes and culture-related issues pose obstacles to acceptance of circular-economy-based products. Also, circular economy solutions demand new competencies and development of additional know-how, coupled with intensified co-operation between businesses and education/research institutions within innovation ecosystems.

Further details of the findings from the impact case studies are incorporated into the following sections of the chapter, on the respective sectors.

4.2 The bioeconomy: Potential, impacts, barriers, and actions for circular transition

The importance of circular transition in the sector

The Nordic countries are rich in bio-based resources and skilled in their management and use. Also, many parts of the region directly depend on bioeconomy activities, and the bioeconomy employs nearly a fifth of the Nordics' population²². The employment impacts are particularly significant in certain regions: for example, in some parts of Norway, a full 48% of the workforce engages in aquaculture²³. Illustrating the above-mentioned challenges of data availability, this figure includes a rather large amount of labour statistically categorised under sectors other than 'Agriculture, Fisheries and Forestry'.

Climate change, resource scarcity, and biodiversity concerns have drawn international attention to the importance of more efficient and sustainable use of bio-based materials. The Nordic countries cannot rely on further economic growth of a bioeconomy based on harvesting more natural resources; instead, pressure to use our resources more wisely grows, as does the concern of preserving our land- and ocean-based ecosystems. At the time of writing this report in 2022, also growing global concerns about energy supply and food self-sufficiency of communities are steering the discussion toward greater focus on prioritising the use of biomass for energy and as input to other materials and products.

Hence, it is clear that exploring different solutions for a resource-efficient and sustainable Nordic bioeconomy is necessary for preparing for the future and for ensuring that the Nordic countries can preserve their economic wealth, societal stability, and natural ecosystems while at the same time reaching our ambitious climate goals.

Circular transition potential in the sector

All of the Nordic countries depend on the bioeconomy, but they differ in their bio-based resources and the value chains in their bioeconomy operations, with these factors also affecting the employment structure and competencies needed in a circularity- and biomaterial-based economy. The countries' bioeconomy priorities naturally reflect the natural resources available. For example, the bioeconomy-related priorities in Finland are largely clustered around the forest sector, while

22. Grunfelder et al. 2020.

23. Waseabi 2019.

agriculture and fisheries are seen as part of the food and beverage industry. In contrast, agriculture forms the core of the bioeconomy in Denmark. For Iceland (along with the Faroe Islands and Greenland), the bioeconomy sector consists mainly of fishery activities and aquaculture, while Norway and Sweden (with Åland) have taken a broader approach, including agriculture, forestry, and fisheries among their bio-based priorities.²⁴

Circular economy approaches hold clear vast but largely untapped potential for driving resource-wise bio-based societies:

- There are bio-based alternatives to non-renewable energy sources and materials. For instance, new biomaterials can be introduced to replace plastic (in all of its use forms), unsustainable textiles, and even concrete²⁵. Notwithstanding claims that all products based on fossil fuels could be made from biomass²⁶, a balance that prioritises food applications over biomass use for energy and product materials must be found so that new biomass-based production cannot endanger supply-chain-security or the use of land for important sectors such as food and beverages.
- We can improve the utilisation of side streams through co-operation and industry networks, thereby stimulating significant prevention and reduction of waste.
- Higher-value novel applications can be developed for bio-based materials.
- We can ensure the circularity of bio-based materials/products and improve their end-of-life handling, thus reducing the need for virgin sources and reducing waste.
- Optimising nutrients' circulation reduces negative environmental impacts from agriculture, forestry, and fish farming.

The use of data and digital tools plays a significant role in this development.

- Digitalisation is key to efficient resource use in primary production, as it allows for predictive monitoring and maintenance, such as monitoring the timing and amount of fish feed needed in aquaculture plants, developing forest-management procedures that support the growth and well-being of production forests, or knowing the optimal timing and amounts for fertiliser use in the fields.
- Throughout the production processes involving biomass, digitalisation opens new opportunities for tracking resource flows and optimising the management and use of side streams and waste streams, thus helping to form a base for co-operation and industrial symbiosis in circular economy.
- Digital solutions and both wider digital and region-linked platforms have a vital role in seizing opportunities for improving circular design, tracking material flows, optimising side- and waste-stream management, advancing data-driven precision agriculture and forest management, and upscaling new business solutions. Work with circular business models in this area entails, among other activities, applying new service-business models that cover both production and

24. Luoma et al. 2021.

25. CLC 2021.

26. European Commission 2022b.

consumption (e.g., related to sharing, trading, or leasing of resources and services).

The role of circular business models in this area involves, among other activities, work with new service-business models that cover both production and consumption (e.g., related to chemicals' leasing and to sharing of resources in the bioeconomy). New business models will be needed especially to commercialise and scale up production technologies that use feedstock from existing waste streams. The other end of the chain offers potential for a loop, via synergies with recycling solutions for other novel materials, since many new materials will require more advanced recycling technologies to be scaled. Partnerships across national and industry boundaries are crucial in the development of new technologies and areas of business.

From a value-chain perspective, the circularity opportunities extend throughout all links in the value chain, while simultaneously creating openings for new value creation in broader value networks.

Narrowing the loops: A circular bioeconomy can be understood in simple terms through reference to narrowing the loop such that biomass is used in the most resource-efficient manner possible, by means of digital predictive monitoring, standardisation, and management.

Slowing the loops: Circular bioeconomy activities slow resource flows by keeping the valuable resources in the loop longer, thus reducing both the need for new resources and the amount of waste generated. This entails tracking material flows, optimising side and waste streams' management, etc., thereby reducing the need for virgin resources while simultaneously minimising waste. It also involves ensuring that products made from bio-based materials are kept in use as long as possible.

Closing the loops: Closing the loops in the circular bioeconomy context means ensuring that bio-based materials and the products created from them that replace other materials can be recycled, while also developing treatment processes and systems for collecting these materials for appropriate recycling.

Box 3: The circularity opportunity of closed-loop wood-based textile solutions

The case study focused on wood-based man-made cellulosic fibre (MMCF), such as viscose and lyocell, that can be made from existing textiles or agricultural by-products, thereby creating a closed-loop solution. The current market share of 'recycled MMCF' is estimated at below 1%, but there is considerable research and development, so a significant increase in the coming years is forecast. Use of existing textiles or agricultural by-products in production of MMCF through recycling is expected to bring significant opportunities for a more circular future as it reduces the quantities of waste generated and reduces the need for virgin materials.

The opportunities arising for the Nordics in this case lie in novel technological solutions for sustainable MMCF production in Sweden, Norway, and Finland. Wood-based textile and circular bioeconomy solutions are particularly interesting for the Nordic countries, with their long history of bioeconomy solutions. Material flows, innovation, and new circular business models could replace some of the current virgin cotton with fibres from the well-maintained Nordic forests and locally circulating textile-waste fibres, even while the textile industry's value chain likely remains international. However, wood-based MMCF needs to be produced at a responsible and regenerative rate, lest it contribute to biodiversity loss and deforestation.

Key impacts identified for closed-loop MMCF are new business and R&D opportunities due to the expansion and upscaling of existing MMCF activities and technologies. Industry-led business and innovation ecosystems are a key enabler for scaling up closed-loop textile solutions. Therefore, adopting a closed-loop MMCF strategy is likely to strengthen regional innovation networks and co-operation within/between Nordic countries. Additionally, a need has been forecast for new greenfield wood-based textile-pulp mills or further conversion of paper pulp mills into textile-pulp mills down the line as the need for paper-pulp mills declines. The climate impacts of the fibres depend considerably on how they are produced. Among the issues to be considered are the origins of the wood feedstock, whether the fibre and pulp production relies on renewable energy sources, and the types of chemicals used.

Barriers to seizing the opportunity include lack of the necessary technologies, of market interest, and of regulation encouraging textile fibres' recycling and reuse, alongside the nature of the fashion industry, which currently does not put emphasis on longevity.

Box 4: The circularity opportunity of new applications for ocean biomass

The case involves improving, optimising, and developing new value chains for ocean biomass and finding routes to higher-value circular utilisation of material streams. This brings in a broad range of potential material streams: fisheries and aquaculture, mussel and other shellfish cultivation, and plant-based biomass in the form of seaweed and algae. These resources can potentially serve as inputs to value chains in multiple sectors – primarily food, drink, and agriculture but also potentially packaging, medicine, textiles, building and construction, and energy generation. Use of aquaculture by-products and associated biomass could contribute to additional applications, such as use for food, pharmaceuticals, cosmetics, and chemicals.

There is already a large amount of promising activity using side streams in the general fish value chain, and other species are being explored in connection with blue biomass. For example, seaweed species can be used both in food applications and as feed for biofuels and fertilisers, and it can even be stabilised and treated such that it is suitable for use in construction as insulation.

Oceans and seas play a significant economic, environmental, and socio-cultural role in the Nordic context, and the Nordics have internationally leading positions especially in technology and innovation for sustainable aquaculture. Even though the bioeconomy sector accounts for less than 5% of total turnover in the overall economies of the Nordic countries, fisheries and aquaculture play a substantial role in employment and export in coastal locations all over the Nordic region.

Key impacts identified for fuller utilisation of ocean biomass include business benefits derived from expansion of existing activities and development of new material streams. New applications for ocean biomass and expansion of the aquaculture sector could lead to higher employment while also providing replacement employment in those areas currently heavily reliant on the oil and gas industry. Even though aquaculture is interwoven with many sustainability challenges, it provides alternatives to less sustainable material flows.

Among the barriers to seizing the opportunity are lack of sufficient technologies, strict regulation of the environmental permits for aquaculture, underdeveloped markets for alternative uses of biomass, the sector's low level of expertise in circular practices, and lack of acceptance by the food industry.

Box 5: The circularity opportunity of predictive management supporting circular food supply-chain solutions

This food-flow-centred case study focused on analysis-based precision fertiliser use in agriculture applying recycled nutrients. The case ties in with the broader context of agricultural residues' utilisation and biogas production. The goal behind nutrients' recycling is optimal use of nutrients in crop production and superseding synthetic fertilisers. Throughout the Nordic region, agriculture plays a central role in the food and beverage sector's value chain, but significant amounts of waste get generated along the entire chain from primary producers to final consumers.

Biogas production plays a role in nutrients' recycling. Agricultural material can feed the biogas-production process. The circular nature is evident since residual sludges and more solid digestate from biogas plants constitute potential fertilisers. With the aid of precision agriculture, the nutrients supplied can be tailored to each field plot (or even sub-plot), with the fertilising adjusted accordingly. While precision targeting is possible with synthetic fertilisers, using organic ones diminishes the need for these and enables circular economy.

The need to develop and apply more precision-oriented fertilising is already recognised; however, precision fertilising necessitates further development of digital tools and technology. 'Climate-smart' precision fertilisation requires details of which fertilisers have been used, the state of the yield, the emissions caused by the activities, and how the various growing seasons compare.

Using less fertiliser is likely to reduce emissions and increase the soil's organic carbon content. Among the environmental effects are smaller negative environmental impacts on our waters and soil-quality improvements. Many of the socio-economic impacts of precision use of organic fertilisers are linked to farmers moving from conventional to organic farming. There are signs of small improvements in employment already arising via this opportunity.

The barriers to seizing the opportunity are the need for synthetic fertilisers, the planning required, legislation that limits further cycling of by-products and side streams, high prices of organic fertilisers, and the risks posed to the farmers should the transition not be supported by creation of suitable conditions.

Impacts of circular transition on innovation and business development

Our focus was mainly on higher-value applications and bio-based substitutes for less sustainable materials, which offer interesting potential for business growth and future opportunities related to new circulation options for bio-based materials. These and other examples of higher-value use of biomass – in fields such as textiles, plastic substitutes, packaging, functional food, cosmetics, and pharmaceutical applications – represent fascinating possible growth areas in terms of novel potential and business opportunities and also illustrate how the circular transition disrupts traditional value chains. Although they do not yet offer significant economic opportunities for Nordic areas volume-wise, these examples of forward-thinking

development are part of change on a larger scale, for there are synergy benefits to be gained from promoting biomass as a sustainable low-carbon alternative to fossil, synthetic, and other such materials in many sectors.

Exploring different solutions for a more sustainable and circular Nordic bioeconomy is necessary in preparing for the future and ensuring that the Nordic countries can preserve their competitiveness as pioneers of circular economy development. The project identified significant business potential in the expansion and upscaling of circular processes and technologies, along with development of new material streams, opportunities, and markets. In the ocean-based bioeconomy domain, putting additional forms of blue biomass (fish, mussels, seaweed, and algae) to food and other higher-value use presents multiple interesting business opportunities for possible future impacts on the climate, environment, and societies of the world.

New business models will be needed especially to commercialise and scale up production technologies that rely on feedstock from existing waste streams. The development of new material streams will bring business to companies utilising side streams and propel growth in R&D, which, in turn, is likely to strengthen regional innovation networks and co-operation within each of the Nordic countries. Wood-based solutions as bio-based substitutes for less sustainable materials show special promise. For example, it has been estimated that global fibre consumption will grow to 150–155 million tonnes a year by 2030. The Finnish company Spinnova expects the shortage of natural fibres to become a business opportunity worth €45–60B by 2030.²⁷

The other end of the chain offers potential for closing the loop via synergy with solutions for recycling other novel materials, since many new materials will require scaling of more advanced recycling technologies. Partnerships across national and industry boundaries are crucial in the development of new technologies and areas of business.

Digital solutions and both region-linked and general digital platforms have a vital role to play in seizing opportunities for improving circular design, tracking material flows, optimising side- and waste-stream management, advancing data-driven precision agriculture and forest management, and upscaling new business solutions. Work with circular business models in this area entails, among other activities, applying new service-business models that cover both production and consumption (e.g., related to sharing, trading, or leasing for resources and services).

Impacts of circular transition on the climate and the environment

Key climate and environmental impacts were found in the potential to reduce CO₂ emissions, reduce the need for non-renewable resources and virgin materials, and increase use of carbon sinks. The biggest environmental impacts currently evident are linked to sustainability of the bioeconomy as such and how to prioritise the use of biomass (for food, feed, higher-value products, energy, etc.) more than to circular practices in using the biomass. A bio-based economy decreases needs for non-renewable resources, thanks to new applications for bio-based materials (e.g., from replacing plastics). Most bio-based material flows produce lower CO₂ emission

27. Spinnova 2022.

levels than other material production, and they function as active carbon sinks in the process. However, the circulation of bio-based materials still has challenges to overcome: many higher-value products created from them may contain contaminating substances (such as hard-to-manage chemicals) that may render their return to the ecosystems problematic. As new technologies and investments for recirculation develop, the useful life of more bio-based materials will grow longer.

Simultaneously, potential for biodiversity loss and other negative impacts on ecosystems was identified. Biodiversity issues such as deforestation or overfishing, with related negative effects, pose significant risks if sourcing of feedstock for new biomass applications is not handled sustainably. It is important to understand that, if positive impacts are to be realised, the new circular uses of biomass should not increase total resource exploitation but, rather, assist in focusing the biomass use in resource-efficient and smarter ways.

Fishing is likely to remain stable or decline in volume, depending on political decisions about quotas. At the same time, the growth of aquaculture is expected to continue as people switch from meat-based diets to more sustainable ones. Although the climate impacts of fish farming in many cases are smaller than those of other animal farming, it is imperative that this growth not result in shifting the environmental burdens of meat production to the oceans.

Adopting circularity principles for the use of biomass helps avoid increasing overall resource exploitation, and smarter use of biomass has positive environmental and biodiversity impacts over time.

Impacts of circular transition on Nordic economies and societies

The main socio-economic impacts were pinpointed in relation to the possibility of strengthening regional innovation networks and of diversifying the employment base. Health and welfare impacts are expected to emerge as indirect consequences of the climate and environmental impacts explained above.

Again, about 1/5 of the Nordic region's population is employed by the bioeconomy²⁸, and, while the traditional primary industries have seen some decline, the employment rate is increasing in locations where new and growing bioeconomy companies are based²⁹. Natural resources play a large role in the industries and exports of the Nordic countries, and the bioeconomy is a strategic priority for all of them, constituting a significant part of the regional and national economies here. Their natural variations are reflected in the availability of biomass (forest biomass in Finland, Sweden, and Norway; ocean biomass in Norway, Iceland, the Faroe Islands, Greenland, and Åland/Finland; and agriculture streams in all the countries but especially Denmark, Sweden, Norway, and Finland). The countries are similar in their societal structure, and all face the same sustainability challenges related to sustainable consumption and production.

The socio-economic impacts of predictive management in agriculture serve as an example. This management has had only small impacts on employment thus far, but the impact may well grow, especially if the significance of precision agriculture rises

28. Nordregio 2020.

29. Refsgaard et al. 2021.

– via employment related to logistics, biogas plants, service providers, etc. At the same time, resource-efficiency can in the long run affect the total number of farmers needed.

Among the direct impacts, scaling of new business activities and industry processes is forecast to strengthen the regional innovation networks that form a prerequisite for development especially in the bioeconomy area. For instance, in locations in the North Sea area, where fish and aquaculture have major socio-economic impacts, industry symbiosis created around circular use of blue biomass has had positive impacts on regional innovation networks.

If transition to a circular bioeconomy is realised at larger scale, it will ultimately influence employment opportunities. These opportunities are not expected to emerge within all regions, however, or to equal extent. Also, the industrial transformation is going to lead to a more diversified employment base in the end, which could have negative impacts on specific local communities, especially those that are heavily dependent on primary production while not necessarily possessing the skills base and technology that a green circular transformation requires. In the long run, though, diversification of the employment base still can be regarded as a positive development with regard to the resilience of different regions in the Nordics. The principles of just transition imply that specifically targeted support might be needed in heavily affected regions.

The main barriers to circular transition in this sector

The circular bioeconomy is hampered by barriers of both market demand and technological solutions.

Technological barriers are especially strong in relation to the lack of fully commercial-scale solutions that could ensure transparency and traceability of materials, in combination with lack of (chemical-based) recycling technologies at scale. Existing technologies are not sufficient to enable circular biomass utilisation. In the blue bioeconomy, sustainable inland recirculating aquaculture system (RAS) technologies are available in principle, but their operation costs make it difficult to develop market-based activity. Hence, RDI efforts are needed to unleash the potential.

The **regulatory barriers** are related mainly to insufficient regulation for enhancing recycling of bio-based materials, including fibres. For instance, there is a lack of extended producer-responsibility legislation and of end-of-life criteria for textiles. The regulation pertaining to plastic waste is not supportive of the circulation of bio-based plastics. Also, the criteria for awarding eco-friendliness labels to products do not necessarily reward utilisation of bio-based or recycled content. Permit procedures were seen as another obstacle to bringing additional bio-based materials into use, as the adoption of new components rarely meshes with current regulation, which is geared toward fossil-based products. This issue is visible with regard to fire hazards, for instance: testing presumes a fossil-based product so is more difficult for bio-based products. As for the blue bioeconomy, meanwhile, challenges related to strict regulation and environmental permits are evident as a key obstacle to growth.

Market barriers exist in relation to such factors as lack of incentives for investors and

a lack of market demand. These are especially visible in the financing for chemical-based recycling technologies: At present, prices of recycled material cannot compete with virgin materials'. In these conditions, there is no economic incentive for circular economy. Using virgin materials is currently both easier and lower-cost, so shifting away from linear use of virgin materials cannot be justified in business decision-making. Furthermore, since this is an area experiencing rapid development, high risks of competition, duplication of effort, and diseconomy of scale were identified too.

Likewise in the blue-bioeconomy sphere, the markets, networks, and value chains for alternative uses of biomass streams – such as large-scale production of seaweed and shellfish – are underdeveloped at present, and RDI activity directed toward new products' development is rarely perceived to possess large-scale business potential.

Cultural barriers are evident especially in the know-how of the enterprises, as some parts of the bioeconomy field are traditionally fairly decentralised and somewhat conservative, involving operations by small-scale entrepreneurs in which circular practices are non-mainstream. Networks and value chains for realising the circularity potential require public support, which may not be available. Consumer attitudes toward new products sometimes are very positive (e.g., those to some substitutes for plastics), in other cases more cautious (e.g., attitudes to what some people call garbage fish).

Actions needed to release the circular potential

At the time of writing, the discussion pertaining to the bioeconomy is interwoven with broader dialogue about how to use our natural resources in a responsible and sustainable way, with focus on energy crises, food self-sufficiency, and security of supply just as much as the green transition and not so much on a circular bioeconomy. In the course of identifying the action needed in the bioeconomy sector, many views were expressed on ways to build a more solid science-based approach to prioritising the use of bio-based materials in the Nordics in such a way that we do not exceed the planet's limits. The more general issue extends somewhat beyond the scope of a study that focuses on what the Nordics can do together to accommodate the circular transition. Though it is recognised as very important, with all of the Nordic countries expressing a commitment to pursuing longer and higher-value use of resources, they only indirectly touch on how to prioritise biomass in the context of assessing alternative uses of biomass sources in a circular economy. In this report's subsection on the food value chain, the issue is dealt with in connection with reducing and preventing food loss.

Bioeconomy developments are closely linked with EU bioeconomy policies, in addition to national priorities. One important facet of them is great variety in the bioeconomy, arising from intra-Nordic-differences. The region's bioeconomy is often rather locally and regionally focused. It is of little use to suggest completing the same development actions for very different regions with different structures. Neither is there much room for such measures as harmonising policies and practices across the Nordics.

The Nordic countries are working on a range of topics together. Actions already taken include prioritising the bioeconomy in Nordic policies (there have been

initiatives undertaken, Nordic policies and research display continuous focus on (circular) bioeconomy activities, and many regional case studies of good practices are available).

In the wood-based bioeconomy field, the most significant impacts for now are probably related to wood-based construction. Besides this, novel textile fibres and substitutes for plastics offer interesting potential for business growth and possible future impacts related to circulation possibilities for bio-based novel materials. Guaranteeing that bio-based materials can stay in use and circulation longer represents vital potential.

Several Nordic initiatives aimed at unleashing the potential of the wood-based bioeconomy were identified. Among these are research-funding mechanisms such as the Nordic Bioeconomy Programme³⁰; the many knowledge-sharing events arranged by the Nordic Circular Hotspot in relation to the bioeconomy in the Nordics; SATIN, working toward a sustainable circular system for textiles in the region; and Nordic Innovation programmes that strengthen co-operation between academia and SMEs across the Nordic region, thereby supporting the development of innovative solutions.

For the blue bioeconomy, the most crucial issues involve using the sea areas efficiently and increasing the overall sustainability of aquaculture while also introducing new species in food and feed use and for ecosystem-service purposes (seaweed and algae production, mussels, etc.). These are bigger hurdles than finding circular bioeconomy solutions is. The Nordic countries have worked together in various marine-activity-focused innovation programmes and in funding the development in the various countries (via the European Maritime, Fisheries and Aquaculture Fund (in Finland, Denmark, and Sweden) and the Norwegian national research and innovation agencies). Currently, the Nordic Innovation programme for a sustainable ocean economy has blue biomass as one focal area, as does the NordForsk research programme aimed at sustainable aquaculture. Also, good networks are in place for strengthening the understanding and monitoring of ocean areas – Nordic exchange of information is vital.

Irrespective of the differences, there are a few critical issues with regard to which the Nordic countries would benefit from exploring specific questions connected with circularity of the bioeconomy together and co-ordinating their actions were doing so is feasible.

Firstly, all the Nordic countries are committed to supporting resource-efficient use of side streams from a zero-waste perspective. Therefore, one key question is how to locale-specifically accommodate development whereby all material derived from wood production is in use longer (e.g., by means of agricultural runoff for energy in biopower plants) and business-viable solutions are found for the side streams from fisheries.

Secondly, all the countries support producing new materials that use biomass in place of materials from non-renewable resources (e.g., replacing plastics and non-sustainable textiles). Concrete actions to support this development might include various means of encouraging public RDI funding for the necessary

30. See <https://www.nordforsk.org/programs/nordic-bioeconomy-programme>.

development and perhaps even considering a Nordic brand or label for biomass-based circular products, which could promote new technologies and attract foreign investments.

Thirdly, all of the countries will need to enhance the range of end-of-life treatment options and recycling for bio-based materials to meet future regulatory requirements, because the technologies now in use (alongside some waste-legislation factors) do not sufficiently support this. The countries could consider co-ordinated response to the need for large-scale circulation of bio-based materials and the larger system for collecting these materials, thereby making sure that they retain their standing as forerunners for circular bioeconomy actions. Specific actions might be national and Nordic pilot/demonstration programmes for testing out circular economy facilities, development projects to create well-functioning systems for recycling other materials, etc.

Promoting the development described above requires bringing the largest industry players together with leading knowledge institutions, investors, and governments in a Nordic public–private partnership for development of a sustainable circular bioeconomy.

Box 6: Seven steps toward releasing the circular potential in a blue bioeconomy

1. Enhancing the smart use of ocean areas through combined-use sites, devoted to both a blue bioeconomy and energy production
2. Optimising the cycling of nutrients in open-sea fish farming
3. Developing commercially viable inland aquaculture based on recirculatory aquaculture ecosystem technologies
4. Making sure side streams are brought onto land and subjected to a zero-waste approach
5. Establishing platforms for dynamic mapping of resources, including ideas for possible ways of putting side streams to use for greater value from an environmental and economic standpoint
6. Developing regional innovation ecosystems based on industry symbiosis in the aquaculture sector
7. Removing market barriers by raising consumers' awareness of new blue bioeconomy products

4.3 The food and beverages industry: Potential, impacts, barriers, and actions for circular transition

The importance of circular transition in the sector

The food and beverage sector comprises key resource flows in the Nordic countries, with considerable turnover and employment. Also, food production is a necessity for the region's supply security. Nordic agriculture is the primary producer of resource flows for the food and beverage industry, which is among the critical industries in many parts of this region. Conditions for agriculture vary greatly across the Nordics. For example, 60% of Denmark's land area is devoted to farming, making Denmark one of the most intensively farmed countries in the world, while agriculture accounts for just 7–8% of Sweden's land area.³¹ In some parts of the Nordic region, fishery and aquaculture operations too provide considerable input to food-related chains.

At the same time, a third of the food produced in the Nordics is lost or wasted along the value chain from primary producers to end consumers³², thus representing one of the key impediments to reaching the global goals of sustainable consumption and production in the Nordic region. Food is wasted at all steps through the food-supply chain, but households are the most wasteful link in the chain, generating as much as 50–70% of the food waste³³. Therefore, reducing food loss and waste is extremely important. Special attention must be given to food-loss types that are often overlooked.

Box 7: Food loss or food waste

According to the United Nations Environment Programme UNEP, food loss and food waste can be defined and, accordingly, differentiated thus:

Food loss refers to food that gets spilled, spoilt or otherwise lost, or incurs reduction of quality and value during its process in the food supply chain before it reaches its final product stage. Food loss typically takes place at production, post-harvest, processing, and distribution stages in the food supply chain.

Food waste refers to food that completes the food supply chain up to a final product, of good quality and fit for consumption, but still doesn't get consumed because it is discarded, whether or not after it is left to spoil or expire. Food waste typically (but not exclusively) takes place at retail and consumption stages in the food supply chain.

31. Lund Gade et al. 2021.

32. Nordic Council of Ministers 2021.

33. IVL 2020.

Circular transition potential in the sector

The relevant part of the study focused on how to use bioresources for food production in a resource-efficient and sustainable way and on the role circularity principles could play in minimising food loss/waste in the whole chain from production to consumption.

There is circular potential to be unlocked throughout the food value chain. In the input industry and primary production, data-driven predictive management for efficient use of nutrients alongside strategic choices and use of side streams for avoiding food loss aid in making sure food's production phase is as sustainable as possible. Furthermore, increasing the use of food-system by-products and residues as feed for animals can preserve more of the food that is suitable for human nutrition³⁴. Data-based analytics can assist in avoiding food loss in the production chain once the raw material enters processing. Each time foodstuffs get transported, advanced logistics and handling procedures are a prerequisite for minimising it. Once the food reaches the service stage, digital platforms that enable shops and restaurants to avoid wasting surplus food enter the picture. This pertains to both food donations, which technology can help render more efficient, and ways to sell the excess. It has been estimated that 10% of food produced in restaurants gets binned. Selling the surplus food (at a discount) helps reduce this loss.

Circular economy approaches hold remarkable potential – only partly unlocked thus far – for enhancing responsible utilisation of bioresources for food and beverages, as well as moving us toward more sustainable food production and diets generally:

- Municipalities have a significant role in developing sustainable and circular criteria in public procurement processes
- Rising consumer awareness will influence attitudes toward food waste and create more sustainable consumption patterns that serve prevention of waste
- The industries engaged in food and beverage activities provide good conditions for circular business development and for new business activities along all the value chains, with the use of data and digital tools being key to many of the associated opportunities
- Unmarketable crops can be converted into new value-added products

The role of circular business models in this area encompasses applying new business models linked to minimisation of food loss and other waste, food-waste management, and deployment of new service models that improve production and manufacturing processes.

New business models often harness **the power of data and digital tools**. Possibilities include

- providing better opportunities to manage supply-chain and material flows, system optimisation, and sharing of information;
- using digital resources for the monitoring, analysis, and documentation of the food waste and loss;
- using data on products' performance for optimising product and service design; and

34. Sandström et al. 2022.

- using digital platforms and related infrastructure to facilitate the sharing of data on surplus food and offer new business models that help to reduce waste.

From **a value-chain perspective**, circular opportunities exist at every link in the flow.

Narrowing the loops could apply strategic choices and utilise side streams to avoid food loss in the fields and seas. At present, only half of the fish catch is utilised, and the WWF has estimated that more than 15% of food in agriculture is lost before leaving the farm³⁵. This issue is very closely connected with matters discussed in Section 4.2 (on the bioeconomy): how to prioritise the distribution of biomass across food, feed, other higher-value products, and energy. In the long run, more resource-efficient approaches in primary production could lead to a decreased need for cultivated areas.

Slowing the loops in the value chain for food, whereby materials and products are kept in the value chain for as long as possible, would bring in different operation models, oriented toward ensuring food waste's prevention. This could involve various kinds of digital B2B and B2C services intended for making sure that food gets consumed while human consumption is still appropriate.

Closing the loops in the food and beverage sector includes circulating food waste for other purposes, such as bioenergy. According to the principles of sustainable circular economy, this should be the last resort in the hierarchy, after appropriate measures to keep products 'alive' for their original purpose of use have been taken. It is important to make sure no food that could be used to nourish humans (or animals) is used for other purposes.

35. WWF 2021.

Box 8: The circularity opportunity of new business models and digital platforms for the minimisation of food loss and waste

The case study presented here focused on digital platforms for minimising food loss and food waste both. Preventing food waste is vital for achieving sustainability and is in the interest of both producers and consumers. The Nordic countries have signed on to meet the UN sustainable development goal (SDG) 12 for sustainable consumption and production patterns. These changes require work along four dimensions: a technology push, a societal pull, a market pull, and a regulatory push.

The food and beverage sector is a key component of the bioeconomy in the Nordic region, with solid potential for more effective resource management through food-waste reduction. By means of new solutions to tackle food waste and food loss, the Nordics may be able to ensure optimal utilisation of resources' value and closing of resource loops in the food value chain. All of the Nordic countries have started focusing on the food waste generated by society and on how to prevent it. Also, the region boasts well-established systems for monitoring food waste.

For the use of digital tools, there is great potential in food-waste prevention: Sharing information about effective logistics should support optimising sales for production tailored to the expected sales demand. Registration and management of data related to food waste generated by shop and other facilities could render the waste's monitoring more efficient and afford smoother sharing of data with other organisations.

There is vast economic and environmental potential in minimising food loss and food waste 'from farm (or sea) to fork'. One key impact is better management of food-production chains, which greatly reduces economic losses from food waste and food loss. Furthermore, optimising procurement supports minimisation of waste at source and affords more precise response to consumer needs. Also, there is great promise related to new business models that involve shorter value chains and better management of professional kitchens and retail stores. Discussion of CO₂ reductions often underestimates the importance of food waste even though this factor is nearly equivalent to the entire world's road transport emissions.

Barriers to seizing the opportunity include the need for smooth logistics due to the short life of produce, food-security regulations, and tax laws that make storage difficult and create an incentive to waste the product rather than reuse/upcycle it. Consumer attitudes too create a barrier to releasing the potential.

Impacts of circular transition on innovation and business development

Impacts on innovation and business development were found especially in cost savings enabled via predictive management and logistics throughout the value chain, new business opportunities related to data and digital solutions, and better management of logistics chains such that less food loss/waste results.

In the stage of primary production, the utilisation of data (e.g., for soil analysis) can produce savings and increase productivity, largely by enabling more optimal use of fertilisers and, thereby, increased earnings. Local business opportunities might well be arising already around the feedstock materials needed in the biogas- and digestate-production optimisation process, as well as in the logistics chain for fertilisers. Realising the opportunities requires spatial details of the availability of nutrients, though.

Better management of food-production chains minimises economic losses from food loss and food waste. One tool in this is to redesign procurement processes such that, instead of only amounts and costs of materials, procurement criteria take into account the optimal use of the materials and minimisation of food waste. There are already numerous examples of businesses building on the logic of minimising food waste through redistribution of products that are near 'expiry'. New businesses have been created throughout the Nordic region for selling surplus food via digital marketplaces.

By means of new solutions to tackle food waste and food loss, the Nordics may be able to ensure optimal utilisation of resources' value and closing of resource loops in the food value chain.

Impacts of circular transition on the climate and the environment

Wasting food is not only an ethics and economic issue – it also deprives the environment of limited natural resources.³⁶ Climate change is going to affect agricultural and food-production conditions, which are intimately connected with biodiversity in the Nordic countries and, thereby, will lead to outcomes such as rising demand for optimisation in primary production. Food accounts for more than a quarter of global GHG emissions, and half of the world's habitable land is used for agriculture. Furthermore, 70% of withdrawals of fresh and ocean water globally goes toward agriculture. For these and other reasons, more sustainable food production helps fight climate change, reduce pollution and the stress on our waters, restore biodiversity, and protect wildlife³⁷.

More resource-efficient and sustainable agriculture holds potential for significant emission reductions. Annually, direct emissions from agriculture globally come to roughly 5,800 million tonnes CO₂-equivalent. For comparison, the global emissions from commercial aviation in 2019 were equivalent to around 915 million tonnes of CO₂³⁸. Using less fertiliser is likely to reduce emissions and increase the organic carbon content of the soil. The synthetic nitrogen (N) fertiliser supply chain alone is responsible for roughly 21.5% of the emissions generated by agriculture. Per

36. Per the European Commission.

37. Our World in Data 2021.

38. IATP 2021.

estimates from recent research, the global climate impacts of synthetic N fertilisers, over the entire production chain, account for 2.4% of global emissions, making this one of the world's most climate-unfriendly, polluting industrial chemicals³⁹.

The biodiversity impacts are truly significant. By some estimates, a circular food and agriculture sector on its own could possibly stem and reverse this century's global biodiversity losses by 2050.⁴⁰

Food waste accounts for 8–10% of global generation of GHGs, which is nearly equivalent to the entire world's road-transport emissions. Reducing emissions caused by food waste would, therefore, mean significantly lower emissions. While the Nordics are a small part of the global food issue, the region's role must not be forgotten. According to a Nordic study from 2017, approximately 3.5 million tonnes of food is wasted in the Nordic region every year.⁴¹ Optimising management and logistics along the entire value chain and minimising both food loss and food waste offer potential to decrease the amount of land and other resources used in food production and, consequently, to lead to reduction in greenhouse-gas emissions, in land use, in waste overall, in pesticide and herbicide application, and in fertiliser use from food production. A reduced need for cultivation would benefit biodiversity when the areas can remain in their natural state. Furthermore, improved nutrient management and nutrient cycling in primary production holds potential to cut emissions significantly, reduce the burden on our waters (especially the Baltic Sea), and improve soil quality through the resulting increase in the soil's organic matter. In turn, the water retention of the soil should improve, and seizing the opportunity could also minimise phosphorus mining and lead to less need to direct land and water to agriculture.

Impacts of circular transition on Nordic economies and societies

The socio-economic impacts of a more circular food sector are related to indirect effects on health and welfare in Nordic societies, changes in labour-system structure, and potential better access to affordable produce.

Food plays a significant role in the Nordic region's economy. About 40% of its food is imported, while the region is also a major exporter of food products such as fish⁴². Throughout the Nordic region, agriculture plays a central role in the food and beverage sector's value chain and is a key socio-economic driver in many locales.

There are intra-region differences to consider in capacities to adopt the various technologies and practices needed for resource-efficient agriculture and food production-chain management. Some solutions, building on such elements as precise information about the physical availability of fertilisers or other chemicals, might require critical mass from the markets and not be available to farmers in more remote locations.

Significant amounts of food get lost along the entire chain from primary producers to final consumers – 4.3 million tonnes in total from Denmark, Finland, Iceland,

39. IATP 2021.

40. Gorst & Forslund 2021.

41. Nordic Council of Ministers (2017).

42. Rouzbeh 2021.

Norway, and Sweden⁴³. Food loss along the entire food chain represents both an economic loss and a social and ethics problem as parts of the population struggle to obtain sufficient food. The socio-economic impacts of food-waste prevention have knock-on effects on consumer behaviour and lifestyles. Accordingly, consumers' awareness is central to the outcome. Varied digital solutions (such as diverse kinds of smart food applications) have potential to make food available at lower cost and, thereby, improve food access for low-income and no-income households/individuals. At the same time, applications of this nature require critical mass in some respects and at present are available primarily to urban consumers, in metropolitan areas. Also, if the ultimate goal is to manage the food-supply chain such that waste is minimised, the availability of food should over time be easier to match with the demand.

Preventive food-waste management could ultimately decrease the need for agricultural products, thus creating potential also for negative employment effects on farmers. Because the value chains in the food and beverage industry are rather complex, there remain great uncertainties surrounding these impacts.

Ultimately, minimisation of loss more broadly makes the food system more efficient and improves food security. This could have indirect positive impacts on health and welfare, due to a reduced climate and environmental burden from the value chain. However, there is great uncertainty surrounding the associated impacts, which also are unlikely to occur immediately.

The main barriers for circular transition in the sector

Technology barriers arise especially in relation to the short life of produce: for the food not to be lost or wasted, the reuse or upcycling of the produce must be fast and efficient. Furthermore, the digital tools currently used for monitoring food waste are not perfect – they do not yet represent a complete solution in their own right, particularly with their current limited implementation and market penetration. For example, in food production, any suspected contamination of food leads to significant waste, as the current tracking technology cannot isolate individual batches of a product. Keeping the food in the cycle faces many such challenges related to the products' nature. For the whole value chain of food production, the implementation of circular practices requires considerable planning.

Regulatory barriers are rooted largely in food-safety regulations, which, while obviously needed, can create unneeded and unwanted barriers to using the products in a more circular way. Another key barrier is tax laws connected with food waste and products in retail. Many regulations make it difficult for shops to do *anything* with products that are close to their expiry date, while economic incentives, such as those of tax structures⁴⁴, can render it less costly to discard food than employ any of the more sustainable alternatives. Regulations specify that some food products are to be stored warm for no more than a certain span of time, after which they may not be chilled or frozen and must be discarded if left unsold. As for earlier links in the value chain, legislation on primary production limits further cycling of food

43. See part I of this study.

44. Until recently, the Danish VAT rules meant that retailers had to pay VAT on donations, making free food costly. A workaround has been found.

production's by-products – the restrictions may be lifted only after food-safety assessments. To a lesser extent, similar restrictions are imposed on the use of side streams (mostly from food waste, such as meat bonemeal and biodegradable municipal waste) as sources for such products as organic fertilisers⁴⁵.

Another general challenge identified is that there are no commonly agreed definitions for food loss occurring early in the value chain (e.g., crops left in the fields or fish remains left in the sea).

Among the **market barriers** are incentives created by low waste-handling costs and strict food-safety regulations: wasting food rather than donating it may seem a safe precaution. In primary production, barriers could arise from conflict between farmers' desire for economic growth and the lower need for primary production should loss and waste be managed better. In retail, there is a paradoxical relationship between discounts that prevent waste and a desire to sell products at full price. Discounting products close to their sell-by date can help reduce the amount of food wasted by supermarkets and other food shops but is still relatively uncommon.

Cultural barriers are the most visible in consumers' desire for food that looks as good as it tastes – and lack of willingness to accept produce that looks less appealing (although otherwise identical to aesthetically pleasing produce) – meaning that much of the produce waste that occurs for aesthetic reasons in primary production is driven by market demand for 'perfect food'. In addition, consumers still struggle to differentiate between use-by and best-before dates.

There is a significant gap between, on one hand, those who could benefit most from various digital platforms and tools for fighting food waste (people/households possibly standing on the verge of food poverty) and, on the other, those possessing the knowledge and capacity to use them.

Finally, farmers may be unaware of the potential economic, productivity, and environmental gains from circular practices. Also, they could incur economic risks when making changes to how they care for their fields. Furthermore, consumers may express negative attitudes to using by-products from certain aspects of society (organic waste, slaughter scraps, any material from sewage sludge, etc.) in food production.

Actions needed to release the circular potential

While it is acknowledged that the greatest climate and environmental impacts from the food supply chain are related to strategic and dietary choices of what food to produce and consume, there is still a lot of potential especially for environmental and business impacts from circular ways of managing food loss and waste along the whole value chain. Furthermore, both political attention to these issues and consumers' awareness of them are vital.

Food waste is already high on the agenda in the Nordic countries, the EU, and globally. The UN sustainable development goals call for a 50% reduction in food waste by 2030. The EU's 'farm to fork' strategy, a part of the European Green Deal,

45. EU 2019.

is designed to reduce food loss and waste through its action plan. Also, the EU mandates reporting of food waste to Eurostat. The Nordic countries, especially Finland and Norway, are spearheading development and implementation of methods for food-waste monitoring and reporting. Still, differences in data-gathering render comparability difficult.

To achieve changes in consumer behaviour, the Nordic countries have been involved in raising political and consumer-level awareness of food-waste issues for many years now through multiple national and region-wide campaigns and projects. Sustainable consumption is listed as a priority in the Nordic vision for 2030 and the corresponding action plan. Lessons learned in the Nordics from consumer-oriented awareness-raising campaigns indicate, however, that such campaigns are not enough to spark change.

Voluntary agreements play an important role in putting food waste on the agenda. Back in 2017, a Nordic food-waste project recommended setting up a food-waste-focused network at regional level (to improve the food system's resource-efficiency) and harmonising the rules for food's redistribution in the Nordic countries in order to prevent waste and remove barriers to a single Nordic food market. Although some of the countries have employed tax-relief programmes to stimulate food donations, there are barriers, related especially to food security within the context of volunteerism-based food-distribution networks that rely on the third sector. These need to be addressed. In one example, the Danish tax authorities released a steering document assuring that food donations would be exempted from the 25% tax on goods, thereby relieving the donating party of an important tax burden and incentivising donations of food. These kinds of instruments do not, however, provide economic benefits to redistribution entities such as food banks to pay for logistics and management of the volunteers' efforts.

The recommendations in the Nordic food-waste report published in 2021⁴⁶ are still highly valid. They call for co-operation among the Nordic countries for streamlining their reporting frameworks such that they can share and compare their data on food waste (Finland and Norway were used as models). Furthermore, the recommendations stress harmonising the methods of quantifying food waste at the point of generation, because ability to connect waste to the root causes for it, whether at organisation or value-chain level, can shed light on suitable waste-prevention measures. The countries are advised to establish, share, and further develop national roadmaps for food-waste reduction and to start monitoring the overall effectiveness of waste-prevention measures for decreasing waste levels. Finally, they recommend establishing Nordic collaboration on developing appropriate national statistics for food waste and a Nordic network for information-sharing and learning related to monitoring of food waste.

The study identified a few critical issues, connected with the circularity of food production, with regard to which the Nordic countries would benefit from looking into specific questions together and from co-ordinating their actions where this is feasible.

First of all, a reporting framework with common system boundaries, definitions, and methods must be developed. This affords sharing and comparison of data on food

46. Hanssen et al. 2021.

loss and waste, in total and *per capita*, over the whole food-related chain. This would encompass common targets for reducing food waste and food loss by 2025 and 2030.

Secondly, public authorities ought to take the lead on reducing food's waste and loss.

Requirements should be developed such that class-II food could be bought and used. One means is to set demands in place for food-waste-prevention measures and related reporting of progress to be criteria in public tendering. Public procurement, hence, has a prominent role in this action.

Thirdly, the Nordics should take a joint policy stand on EU regulation pertaining to utilisation of food-industry by-products and waste. Quality and safety standards must be developed, but so must mandatory food-loss monitoring and reporting obligations.

Lastly, food donation and other redistribution for human consumption must be encouraged. This necessitates giving precedence to use by humans over animal feed, processing for energy use, etc.

4.4 The building and construction sector: Potential, impacts, barriers, and actions for circular transition

The importance of circular transition in the sector

The building and construction sector accounts for a significant proportion of materials' consumption, energy use, and waste generation globally: 50% of the earth's raw material extracted is used in construction, and the service life of buildings and structures accounts for nearly 40% of energy consumption. Also important is that a considerable amount of the energy consumption occurs in connection with raw material's extraction and the manufacturing of construction products. Of all waste generated within the EU, 30% comes from the construction sector. The sector also accounts for more than 10% of economic activity in the Nordic countries. Transforming this sector, therefore, is one element at the heart of circular economy. European Union Green Deal materials pinpoint the construction sector as a key area of focus for transition, alongside fields such as textiles and plastics. In addition, the Nordic countries are home to advanced construction know-how and to related markets that transcend national boundaries and encompass significant export activities.

Circular transition potential in the sector

Transforming the building and construction sector requires rethinking the entire life cycle of a building, from questioning the need for the building in the first place, through reducing the need for virgin resources and increasing its energy- and resource-efficiency (by means of good design, choices of materials, project management, and logistics), to optimising the use, reuse, and shared use of buildings for different purposes while also improving construction-waste management.

Circular economy approaches hold immense only partly unlocked potential for the sector. In our study, circular economy opportunities were found specifically in better (re)utilisation of buildings and other structures, exemplified by the following hierarchy, modelled on the waste-prevention hierarchy:

1. With the highest priority, using unoccupied spaces for their original purpose (e.g., putting vacant offices to use as office space)
2. Repurposing unoccupied spaces (e.g., office-to-housing use) or putting occupied space to a new use (e.g., in office-to-housing use)
3. Reusing superstructure
4. Reusing building elements (i.e., doors, windows, etc.)
5. Reusing the material (for instance, after demolition)

In this multi-step approach, the top two priorities are aimed at prolonging the life of existing buildings and decreasing the need for new ones, which does require ensuring that repair and rebuilding is made possible through circular thinking already in the planning and construction phase.

Reuse of superstructure, building elements, and materials is aimed at elimination of waste and at reducing the need for virgin materials in building work. With this hierarchy, the main task is to question the need for new construction in the first place and focus on the circulation of building materials as the last – and least attractive – option.

The use of data and digital tools plays a significant role in this development, in offering possibilities for

- circular design, solid supply-chain management, and material-flow management via system optimisation and information-sharing, through such means as building-information management (BIM) systems and digital material passports, which assist in handling information and tracking the material and energy flows;
- great leaps in resource-efficiency via better understanding of the flows of materials and how services get used within the economy;
- using robots and 3D printing to contribute to fuller utilisation of reuse and recycling and to cutting back on construction waste;
- digital platforms and IoT solutions for predictive maintenance and documentation; and
- digital platforms and related infrastructure to facilitate sharing of resources.

The role of circular business models in this area includes exploiting opportunities for

- sharing-based business models that increase existing buildings' utilisation rates and maximise their value,

- creation of business models based on renewable and regenerative materials,
- business models built on collaboration and efficiency gains,
- business models that encourage minimising waste and errors,
- digital marketplaces for assets and materials that would otherwise go to waste, and
- designing for modularity and disassembly etc.

The value-chain perspective in construction is particularly complex to compass, as each construction situation is unique and the process before actual construction begins may take several years, in which time the actors and prerequisites might change.

Narrowing the loops ties in with means of circular design and choices of materials that can meet needs efficiently and without unnecessary resource use. The planning and design phase is crucial for enhancing the circularity of buildings. Narrowing of flows also addresses material-efficiency and waste-handling. The construction industry is among the sectors showing the lowest rates of efficiency improvement; the difference from, for instance, the automotive industry or manufacturing, is stark. Currently, between a fifth and a sixth of the materials is lost during construction processes⁴⁷. For example, 80,000 tonnes of gypsum gets wasted in Denmark each year⁴⁸. Reducing these figures substantially would narrow flows by reducing material-intensity. There are companies that focus on minimising waste in construction, such as Saint-Gobain with its Material@Hand service concept, wherein bespoke cutting of gypsum and steel minimises waste⁴⁹.

Slowing the loops in the construction sector means ensuring that existing buildings function as long as possible, through repairs and rebuilding, in combination with optimal use, shared use, and reuse and repurposing of buildings. Key in this area is questioning the need for new construction. Utilisation rates are low in several respects; post-pandemic figures point to office-space utilisation rates of only 50%; many public facilities, such as schools, get used for eight hours a day at most; etc. Also, for instance, Sweden's standard office dimensioning is 16 m² per person, which one could argue is quite generous. New construction is tightly bound up also with societal needs related to, for instance, population development, locations of residential and work spaces^{50,51}, and municipal and political factors such as job opportunities' creation. In addition, property tax and access to capital influence living space; e.g., people with a high income tend to own more than one house and have large houses. Finally, various players have found it highly profitable overall to build new homes and invest in properties.

Closing the loops entails ensuring that built structures' materials can be reused – and actually are – in loops that follow. This includes addressing the important issue of hazardous materials found in construction waste, which sometimes hamper reuse efforts.

47. Boverket 2018.

48. Opstrup Wedel 2021.

49. CircularX 2022.

50. Zu Castell-Rüdenhausen et al. 2021b.

51. Wahlström et al. 2021.

Box 9: The circularity opportunity of models for increased (re)utilisation of buildings

Construction and demolition waste accounts for more than 30% of the waste generated in the Nordic region. Numerous activities in the Nordics currently focus on increased building (re)utilisation.

Digital tools suited to the early stages in building design can help designers select materials and production methods that enable structures to be designed for later adaptability. Some of the interesting solutions are 'digital twins', remote sensors (e.g., to measure moisture levels), tracking of resource use in buildings (e.g., water and electricity consumption), and smart sensor technology. These can contribute to energy-efficiency and reductions in carbon emissions and facilitate reuse/recycling. Digitalisation is growing more and more important in the Nordic building and construction sector, but significant untapped potential remains.

Furthermore, such new business opportunities as leasing, sharing, or rental of unused space show great potential for fuller utilisation of existing buildings and their structures/components. New design methods and approaches geared for increased building (re)utilisation are gaining traction.

Positive long- and short-term business impacts from direct cost savings related to resource consumption are expected to manifest themselves as buildings stay in use longer, resources are shared, and more building materials get reused and recycled. The most obvious direct positive impact lies in a smaller material footprint. Increased rates of reuse and recycling are expected to bring lower carbon emissions too. Nonetheless, climate impacts may differ greatly, depending on the initial components (and constituent materials) to be repurposed or reused. Additionally, buildings represent social and cultural capital. Therefore, their increased (re)utilisation contributes to preserving Nordic heritage and history.

Some barriers to seizing the opportunity are shortcomings in accessibility of information, which may be lost by the time it is needed; the buildings' life span, lack of economic incentives to switch from current business approaches, hazardous substances contained in existing buildings precluding reuse, and needs for additional knowledge and testing (safety guarantees demand significant expertise and testing). While the last of these represents a need for significant investment, it can also lead to cultivating valuable skills in R&D.

Box 10: The circularity opportunity of digital platforms that support circular economy

Digital platforms are a means of increasing the degree of utilisation of surplus resources already available. Such platforms enable data-driven, cross-sector, end-to-end interactions for circular economy by overcoming information asymmetry between actors. In their simplest form, these platforms provide information about underused resources and material streams and provide a possibility for buying or otherwise receiving the resources. At their best, digital platforms catalyse collaboration and shared benefits by unlocking relevant information and by actively orchestrating interaction among stakeholders on the platform.

Digital platforms are needed for maintaining value by circulating materials as long as possible. A common challenge is that many of these digital platforms are established through public development projects and lack an ability to expand their services to commercial scale.

The impacts identified from digital platforms for materials exchange cover a wide expanse, especially with regard to business effects, which depend on the segments of the material markets possibly targeted. Some of the generic business impacts are related to cost savings from avoiding waste-handling fees. Also, digital platforms enable the optimisation of logistics and can generate new business. Digital platforms hold massive potential for positive impacts on the climate and natural environment. However, there are multiple uncertainties linked to the size of those predicted impacts and the pace of their emergence, and it should be recognised that digital services consume significant amounts of electricity.

Among the barriers to seizing the opportunity are shortcomings related to good interfaces, up-to-date data, and quality and comparability of the materials. Systems for environmental permits can vary even within a given country. Furthermore, the legislation seems to lag behind innovation and does not offer enough incentive for a shift to more recycled materials. Also, there are difficulties related to timing between supply and demand and in attracting users to a new marketplace.

Impacts of circular transition on innovation and business development

The Nordic countries possess advanced expertise in construction, including extensive competence and technology-specific expertise in building and construction for cold environments, remote areas, and otherwise challenging contexts, as represented by various parts of the Arctic region. This constitutes a significant competitive advantage that can, together with circular design competencies, be exploited also in export markets.

One key impact on innovation and business development that we identified is tightening of the circularity requirements for building materials and design. In the construction phase, circular design thinking can increase efficiency in general within space use, transport, etc. while also eliminating various errors and increasing the value of materials by preventing waste. In the long run, circular design in the

construction sector could well lead to cost savings, larger markets for the relevant material streams, and new business models and business growth connected with marketplaces and logistics.

Growing demand for circularity of buildings will have a direct impact on producers of building materials, buildings' owners, and developers. These impacts can either create or diminish business opportunities. Digitalisation is vital throughout the service life of a building, enabling new business models to emerge. Traceability (via digital product passports) and use of AI-based tools (e.g., for analytics) create new opportunities for material markets.

In the long run, circular practices in the construction sector will lead to cost savings and new value creation. With circular design techniques, the monetary and material-use costs of mistakes in particular are expected to fall. For example, between 10% and 20% of the GDP from Sweden's construction sector is generated via rebuilding and renovation due to faults, deficiencies, and damage. Therefore, the impact foreseen is considerable. The estimated costs related to new resources alone come to SEK 24–73B a year⁵².

Positive long- and short-term business impacts alike – in the form of direct cost savings – are expected in relation to resource consumption as utilisation of buildings gets prolonged, resources get shared more, and more building materials enter reuse and recycling. There may be transitory direct and indirect negative impacts during the transition toward circular economy in construction, stemming from the growing need for planning, documentation, logistics, storage and transportation of building materials, and overall resource-efficiency, along with associated regulation. It is important to differentiate between short-term and long-term impacts. In a Swedish case study⁵³, selective demolition was estimated to be nearly twice as expensive as conventional demolition. For the long term, though, the positive impacts can be expected to offset temporary negative ones that may be created during implementation.

Also, using raw materials from waste streams holds promise for cost savings or new economic streams (from saving on disposal fees or from reselling materials). Digital marketplaces and platforms for materials exchange have a role in such development. Among the business impacts of larger material markets might be savings on waste-reception fees if more materials and side streams are used. Digital platforms enable the optimisation of logistics too and can help decrease transportation costs, simultaneously bringing new business to circular-economy-based companies, businesses that create side streams, or completely new enterprises. Optimisation and matchmaking can pave the way to new types of business model, and data-analysis-based approaches to business may emerge. Still, some logistics challenges remain to be addressed, on account of differences between where the material is and where it is needed. Additionally, it should be noted that digital services, platforms, and infrastructure consume significant amounts of electricity.

At the same time, decreased new building activity will have negative business impacts in this sector, with a need to rethink sustainable business models and ecosystems.

52. Boverket 2018.

53. Sheidaei & Serwanja 2016.

Impacts of circular transition on the climate and the environment

Construction and demolition waste (C&DW) currently accounts for more than 30% of the waste generated in the European Union and on Nordic level⁵⁴. Improving the circularity and decreasing waste will have significant impacts on the climate and environmental burden. The study's examination of this sector's circular transition identified key possible climate and environmental impacts linked with emission reductions brought by producing less material, engaging in more reuse and recycling, reducing waste and the need for extraction of virgin materials (by means of reuse), using substitute materials, and landfilling the materials less. Potential risks were identified in the handling of hazardous waste. That is, while reuse, material substitution, and reduction in construction-sector waste are projected to reduce resource consumption in the Nordics by 20% from current levels⁵⁵, thereby shrinking the material footprint, there is a possibility of hazardous waste being generated from existing buildings. Also, older building stock often consumes large amounts of energy. These factors have to be considered in any repurposing of older buildings.

Researchers have estimated⁵⁶ that incorporating circular economy into the Nordic construction sector could decrease GHG emissions significantly. However, the climate impacts that are possible differ with the initial components/materials to be repurposed or reused. Alongside such efforts, further emission reductions could be achieved by incorporating the use of sustainable design techniques into building design.

Increasing the utilisation of existing buildings is a promising avenue for reducing the need for new construction, thus contributing to resource-use efficiency and reduced carbon emissions, during both construction and use. Likewise, better development of markets for excess construction materials could decrease the need for pouring resources into new materials and assist in tracking complex circular material flows, their environment-safety and potential CO₂ emissions, and material-efficiency. It is safe to say that digital platforms hold massive potential for positive impacts related to the climate and environment; however, there are multiple uncertainties as to the size of the predicted impacts and the pace of them coming to pass.

Increased circulation of the materials already present aids in avoiding emissions, through less burdensome waste logistics and reduced use of virgin resources. In one example, prioritising local construction materials would considerably reduce emissions from transport when the need to traverse longer routes diminishes. Logistics activities related to circulation of materials need to be planned and timed well, for avoidance of unnecessary transport costs and emissions.

Energy consumption is another key factor with relevance for any built environment, so estimates should consider this too, for the space's entire life cycle, also in terms of CO₂ equivalents for a wide range of alternatives and space-use/utilisation scenarios⁵⁷.

54. Zu Castell-Rüdenhausen et al. 2021a.

55. Høiby & Sand 2018.

56. Høiby & Sand 2018.

57. Confederation of Finnish Construction Industries 2020.

Impacts of circular transition on Nordic economies and societies

Key socio-economic impacts were visible in relation to developing housing, jobs, and business activities in various areas by means of adaptive (re)utilisation of buildings, skills development in the building and construction sector, new employment opportunities related to digital platforms, and safety and health impacts stemming from buildings and their use. The ILO has estimated that increased recycling of building waste could create six million new employment positions in Europe by 2030⁵⁸.

Buildings play a fundamental role in how people live and inhabit areas. Transition to circular design, building, operation, and maintaining of buildings promises strong direct socio-economic impacts that reverberate on the living environment, health, and well-being. Building (re)utilisation in the form of repurposing can assist in revitalising existing neighbourhoods and communities – bringing new housing, jobs, and business activities to previously underutilised parts of both urban and rural areas. Reuse allows for a building's continued use and helps it remain a viable community asset. Additionally, buildings represent social and cultural capital; therefore, greater (re)utilisation of buildings contributes to preserving Nordic heritage and history.

One of the trends today, strengthened by the COVID-19 pandemic, is multilocation, with some market analysts predicting 30% lower demand for office space.⁵⁹ There are ample opportunities to increase space utilisation, rethink existing office designs to accommodate changes in work patterns, and potentially avoid new construction. Adapting buildings for new purposes (e.g., for remote office spaces) can also affect people's options for choosing where to live on other grounds than proximity to one's place of work, thus affecting demographic and socio-economic elements of various Nordic locations.

Adaptive (re)utilisation can provide renewed vitality to any building that may be underused, abandoned, vacant, dilapidated, or obsolete in function. However, building (re)utilisation is not always possible. Existing buildings, their elements, and their materials cannot always meet new building standards. There may also be health and safety concerns connected with building materials. For instance, now-banned toxic materials once used in building construction should not be reused, and human exposure to them should be limited. Moreover, significant expertise and testing are needed, for guaranteed safety when buildings are repurposed and when components get reused. Yet the latter can lead to new skills development as R&D and innovative solutions are cultivated to support buildings' (re)utilisation. Clearly, smart utilisation and better (re)utilisation of buildings can have diverse impacts on people and societies.

If business services coalesce around material markets and other digital platforms, they will support knowledge-sharing, business development, and new employment. A digital sharing economy is of interest to companies and consumers alike, who envision both economic and social benefits in the form of environmental protection. Replacing many material elements of the production process and distribution of products/services with mapping of information via online platforms enables optimising utility from the resources used. There is no indication that the digital sharing economy should bring on any negative effects from decreased need for

58. ILO 2018.

59. CNN 2021.

labour, yet negative impacts may still occur when platforms contribute to job insecurity (this is one of the general challenges associated with platform economies).

Circular economy will lead to new skill-development needs in the sector. According to a study by Sitra (2021)⁶⁰, the greatest increase in labour is expected to occur near the end of the value chain (building demolition and recycling of building materials). That said, the skill requirements⁶¹ in the building and construction sector are changing along all parts of the value chain, from planning and design to demolition. Especially in planning and design, the need for understanding the life cycle of buildings; material-related knowledge; and understanding of modularity, longevity factors, and building safety will increase. This change has to be mirrored in the education and training.

An increase in modular building might also influence where employment is physically centred, by decreasing the need for workers on construction sites while increasing the need for labour in factories, where the modules are created. On the other hand, the necessity of renovation and rebuilding in the existing buildings' locations will grow⁶².

The main barriers for circular transition in the sector

The construction sector exhibits one of the more complex business-ecosystem structures. This in itself is a key barrier. It involves numerous actors, applying complex and varying business models that are interlinked, in projects that often feature relations with several private and public actors. The nature of 'one-off' projects adds complication, especially in combination with the structures' long service life relative to that of, for instance, the automotive or electronics industry's output. On top of this, there are several underlying drivers of increased construction related to general societal developments, such as changes in demographics, business locations, work habits and norms (as witnessed in consequence of COVID-19), taxation, local politics, digitalisation, and mobility.

Technology barriers

We lack technologies for optimising materials' use in buildings. One study⁶³ shows that 50% of the steel used in them is surplus to what the desired structural properties necessitate. Better use of digital tools for learning about and optimising material usage might be required. A similar issue could arise in the realm of reused construction material (entire substructures especially): it is sometimes difficult to get the dimensions exactly right, and overdimensioning is likely. Such issues render it difficult to devise generic strategies and policies in this area; instead, the options require case-specific investigation.

Further technology development is needed also for automation and higher efficiency in areas such as 'de-construction', where used materials have to be sorted, assessed, and subjected to quality assurance in a cost-efficient way. Market examples of technical support for this do exist, especially for assessing interior elements, but are

60. Sitra 2021.

61. Sitra 2022.

62. Sitra 2021.

63. Moynihan & Allwood 2018.

not applied at large scale or in general use for de-construction. Also, the design of structural components such as walls, frames, and flooring usually focuses on simple construction and use rather than on these components' reuse. Again, there have been several pilot projects, but few related systems are in large-scale standard operation.

Digital solutions for storing information on buildings' components and materials must be kept aligned with technological developments throughout the life of the building and be updated accordingly – otherwise, accessibility of the information may be compromised by the time it is needed. Yet challenges are still visible in relation to keeping the data up-to-date and reliable. Furthermore, the data's quality and comparability of data usually are insufficient.

One more source of challenges is the life span of buildings, noted above. They normally last 50 years or more, in which time technologies and styles change significantly. This means that components might not end up reused, for reason of obsolescence.

Regulatory barriers

Disparity of building regulations, which differ among individual EU member states, can hinder trade both within the European Union and between Nordic countries. In spring 2020, the Nordic states set up a joint steering group to co-ordinate their harmonisation of building regulations. However, experts expect new harmonised regulations to be unable to overcome the above-mentioned barriers on their own, let alone constitute sufficient policy instruments for accelerating transition toward circular economy in the Nordic construction sector. Expectations are that companies may need stronger economic incentives to switch from their – often linear – current business approach.⁶⁴

Systems for environmental permits can vary even within a single country, so a solution that works in one place may not receive a licence to operate somewhere else. There are challenges connected with classifications and procurement criteria also – e.g., in relation to end-of-life waste definitions. For the material's full potential to be unleashed, it ought to lose its designation as waste. However, one should examine whether the regulations truly create barriers or, rather, the actors do not understand how to interpret them. So far, though, the legislation does seem to lag behind innovation and not offer enough incentive for a shift to more recycled materials. Lack of regulation that could somewhat 'force' data-sharing strips the digital platforms of their fullest potential. So long as actors need not share information about side streams or the waste generated in production, loss of materials in the cycles is inevitable.

Hazardous substances contained in existing buildings often preclude their reuse. Old buildings and their materials cannot always meet new building standards. End-of-life waste protocols are not sufficient to keep various of the materials in market circulation longer. Article 6 of the Waste Framework Directive (WFD), Directive 2008/98/EF⁶⁵, states that criteria specific to end-of-life-waste should be considered at least for aggregates, paper, glass, metal, tyres, and textiles, but there is no direct imposition of any obligation to set such criteria. Consequently, the Nordic countries

64. Høiby & Sand 2018.

65. See <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN>.

could differ vastly in how their C&DW is treated.

Market barriers

A key issue from the market angle is that new construction from virgin materials has proved extremely profitable. So far, no lack of demand for them is evident (with the exception of some pandemic-linked fluctuations in demand, responses to political situations, etc.), and costs of raw materials are generally low in comparison to reuse. Hence, no incumbent drivers encourage longer use of buildings or the reuse of construction materials. Though there is some movement toward greater demand for reused construction materials, the trend comes mainly from large construction companies, not from the public sector (except for a few profile-raising projects).

Another factor is that the building materials are tied up in use for a long time, rendering a return-on-investment rationale challenging – arguments for designing buildings for ease of repurposing or disassembly seem less compelling.

Closed material loops require effective and well-connected processing infrastructure that incorporates selective waste-collection points, processing facilities, adequate organisation among demolition companies, suitable online platforms, and databases informing about the market for reused and reusable materials. This value chain has only just started to take shape.⁶⁶ Since it is underdeveloped, substantial market barriers remain.

As for digital building information systems and marketplaces for side streams of construction and building, several market barriers impede development. Firstly, digital platforms do not work by themselves – there need to be service business models created around them. The design of the platforms does not always support this development: digital platforms must be backed by good interfaces if the intent is to encourage new business models to flourish around them. Among the market barriers to thriving marketplaces for side streams are difficulties of timing between supply and demand; problems in matching demand with exactly the right material (e.g., building materials that have been treated in different ways are not always interchangeable); and the small size of local markets, especially in more sparsely populated Nordic locations. Furthermore, irrespective of how well the digital information flows, large challenges exist in relation to storage and logistics. Long-distance transport of materials is rarely justified, and there are few physical storage spaces that could render the material exchange profitable. Especially when low waste fees get factored in, there are insufficient economic incentives for ensuring the reuse of material.

Cultural barriers

The building and construction sector is often perceived as rather conservative, and many companies might indeed be reluctant to alter seemingly well-functioning processes. However, there seems to be a clear shift in which some forerunners are paving the way for circular building processes. In the process, they are raising awareness among other members of their networks⁶⁷.

The lack of building-information modelling and material passports for old buildings –

66. Højbye & Sand 2018.

67. Sitra 2022.

especially in combination with low quality of statistical data on material flows – poses a major challenge to implementing building (re)utilisation. Recent projects undertaken by Nordic cities such as Helsinki and Gothenburg are good examples of what is required of municipalities wishing to realise the potential in existing property before pursuing new construction.

Another cultural barrier is shortcomings in quality assurance for reused building materials. As multiple Nordic case studies attest, we need additional knowledge and testing so that quality-assurance marking schemes for these materials can become adequate.

In the realm of attitudes toward markets for material side streams, attracting users to a new marketplace is especially challenging in B2B environments. Intermediate services could help in this regard, since information and the marketplaces tend to be hard to find without them and the benefits for a given company may seem unclear. Another factor is the authorities' attitudes and how well they can support the development of such digital ecosystems.

Actions needed to release the circular potential

The building and construction industry has been recognised as one of the sectors that are critical for the low-carbon circular transition. The nature and complexity of the construction industry, as described above, makes it even more necessary to collaborate on the actions and proactively apply a systems approach.

The actions that the study identified as necessary cover the whole life cycle – new buildings and their design (incl. development of circular design), renovation, and beyond (incl. enhancing knowledge of materials and creating building information systems). Experts recognise that more focus should be put on expanding from pilot scale and on modular structures, business models and their profitability in ecosystems, use of existing structures, need analysis, and creation of greater flexibility in buildings.

On the Nordic level, many actions are already in progress through regional frameworks such as Nordic Networks for Circular Construction, the region's programme for sustainable construction (Nordic Sustainable Construction), the Nordic Circular Hotspot, and Nordic Innovation. These frameworks are aimed at integrating circularity into the construction industry by compiling and sharing knowledge; promoting education, networks, multi-nation fora, and awareness-building; developing and harmonising practices in such activities as public procurement; and, thereby, enabling a new market for circular construction. The ensuing actions have yielded concrete results: such as the Declaration on Low Carbon Construction and Circular Principles in the Construction Sector, creation of common metrics for circularity in the built environment, and work to educate the industry in circular business models (the Nordic Circular Economy Playbook). Also, the Nordic countries have agreed to collaborate on uniform collection of data related to construction's emissions.

Continuing the work initiated by these Nordic networks is important. The main issue is how to support it further and keep construction-related industries on the agenda, all while avoiding overlap in the actions and promoting exchange of information.

Addressing this area for development requires a systems-thinking approach, possibly

with consumption-limit-based targets for construction, whereby designing buildings to suit multiple purposes becomes the norm and public procurement focuses on lifetime factors rather than only the initial building-investment cost. Public-private partnerships and coalitions of all parties in the construction value chain are necessary for progress that is scalable and goes beyond pilot tests limited to specific areas. Also, strict eco-design principles need to be applied as a rule, not the exception.

Action is still needed in all policy areas, from regulation and standardisation to knowledge development and education.

Nordic-level input on EU initiatives is crucial. This includes giving joint Nordic input on EU-level initiatives within the Green Deal such as development of the Construction Products Regulation, the EU's Building Logbook initiative, and the EU Sustainable Carbon Cycles initiative (with support for quantifying the climate benefits of biogenic carbon stores in buildings as the initiative progresses).

Secondly, we should continue and expand the accumulation and sharing of knowledge. Knowledge-building and knowledge-sharing associated with circular public procurement advance through relevant authorities' activities. Also, best practice for it must be developed, moving from discussion to concrete actions. Some efforts in this direction are in progress, through Nordic Sustainable Construction work packages 1–2. The knowledge-building should cover the possibilities for repurposing buildings and extending their life cycles, encompass ownership models and concrete actions for shifting ownership in the Nordics such that construction companies are encouraged to own the buildings longer than they do at present, and thus give incentive for construction with lower maintenance costs and a longer life. In addition, it is important to continue the R&D and knowledge work connected to refurbished materials and to demolition waste.

Thirdly, the Nordics should consider adopting certain EU policies in advance of EU rollout. The countries could investigate whether some parts of the upcoming EU strategy for circular construction can be applied earlier or more swiftly in the Nordic region. This might be relevant with respect to the policy on a quota for reuse of construction materials, such as the 15% target suggested by the EU, or adopting the principles on eco-design in public procurement of construction. Joint Nordic initiatives could address how regulation or incentives (stick or carrot mechanisms) could serve ensuring that circular strategies (for longer service life, repurposing, using an old building's shell, etc.) are assessed and applied before any demolition decision. Another example is work on joint Nordic instructions for pre-demolition audits (benchmarks can be found in the Danish environmental ministry's work in this area and DG ENV's guidelines for waste audits).

Finally, government authorities need to take the lead in target-setting and in circular public procurement of construction. One obstacle here is that public procurement exhibits many variations at local and regional levels. Still, were the Nordic governments to exercise their power over the authorities under their control, they could be front runners in construction-related circular public procurement. The four-step principle from the Swedish Transport Agency could function as common guidance for the governments.

The four-step principle applied by the Swedish Transport Agency

Step 1: Is it possible to address an identified deficiency by reducing or changing demand?

Step 2: Can we identify more efficient ways of using existing infrastructure?

Step 3: Consider limited renovation/repair.

Step 4: If measures in line with steps 1–3 are not enough to meet the needs, consider new investments or major renovation.

As a next step, more detailed target-setting could be developed collaboratively, even if targets may vary among the countries. As for the other sectors studied, public–private partnerships are vital for successfully forming a new market and economy. For the construction industry, this cannot happen without strong involvement and target-setting on the part of public actors (e.g., municipalities). Collaboration across borders in creating public–private partnerships could strengthen the incentives for municipalities to join the effort.

4.5 The mobility, transport, and logistics sector: Potential, impacts, barriers, and actions for circular transition

The importance of circular transition in the sector

Mobility and transport logistics is identified both as a very important sector in its own right and as a circular economy engine more generally across the Nordic region. Depending on how it is defined and measured, mobility and transport accounts directly for at least several percentage points of total national GDP in all of the Nordics⁶⁸ and is a significant source of employment across those countries. The sector remains stubbornly linear: despite (patchy) developments such as increased use of biofuels and partial electrification of fleets, transport and logistics accounts for perhaps a third of all GHG emissions, with much of this stemming from privately operated road transport⁶⁹. It has been noted that progress in residential energy use, electricity generation, etc. is exacerbating the relative emissions burden from a fossil-intensive transport and logistic sector.

Alongside the challenges are opportunities. Progress in decarbonisation and improving the renewability of the Nordic electricity supply (with countries or specific regions attending variously to hydropower, bioenergy, wind power, and geothermal sources) puts substantial benefits of circular transition within closer reach. Electrification of transport is an especially promising avenue to reducing environmental burdens.

The economic imperatives for the de-fossilisation of transport and logistics are becoming more and more compelling on an almost daily basis at the time of writing. Geopolitical developments and the consequent energy crisis have resulted in spiralling costs of fossil fuels.

68. Trading Economics 2022.

69. Sovacool et al. 2018.

There is little sign of reduction on the demand side for mobility and logistics, although both COVID-19-related factors and the potential global economic downturn arising from current geopolitical events may affect demand. This means that reducing unit costs for transport and logistics is extremely important for the overall economic and, ultimately, societal health of the Nordic region. The potential influence of circular transition in this sector extends well beyond purely environmental factors.

Circular transition potential in the sector

Transport and logistics is a broad field, so the project team divided it into two subsectors: land-based personal mobility of people and the movement of goods. Increasing the circularity of the former is usually framed in terms of MaaS solutions, whereas advancing the latter is often called smart transport logistics or something similar. Transport systems for humans and freight vary across the Nordic region, depending on factors such as local geography, topography, and population density. There are many similarities nonetheless, such as the relative concentration of populations in large, fairly spread-out metropolitan centres. The need for long-distance domestic transport is noticeably lower in some of the countries (Denmark and Iceland in particular), but in general terms the challenges and opportunities connected with circular transition are fairly similar throughout the region.

In the field of personal mobility, the market is at the heart of the transition potential: a clear need and untapped potential exist for attractive markets for MaaS solutions. The technology and infrastructure to physically deliver the solutions are largely available already, so development emphasis should be directed to establishing favourable conditions. For flows of materials and goods, there is also an imperative to work on developing well-functioning digital marketplaces specifically. Transition depends greatly on further development of technologies to deliver the solutions also (such as electrified or autonomous vehicles), alongside relevant social, legal, and regulatory elements. In short, there are fewer immediate barriers to implementation of personal mobility solutions in the short term.

The following circular economy approaches' potential has been partially unlocked already:

- Replacing the movement of people or goods by privately owned/operated always-available vehicular solutions with alternatives that promote economies of scale, efficiencies of operation, and increases in sustainability (for instance, moving away from fossil fuels)
- Facilitating end users' access to these alternative solutions, via technologies or systems that promote ease of access but also by establishing and properly managing the marketplaces for such access
- Promoting service-based solutions that reduce the emphasis on physical assets (e.g., vehicles) in favour of the functions that such assets provide
- Ensuring the utilisation of assets such as vehicles that might otherwise be wasted or underutilised
- Extending the service life of physical assets and materials, promoting recovery, and focusing on reuse of materials and assets at end of life

The use of **data and digital tools** plays a significant role in this development.

Digitalisation is central to end-user access to personal mobility markets; both existing and future MaaS implementations depend critically on digital infrastructure. This involves work such as the sharing of information and data among the actors and on real-time monitoring and analysis of circular systems for operations such as balancing between supply and demand.

The existence of a fundamentally digital-only marketplace for personal mobility is now entirely standard. This cannot yet be said for the movement of goods, but the establishment and development of such marketplaces is surely inevitable.

Digital developments in mobility markets' core operations will grow increasingly important, not least through the development of autonomous vehicular operation – which, again, has advanced further in the personal mobility sphere though representing enormous scope for progress in the freight-transport arena.

Another facet to digitalisation's significant present and future bearing on the support, development, and maintenance of transport and logistics marketplaces is the support it can give system design and optimisation, both for systems as a whole and for physical assets therein.

Any advances beyond incremental development of circularity and sustainability in the transport and logistics sector require **circular business models** to play a strong, increasing role in this area, by definition. These models are a prerequisite for MaaS and logistics as a service (LaaS), alongside various kinds of emerging business in which buying and selling of vehicles is replaced with service-based models, hire, and sharing.

From **a value-chain perspective**, opportunities for circularity are visible along the entire chain – not just at specific links (elements/activities in the value chain) but also in how the value chain is designed and organised as a whole. It is noteworthy that some of the circularity approaches listed above exert an influence primarily from the end-user standpoint (for instance, if end users switch to MaaS or circular logistics, then their individual contributions to circularity and sustainability improvements are tangible), yet others do involve the overall performance of value chains. One finding from the ongoing Nordic project on product–service systems⁷⁰ is that examining sustainability and circularity from both the individual-user and the system perspective is important.

For dealing with the mobility and logistics sector's loops and flows, the focus is principally on **narrowing the loops** via efficient use of resources. This is normally conceived of at the scale of physical assets (e.g., vehicles), with the raw materials for those physical assets being considered only by implication.

That emphasis aside, **slowing the loops** through good design of physical assets is rather important, albeit more so in the logistics arena than in personal mobility. The latter focuses more on the efficient use of existing assets than on the design of new ones.

Closing the loops via recycling and reuse of constituent raw materials will always be somewhat important but appears considerably secondary to the configuration of systems for the efficient use of (existing) resources and assets.

70. See <https://planmiljoe.wixsite.com/pssinthenordics>.

Box 11: The circularity opportunity of logistics for circular transport

Transport logistics is a significant source of emissions across the region, with obvious potential for efficiency improvements and greater sustainability via circular transition. There are (at least) two distinct pathways to circular transition in the land-based transport logistics sphere: 1) increasing operations' efficiency while retaining the general vehicle-ownership paradigm and 2) revising the paradigm connected with vehicle-ownership/operation, with the implied shift away from a privately owned always-available vehicular solution.

Digital tools will always lie at the heart of circularity developments for transport logistics. Examples include digitally driven planning and co-ordination in fields such as reverse logistics (the collection and transport of waste) and online shopping and delivery. The push to develop and deploy ever more autonomous vehicles in the transport logistics sector continues apace.

Among the key impacts pinpointed are greater efficiency, lowering of costs, and enhancing circular economy approaches at various scales while opening significant business opportunities for logistics and technology companies. There is vast potential for reduced environmental impact, at first through more efficient use of existing transport modes but also via developments such as electrification. Automation and 'smart' operation may increase the extent of the need for highly skilled labour. The total number of positions available may fall, however.

Some of the barriers are challenges in circular operation of logistics value chains and in the development of autonomous-vehicle solutions, regulatory barriers connected with autonomous freight vehicles on public roads and reverse logistics in general, and consumer attitudes toward a shift away from always-ready solutions.

Box 12: The circularity opportunity of smart mobility solutions

The development of mobility solutions that reduce the demand for private vehicles' ownership and use is a fundamental pathway to reducing the environmental burden created by personal transport. The case study of this opportunity was focused specifically on MaaS solutions.

The key elements of MaaS are integration of several transport services/modes and on-demand accessibility of the service. Transition to MaaS entails a holistic relationship with the larger system in connecting separate routes together. Also, MaaS implies a shift away from a supplier-centred paradigm typical of traditional public transport and toward a user-centred one wherein both users and suppliers shift and adjust their behaviour, often in real time.

Several Nordic countries have been at the forefront of MaaS developments for a considerable while. Their work incorporates established large-scale operations, smaller-scale and/or preliminary pilot operations, and underpinnings in research and development. Some commercial-scale solutions are evident in the biggest Nordic cities.

There is considerable scope both for introducing new MaaS implementations across the Nordic region and for driving new and existing implementations alike. At present, MaaS remains largely an urban/metropolitan concept. However, its extension into rural areas seems inevitably crucial among future developments. The key impacts identified include growth in business volume for the non-personal-transport sector, increased efficiency and economy of scale across the entire sector, and emissions reductions (though shared-mobility solutions lead to more emissions in some cases).

Some barriers to seizing the opportunity arise from difficulties and reticence related to sharing data and information between public and private actors, weak co-ordination and duplication of effort, the need to share public funding (subsidies etc.) between public and private actors, and the business case being ultimately unclear. It appears that every MaaS implementation beyond pilot stage in the Nordics has experienced significant economic difficulties. There are also issues concentrated around a uncertain willingness to pay and related to market demand.

Impacts of circular transition on innovation and business development

As mentioned above, circular transition in the mobility and logistics sector largely implies business development *a priori* more than as merely a driver. Both personal mobility and transport logistics will foster more conventional innovation in terms of research and development for the new types of (vehicular and infrastructural) physical assets that are going to populate the developing value chains for mobility and logistics. However, it is the development of the systems themselves that will yield the largest gains on an ongoing basis.

Particularly for personal mobility but also for transport logistics, the ideal characteristics of new business models are widely known, at least in qualitative

terms: ease of access for end users, co-ordination of activities among the various actors, and regulatory frameworks that accommodate the models. There is ongoing effort to carry these ideals over to models that work in practice – in economic, environmental, and social terms.

That said, there are tangible potential business impacts. Increasing efficiency and economy of scale in mobility and logistics will lead to cost savings, which should be considerable, highly significant, and realisable over relatively short time scales. Some researchers have estimated that logistics companies could generate up to 10% revenue growth from new blockchain-related services. In the context of autonomous driving in particular, blockchain shows potential to bring significant new business.⁷¹ An Arthur D. Little study addressed a use case that involves 'around 25 percent additional sales through creating a customer ecosystem that allows it to sell additional services along the transportation chain in a convenient way'.⁷²

Cutting of costs in logistics in particular will function continuously as a key driver for various industrial and personal activities. Such impacts can be regarded as virtually certain if the developing business models and systems reach stability and maturity. In this scenario, reduction in the logistics sphere's idle or underutilised assets is all but certain, though less so for personal mobility (as discussed below). New digitally based business concepts are also guaranteed to emerge, although there will be both winners and big losers in the race to develop them. The stakes are extremely high.

Impacts of circular transition on the climate and the environment

As outlined above, mobility and transport operations are major sources of greenhouse gases and other pollutants, and in several respects, they still lag behind other sectors in decarbonisation and environmental-impact reduction.

In the context of personal mobility, increasing deployment of MaaS is a reasonably secure route to lower direct emissions reductions in comparison to existing transport ecosystems. According to a 2018 study report⁷³, Nordic households that replace use of a private car with car-sharing can reduce their number of vehicle-travel kilometres (VKT) by roughly 30–45% and their greenhouse-gas emissions by 130–980 kg CO₂-equiv. per year. It was also estimated that, were 5% of households to switch from car ownership to ride-sharing, there would be potential to reduce greenhouse-gas emissions by between 0.7% and 5.3% from the current baseline (the Nordic countries differ in potential).⁷⁴

There is significant room for Nordic households to shrink their transport-related climate footprint. However, this carries some significant caveats: variations between countries and between regions therein are to be expected, reflecting differences in extent and mode of personal mobility between locations. MaaS remains largely an urban/metropolitan concept, largely (but not exclusively) for reasons of commercial/economic viability. Moreover, not all shared-mobility services enhance sustainability; in some cases, low- or zero-emission transport modes (walking or cycling) are being superseded by powered alternatives that actually increase emissions. Also, it is far

71. Arthur D. Little 2018.

72. Arthur D. Little 2018.

73. Laine et al. 2018.

74. Laine et al. 2018.

from given that the demand for transport is immutable – indeed it seems certain that, in at least some cases, availability of multi-modal personal mobility solutions may in and of itself stimulate demand.

Personal mobility solutions are anticipated to ultimately reduce the use of natural resources connected with the manufacture of private vehicles. However, their ability for decrease demand for private vehicles is not proven and appears far less secure than the downward pressure on the use of those vehicles. It remains unclear whether MaaS will significantly reduce manufacturing and, thereby, the use of virgin resources.

It is certainly conceivable that the proportion of private vehicles going idle/underused could rise, rather than fall. Alternatives to the car must emerge as genuine competitors to the ownership as well as the use of the private vehicle.

In the transport and logistics sector, 'green logistics' is the main thrust of advances and a precondition for fuller development of circular economy. The climate effect of circular logistics on indirect infrastructural elements of the value chain is less clear. Reductions in so-called capital environmental expenditure and use of natural resources (particularly linked with the manufacture of vehicles and related infrastructure) seem reasonably self-evident. However, the infrastructural elements seem not to have received sufficient attention in analyses of possible future systems thus far. For example, a need for larger – and ultimately vast – quantities of computation power seems clear. Such factors, which are anything but climate-neutral, demand considerably more analysis.

Impacts of circular transition on Nordic economies and societies

The circular transition in mobility and transport promises impacts on societies, both with respect to socio-economic effects on individuals and on societies more broadly. At global level, people spend 11% of their disposable income on personal mobility, making it the second-largest item in household spending. In Finland in 2015, the annual market in the transport sector was worth €30 billion, with personal mobility making up about half of it.⁷⁵

Highly efficient transportation systems promise a relative reduction in this expenditure with consequent increases in quality of life more generally. However, this is far from certain, depending on a number of related factors: the economic viability of MaaS implementations, their ability to deliver mobility at a lower overall cost to the consumer, and the displacement of other expenditure such as that on private vehicles.

Widespread adoption of MaaS implies necessary changes to behaviour and perception on the part of end consumers. For example, there is evidence to suggest that tolerance of delays is higher for private vehicle use than for public transport. In the absence of broad-based changes in perception, worries about delay could represent a barrier to public reliance on mass transit. More generally, even the best designs for MaaS cannot match the flexibility and availability options offered by the private motor vehicle, so there is a widespread need for end consumers to make compromises related to their personal mobility activities.

75. Finnish Transport Agency 2015.

Widespread adoption of MaaS does possess potential for societies' increased liveability in general, via reduced congestion and pollution, particularly in urban areas, but these effects are highly uncertain. This also hints at regional tensions in transport provision and policy developments, particularly between urban and rural areas. Geography-related inequality of opportunities for personal mobility seem inevitable over any conceivable time scale.

The effects of circular transition in transport logistics are probably less transparent to individual consumers. Increased efficiency and reduced logistics costs do imply a drop in prices for goods and services, but this benefit is arguably less tangible than those for personal mobility. Changes in end consumers' perceptions and behaviour would also smooth the circular transition in logistics. For example, tolerating wider delivery windows for goods is known to be a strong driver of logistical efficiency – the widespread adoption of (more) circular transport logistics would be aided by broader consumer acceptance of the need for flexibility in delivery. Circular logistics promises lower congestion and increased liveability in similar fashion to circular mobility, but the effects are bound to be less pronounced.

Automation and smart operations in logistics are likely to change the labour profile connected with these business areas. It seems certain that there will be greater focus on more skilled labour, with new job types emerging in more heavily automated, data-driven areas of digital business. A significant risk of lower total employment numbers seems likely in that many opportunities, particularly for the less skilled, may disappear in light of increased automation.

The main barriers to circular transition in the sector

Technological barriers

The technological barriers are estimated to be less serious, or at least less acute, than other barriers. This is especially evident for personal mobility, where MaaS developments depend more on organisational and systemic than on technological advances. There are some issues related to flows of information through complex systems of multiple actors, but technological concerns are not the primary ones. Transport logistics is somewhat more reliant on technological barriers being overcome, especially with respect to autonomous vehicles' development and 'smarter' arrangement of value chains. Both elements require highly complex computation work, often performed in real time.

Regulatory barriers

Whilst regulatory drivers may be at the heart of solutions for MaaS (via their influence on market, organisational, or cultural issues), they do not in themselves solve the regulatory problems. For transport logistics, the picture is markedly different and specific regulatory barriers are very much at the fore. Deployment of autonomous freight vehicles on public roads is a centrepiece of ongoing developments in the regulatory sphere, and clearly there are enormous barriers to be cleared before this can become routine. More generally, reverse logistics is subject to especially strong policy and regulatory pressure wherever public bodies are involved,

as is often the case.

Market barriers

Market issues are undoubtedly among the most significant hurdles in the fields of personal mobility and MaaS. The fundamental economic case for MaaS has appeared shaky in almost every implementation that has progressed beyond pilot stage. A thriving MaaS system implies economic viability for many actors therein, all of which face challenges and pressures, of various sorts. If left to its own devices, the market might well be populated by multiple actors performing similar or identical functions. Hence, competition could pose a hindrance rather than propel efficiency gains in this case – actors chasing niche markets could perpetuate diseconomies of scale. Many of the associated issues are relevant also for smart transport logistics, although the relative immaturity of the latter field perhaps suggests that they are not so visible at present.

Cultural barriers

Attitudes and behaviour-linked issues are obviously fundamental to the circular transition in both personal mobility and transport logistics. In both cases, the necessary move away from solutions typified by direct ownership/operation of vehicular solutions entails a flexibility and immediacy loss that end users will find hard to countenance. Ultimately, the success of circular transition in transport modes hinges on end-user acceptance more than on any other single factor. This is already quite evident for personal mobility, where tangible alternatives have already been presented to users: in the final analysis, future demand for MaaS remains murky. While the transport logistics field is less advanced in this respect, it seems inconceivable that similar issues will not arise there too.

Actions needed to release the circular potential

Many of the overarching structures and frameworks needed for action supporting mobility and transport's circular transition are already in place. Carbon-neutrality targets across the region set the overall context for the actions. Within that context, firmly established bodies exist to foster relevant research, development, and innovation – Nordic Innovation, Nordic Energy Research, etc. These have specific programmes in progress, among them the Nordic Innovation one for smart mobility and the Nordic Energy Research programme for electrification of transport. Resources such as the Nordic Circular Economy Playbook, containing examples from transport and logistics, are available. Furthermore, entities such as the Nordic Smart City Network and the Nordic network for zero-emission delivery of goods have been established for the sharing of knowledge and experience.

Nevertheless, it is clear that significant action is still required in all policy areas to overcome the barriers.

Firstly, significant action is needed to translate the solutions to practical scale. While what should be done is well-publicised, the issue remains of how to deliver the solutions in practice. Notwithstanding stakeholder networks and various well-

designed, well-intentioned support programmes, the fact remains that circular personal mobility and smart transport logistics remain, for the most part, fairly elusive in practice – however solid the concept.

Secondly, the sector needs research, development and innovation (RDI) activity to resolve the remaining technological issues and unknowns. This includes work toward technologies and systems for the handling and processing of data, relevant for both mobility and logistics. Also necessary are developments specific to autonomous vehicles, which are particularly important in the logistics sphere but also have relevance for mobility. In addition, technologies driving electrification of vehicle fleets deserve focus. Co-ordination and rationalisation of activities on the ground is emerging as crucial. In the logistics field in particular, these efforts could be driven by the use of ‘trusted brokers’ or other third parties to manage the demand from various end users and balance this with available supply of services. The brokers are certain to take the form of digital platforms and algorithms, which still require significant technological development.

Thirdly, with respect to regulation, work for better-regulated deployment of autonomous vehicles on public roads is essential for the long-term developments foreseen in the logistics and to some extent the mobility sphere. Other desirable regulatory actions can be characterised in summary as those that drive practical implementation of current well-recognised principles. For instance, the existence of collaborative networks of cities does not seem to preclude apparently *ad hoc* approval of MaaS initiatives by local authorities. Direct regulatory input could counteract the latter phenomenon – for instance, via compulsory introduction of national or regional review panels for city or regional infrastructure plans. In the logistics arena, public procurement criteria are a potentially powerful driver of development. The criteria should specify smart(er) transport logistics as a desirable or even a compulsory element of each bid.

Fourthly, market barriers are probably going to require fairly direct intervention from national and supranational bodies, at least to some extent. The basic economic conditions for personal mobility and MaaS remain extremely challenging, and continued disbursement of public funding (possibly in larger amounts) might be necessary to bring these systems to fruition. This, in turn, entails regulatory concerns – not least related to the public financing of private entities – that call for further attention. There appears to be a clear danger of personal mobility markets being overcrowded with (private) actors, and it seems that the number of independent and self-sufficient market actors within MaaS ecosystems should be relatively low where this is reasonable. Perhaps mergers or alliances could achieve this, providing insulation against market pressures and diseconomy. Ongoing projects such as Nordic Open Mobility and Digitalization, or NOMAD (see nomadmobility.org), promise much useful insight illuminating the technical and organisational issues related to MaaS; the key is to capitalise on the knowledge created, in the form of specific actions and policy initiatives.

Finally, overcoming cultural barriers requires concerted end-user and public education, encompassing information campaigns and other endeavours. The obvious parallel is with the uptake of private electric vehicles, particularly in Norway, where sustained promotion coupled with highly visible tangible benefits such as preferential lane use and parking engendered a large-scale change in consumer habits. Research

and work related to MaaS are increasingly focused on relatable scenarios and examples for end consumers, showcasing ways they can use MaaS in uplifting, smart, and resource-saving ways.

5. Policy actions at the Nordic level

5.1 Policy instruments of relevance for the circular transition

Policies, defined as laws, regulations, procedures, administrative actions, incentives, and voluntary practices of governments and other institutions⁷⁶, are implemented by means of instruments or 'governance tools' that reflect the intention behind the policy⁷⁷. Selecting which policy instruments are to be used is one of the most powerful mechanisms for managing resources. Alongside the decisions on the policy instruments, it is important to consider their application, for identification of the impact⁷⁸. Concrete examples of policy instruments are roadmaps and strategies, information campaigns, research, grants, bans, and subsidies⁷⁹.

Policy instruments can be classified in many distinct ways. For our study, we relied on the Circle Economy National Policy Framework⁸⁰ (with adjustments for Nordic context), the key policy functions of which are presented in Table 4.

Table 4: Key policy functions (adapted from materials from Circle Economy 2021)

Policy function	Role of the function	Examples of instruments
Mobilise	Sets the direction of and builds momentum toward long-term change, while also dictating how this direction is determined and governed	• Roadmaps, strategies, and targets • Institution design enabling circularity • Public consultation • Matchmaking platforms
Educate	Increases the overall level of awareness and builds the necessary skills and knowledge around circular economy to encourage long-term change	• Information campaigns • Awareness-raising events • School programmes • Encouragement of workplace training • Extracurricular activities • Sharing of data, knowledge, and information • Greater standardisation of data collection

76. Centers for Disease Control and Prevention 2022.

77. Ali 2013.

78. Ali 2013.

79. Circle Economy 2021.

80. Circle Economy 2021.

		• Research • Innovation programmes
Manage	Influence the use and function of physical and material elements within the national environment	• Public procurement • Infrastructure to support resource cycling • Development of regenerative infrastructure • Circular use of publicly owned assets
Incentivise	Supply market-signal details and support to businesses, citizens, and governments, to promote certain activities	• Grant funding • Debt financing • Incubator and investment schemes • Extended producer responsibility • Public-private partnerships • Charges and tariffs • Fines • Tax incentives • Subsidies
Regulate	Change the rules of the systems to reach compliance through enforcement	• Monitoring and enforcement • Bans • Performance standards • Technology standards • Labelling

Several policy levels affect circular economy development in the Nordic countries.

The policy work at EU, national, regional, and local levels is outlined below. All of these levels have distinct roles in promoting the desired policies. **The main focus of our study was on a fifth level – i.e., policy instruments available within formal Nordic co-operation under the auspices of the Nordic Council of Ministers.**

Denmark, Finland, and Sweden are EU member states, while Norway and Iceland follow EU decisions closely. Hence, EU policy instruments play a crucial role in developing circular economy in the Nordics.

The EU is able to pass laws, and it alone has the competence to create instruments addressing such matters as the marine plants and animals regulated by the common fisheries policy. In certain areas (areas of shared competencies), the Member States are able to pass laws of their own accord if the EU has not already proposed laws or has decided that it will not do so. Among these areas are employment and social affairs, agriculture, fisheries, the environment, consumer protection, transport, and energy. There are also areas in which the EU can only support, co-ordinate, or

complement the actions of its member states (areas of supporting competencies).⁸¹

On national level, the region's countries promote circular transition through regulatory instruments (legislation and bans), by articulating national visions and ambitions, via economic incentives such as financial support and tax breaks, by guiding the market through public procurement, by spreading awareness through communications, and by filling research gaps via national RDI funding. The countries also control significant assets whose efficient management can promote the transition and attract investments.

At regional level, the provinces and counties can set joint targets and declare shared ambitions. Furthermore, these jurisdictions often possess rights to grant permits for processing plants of various types and other businesses, and they create province-specific plans through which significant decisions on land use are made. Furthermore, regions facilitate co-operation on various themes, and their authorities can apply for funding (e.g., from the EU).

At local level, circular economy becomes concrete in the municipalities. Decision-making and various experiments can be conducted more quickly by municipalities than nationally. Voluntary commitments can promote the municipalities' own circular economy work, and, in addition, successes strengthen a given municipality's leadership and its competitiveness in relation to other municipalities.⁸² Also, the municipalities hold power related to various types of local permits, and they make the city plans that guide what sorts of activities can officially be implemented and advanced in the region.

Municipalities control significant amounts of monetary resources that can ease the circular transition through public procurement. For example, municipalities in Finland spend €20 billion yearly through public procurement⁸³. Such sums have potential to steer the market. The municipalities play a role in attracting investments too, by creating favourable conditions for circular businesses within their area. Advisory services are one component of this set of conditions. Municipalities also have the opportunity to act as a platform for circular economy experiments by companies and residents, from which more sustainable practices that could take permanent root can be born.⁸⁴

Cities and municipalities are the key set of actors for public transport and make the most relevant decisions on land use, construction, and waste management. Municipalities can also support and develop some of the circular economy skills required, for example, in workplaces and in building more sustainable day-to-day life. Of the levels of government, the municipality is the closest to the residents, so it can readily share information with them and guide them toward a more sustainable lifestyle. A municipality should create an environment where it is easy for residents to make environment-friendly choices.⁸⁵

In the policy field, Nordic-level co-operation can take many forms. The aim behind co-operation at this level under the Nordic Council of Ministers is to find 'solutions wherever and whenever the [Nordic] countries can achieve more together than by working on their own'⁸⁶. Among the policy areas with special relevance for the

81. European Commission 2022a.

82. Karppinen & Pirtonen 2021.

83. Huikko 2019.

84. Karppinen & Pirtonen 2021.

85. Karppinen & Pirtonen 2021.

86. Nordic Council of Ministers 2022b.

circular transition are the Nordic co-operation on⁸⁷

- legislation and justice – becoming the world's most integrated region requires similarities in legislation and in interpretations of it;
- digitalisation and innovation, primarily joint efforts to create a coherent and well-integrated digital region while promoting a green digital transition;
- the environment and climate, with political co-operation to tackle the challenges related to the climate; the state of our air, water, and soil; and biodiversity, which are growing in size and number;
- energy, to support meeting the national targets for the transformation;
- education and research, including development of the competencies and skills that the future requires and of joint R&D addressing relevant topics;
- working life, with efforts targeted especially at the region's business opportunities and socio-economic welfare;
- the Nordic bioeconomy amid green transition, for creation of circular and sustainable local solutions; and
- sustainable development as an overarching strategy for a sustainable and integrated Nordic region.

The Nordic Council of Ministers and the overall Nordic co-operation have various policy instruments available to promote common Nordic targets in the respective countries. The work can express visions and ambitions, create awareness through communications, educate, fill research gaps by commissioning the studies needed, give financial support to catalyse change, and co-ordinate various processes. Another important tool is to influence national and EU decision-making from a shared Nordic point of view, where relevant.

5.2 Analysis of Nordic policy action in support of the circular transition

Nordic co-operation already actively supports the region's circular transition, through a wide range of policy instruments. The subsections below map selected key initiatives to the policy framework, to characterise the range and scale of ongoing action and to shed light on possible gaps, for further action. Together with the previous chapter's analysis of the need for action in the individual sectors selected for attention, this chapter provides a starting point for building a framework for well-prioritised and solidly co-ordinated Nordic progress toward circular societies.

Mobilising the stakeholders of the transition

The policy function of **mobilising** includes establishing visions and ambitions, handling governance of the transition, and coming together for action. The policy instruments used are roadmaps, strategies, and targets; institutional design that enables circularity; public consultations; and matchmaking platforms, with the policy function being implemented at all levels, from the EU Green Deal and Circular Economy Action Plan to the national strategies, strategic programmes, and

87. Nordic Council of Ministers 2022a.

roadmaps (presented in Chapter 3). Although not all of the Nordic countries have specific circular economy action plans, there are circular-economy-related ambitions and targets present in national policies in nearly all of the Nordic countries. **To strengthen the policy function of mobilising, it would be beneficial to make the circular economy ambitions explicit in all these countries.**

On the Nordic level, circular economy ambitions are explicitly and visibly included in the Vision 2030 statement of the Nordic Council of Ministers and, additionally, in relevant sections of the action plan for 2021–2024. **What could be stronger is a co-ordinated approach to setting targets for the transition.**

Secondly, designing institutions such that they support circular economy policies is at least partly actualised, thanks in part to the dedicated **Working Group for Circular Economy** (under the region's environment ministries) and other implementing organisations, especially Nordic Innovation. For the coming years, **specific effort could be directed to cross-cutting and multi-sector co-ordination to address circular economy issues at Nordic Council of Ministers secretariat level**, to ensure that all relevant sector-specific committees are aware of circular economy developments in other sectors and to support a systems approach to circular economy issues. As this study has made abundantly evident, the transition required extends across sectors, disrupting traditional boundaries, so demands broad-based co-operation across industries and spheres of society.

When it comes to public consultations and matchmaking platforms, several initiatives have been launched in aims of convening for action. Specifically, the emergence of the Nordic Circular Hotspot, with its matchmaking venue (the annual Nordic Circular Summit) and the transition groups now being established, represents an important step toward mobilising the region. Also, several Nordic studies and project initiatives (including our own work) feature consultation that covers a broad spectrum of stakeholders. **What could be strengthened further is outreach work and the impact of consultation and matchmaking**, which so far have been of a somewhat *ad hoc* nature.

Developing the awareness, skills, and knowledge needed for circular economy

The policy function of **educating** encompasses a broad range of policy instruments both for education and for RDI: information campaigns and awareness-raising events; workplace- and school-based training (and extracurricular activities); sharing of data, knowledge, and information; standardised data collection; research and innovation programmes; etc. There are **numerous opportunities for co-ordinated action of the Nordic countries.**

Awareness-raising relevant to the circular transition includes at least the above-mentioned Nordic Circular Summit, various other events (e.g., the circular economy conference held under the Norwegian presidency of the Nordic Council of Ministers in June 2022), and actions targeted at sustainable consumption that are connected with the Nordic Council of Ministers Action Plan for 2021–2024.

Awareness-raising activities and materials are among the key instruments available at the Nordic level – in this connection, the Nordic Circular Playbook for Manufacturing Industries and related training that Nordic Innovation provides for

companies are worthy of specific mention. The opportunities to influence school programmes and workplace training are more indirect and might take such forms as research-based recommendations for skills development in Nordic regions (e.g., provided by Nordregio in connection with regional analyses) and room for companies to participate in Nordic awareness-raising networks and events.

The Nordic Council of Ministers has **effective policy instruments for supporting knowledge's management, sharing, and co-ordination**, with some circular-economy-relevant examples being the Smart City network, the Nordic network for zero-emission public procurement, the Nordic Circular Construction Network, the Nordic Sustainable Construction programme, and co-operation among the Nordic statistical bureaux. With regard to enhancement of standardised data collection, the **challenge of measuring and monitoring circular economy** has been subject to scrutiny by the Nordic Working Group for Circular Economy, and our study's sector-specific analyses identified **several respects in which further co-ordination and harmonisation of data's collection and management would be beneficial** for the circular transition of the region. These encompass, among other issues, conducting general monitoring of circular economy (via Nordic statistics bureaux) and addressing phenomena such as food loss, standard definitions, and reporting frameworks.

The study pinpointed the role of RDI for pollinating the space with knowledge and ideas, for market solutions – this is a critical cross-cutting enabler of circular transition. Although national research and innovation-funding agencies and the EU provide the majority of the funds, research and innovation programmes are a key instrument also in Nordic co-operation, and a substantial proportion of the joint Nordic budget is channelled to activities facilitated by the organisations Nordic Innovation, NordForsk, and Nordic Energy Research. Many of these programmes are implemented in co-operation with national agencies. In addition, research-based studies are commissioned by several sectors and working groups under the Nordic Council of Ministers, among them the Working Group for Circular Economy. The list of ongoing initiatives that support circular transition is too long to present here in full, but some of the key initiatives of relevance for the topics dealt with in this report are

- Nordic Innovation programmes for 2021–2024 that address AI and data, circular business models, Nordic green/smart mobility and connectivity (several individual programmes), sustainable construction, sustainable minerals, and a sustainable ocean economy;
- NordForsk research programmes for sustainable agriculture and aquaculture;
- the Nordic Energy Research programme on energy and the environment, combined with various actions targeting more sustainable transport logistics;
- Nordregio's work with Nordic theme-based groups for regional development and planning in 2021–2024 for green and inclusive development of both rural and urban areas specifically and for green, innovative, and resilient Nordic regions; and
- studies commissioned by the Nordic Working Group on Circular Economy to examine producer ownership models and address other themes.

Managing and monitoring the transition

This policy function of **managing** includes policy instruments that set circularity-related criteria for public procurement of assets and support innovation-oriented public procurement, establish infrastructure to support resources' cycling and regenerative infrastructure (creating a net-positive environmental impact while improving societal well-being), and enable circular use of publicly owned assets (land, buildings, and equipment).

The study identified co-operation on public procurement as another critical cross-cutting enabler for the circular transition. Circular public procurement in the Nordics has been on the agenda for several years now (e.g., see the CIPRON project's report from 2017⁸⁸), and the recently completed project and Nordic market dialogue on zero-emission delivery of goods⁸⁹ have brought useful insight related to methods for innovative procurement, with practical examples from the various countries. It is crucial to continue the cross-border dialogue on how to ensure that public procurement supports principles of sustainability and circularity. Likewise, **the role of cities is key to circular economy development in many sectors**, as the cities have great impact both through procurement and by providing services and platforms for economic activity. Nordic co-operation initiatives could put even more effort into supporting cities' networking and knowledge exchange.

The possibilities for Nordic co-operation that supports the development of infrastructure were seen mainly as stemming from **identifying and co-ordinating the infrastructure needs in the various countries/regions and providing co-incentives for its further development**, thus helping to attract investments. Several Nordic studies have been devoted to understanding the infrastructure's availability and to supporting Nordic networking for circular economy infrastructure. Some examples are the Nordic network for eco-industrial parks, studies of biogas plants' availability and the need for them, digital infrastructure, and Nordic testbeds. Another important matter, of course, is to identify the next steps for development, once the assets and needs have been pinpointed, along with the role that Nordic co-operation could take in that development. Our study specifically identified the availability of recycling facilities covering many kinds of bio-based materials (newer ones included) as a growing need for the countries that could be looked into jointly.

The final issue mentioned above, circular use of publicly owned assets, can be approached in two ways: a) practising circular use of one's own assets and b) providing opportunities for co-operation among public actors in relation to this matter. Especially, those aspects of circular economy that encourage longer and **shared use of assets, products, and services** could be further explored through the Nordic co-operation.

Providing economic incentives for circular transition

The policy function of **incentivising** encompasses direct financial support, economic frameworks, and fiscal frameworks. Among the policy instruments in use today are grant funding, debt financing, incubator and investment programmes, extended

88. Alhola et al. 2017.

89. Kihl et al. 2021.

producer-responsibility schemes, public–private partnerships, charges and tariffs, fines, tax incentives, and subsidies.

The Nordic co-operation mechanisms govern many of the possibilities for smaller-scale **grant funding, such as funds for circular-economy-related RDI** – all relevant elements addressed in the foregoing discussion of education. Other instruments of financial support are probably beyond the council's scope of action, but one could also mention Nordic-based international financial institutions such as the Nordic green bank Nefco, providing risk capital for international green projects by Nordic SMEs.

Extended producer-responsibility schemes are currently being studied in a large-scale project commissioned by the Nordic Circular Economy Working Group. This project, which includes piloting, is a step toward fuller Nordic understanding and **development of producer responsibility and other circular-economy-oriented ownership models.**

The development of public–private partnerships was identified as another critical factor in the circular transition. These too can be catalysed with the aid of Nordic co-operation (e.g., Nordic Innovation), but development into PPP models with a genuine impact requires critical partners from both industry and public authorities in the countries to join the effort actively, in sufficient numbers. Some sectors already have strong Nordic industry networks. Furthermore, the Nordic Circular Hotspot and its stakeholder groups could – pending the development of participation – turn into strong PPPs driving the circular transition.

The Nordic countries are good at implementing development projects and pilot systems. Accordingly, among the opportunities found was **developing the Nordic region into a testbed** for circular economy solutions. Simultaneously, **one of the key challenges identified in the study involved scaling the pilot projects to market level.** Steps toward better frameworks for this are being taken, though – for example, in the Nordic Smart Connectivity programme, which is designed to map the pilot work done and, proceeding from the lessons learned, attempt to create tools that better support scale-up.

Finally, fiscal frameworks are governed primarily at the national level, but routes are open for **exchange of experiences** and for **testing out instruments such as subsidies in co-operation.**

Developing better regulation for circular economy

The policy function of **regulating** utilises the policy instruments of monitoring and enforcement, bans, performance standards, technology standards, and labelling.

In increasing proportions, circular-economy-related regulation is issued at EU level, supported by national interpretation and implementation. The role of Nordic co-operation could comprise several distinct actions. The Nordic Council of Ministers can facilitate collaboration among the countries on

- dialogue on the input to forthcoming EU regulation;
- dialogue on the national interpretation and implementation of existing EU regulation;

- knowledge-sharing and dialogue dealing with lacking or contradictory regulation and with differences between countries/sectors; and
- development of voluntary standards and labelling, advancing Nordic 'brands', labels, and standards.

Finally, our study pinpointed dialogue on regulation as an opportunity for deeper co-operation. Diverse activities are already in progress (e.g., within the Nordic Circular Hotspot framework), but the dialogue, if it is to create an impact, should encompass the policymaking level (e.g., the sector-specific committees of senior officials).

The Nordics are experienced in creating sustainability frameworks, as the case of the classic Swan environmental label attests. Another good example is the ongoing work aimed at **developing and endorsing Nordic voluntary metrics** for sustainable and circular construction.

Summing up needed Nordic policy action

In summary, there is already a hefty pack of actions in place to accelerate the circular transition in the Nordics. Overall, the Nordic countries can support the transition by creating a favourable enabling environment, co-ordinating national input (especially to EU processes), exploring the possibilities for harmonising regulation, and supporting the development of infrastructure and ecosystems needed in circular economy. Furthermore, Nordic co-operation can play a significant role in developing the knowledge base needed for managing circular economy activities, by co-ordinating national efforts and pursuing sufficient harmonisation of standards. If the Nordics wish to be more ambitious, the region could explore its ability to test and pilot the implementation of various key actions before they become mainstream in the EU, because the collaborative tradition and existing structures of governance provide a framework that favours fast-tracking action.

Among the important outcomes of our study was identification of critical gaps and barriers to transition: areas where intensified Nordic co-operation and joint action could help release the circularity potential. Our analysis applied the assumption that limited financial resources are available for Nordic co-operation and that most Nordic-level action can be achieved instead via dialogue and co-ordination of national-level activity, accompanied by some incentives for networking and knowledge exchange. The recommendations in the final chapter reflect these boundary conditions.

6. Conclusions and policy recommendations

6.1 Conclusions from the study

Our two-year study of circular economy's potential and the actions required for it in the Nordics has put emphasis on a holistic perspective wherein circular transition is a dynamic and systemic change that features materials, value, and knowledge flowing in larger ecosystems and value networks across traditional industry boundaries. The transition manifests itself on several levels, it is connected to global value chains, and the associated phenomena are not restricted by national borders. This transition requires decisive action and corresponding investments in businesses, markets, knowledge development, and policy development – all on local, regional, national, and EU level.

Circular economy cannot be dealt with in silos, for this transition occurs at the nexus of traditional industries and something more. Here, developments in numerous areas create cross-cutting effects. For this study, we chose to focus on four key sectors within Nordic economies, sectors whose value chains affect the economies and societies, along with the climate and environment, in crucial ways: the bioeconomy, food and beverage, building and construction, and mobility and transport logistics sector. This emphasis was chosen not to reflect the lines of current industry classification categories for statistical reporting but with an understanding that the value chains analysed encompass large parts of the manufacturing industries. Furthermore, our approach gave specific emphasis to new circularity-oriented business models disrupting the linear value chains and creating ecosystem-based value networks and to the role of data and digitalisation in this development.

Of course, fundamental changes in business culture and operations come with a cost, so policy-level actions can be tuned to create regulative and operation environments that favour this transition. In addition, public investments are going to be required, especially for creating the infrastructure for circular economy and for developing the skills needed.

Industries and businesses in the Nordic region are interconnected in a whole host of ways, so it is unsurprising that they encounter some of the same challenges. At the same time, the countries also differ considerably from each other in industrial terms and geographical considerations. Both similarities and differences must be taken into account. Our study has provided a snapshot of the continuing development and highlights opportunities for Nordic co-operation to contribute to and accelerate the circular transition in such a way that it maximises the potential for synergistic positive impacts on the climate and environment, economies, and societies in each of the Nordic countries. While Nordic co-operation already addresses many themes linked directly and indirectly with the circular transition, it is crucial that the region's collaboration continue with that transition clearly on the agenda and – moreover – carry the momentum forward to scale up the co-operation and target the actions precisely. Nordic co-operation can play an important role in facilitating links across the different levels and key players in the transition and bring them together in

public-private partnerships aimed at making a genuine impact. It is our hope that the recommendations of our project to the Nordic Council of Ministers and the Nordic cooperation can serve as inspiration in this development.

6.2 Policy recommendations

At overarching level and in a cross-cutting manner, we recommend the Nordic Council of Ministers to:

1. Facilitate policy dialogue in relevant Nordic committees of senior officials, in pursuit of joint statements and recommendations for the Nordic countries.
2. Co-ordinate the handling of circular economy issues at Nordic Council of Ministers secretariat level, to ensure information-sharing, identify synergies, and avoid overlap and conflicts, while also dedicating resources to this co-ordination and designating clear contact points.
3. Co-ordinate input to those EU policy processes of significance for circular economy in the Nordics. Though the Nordics may not have a joint stand on the topics, dialogue to prepare for EU regulation and its national implementation is always useful and helps the countries concerned understand the impacts of the regulation in question.
4. Support networking between cities, because cities hold power to influence change directly in several of the sectors studied, through public procurement, establishment of local guidelines, and collaboration on practices.
5. Encourage co-operation on public procurement guidelines and practices at national, regional, and local level alike, for guaranteed inclusion of circular economy principles.
6. Continue facilitating the Nordic networking for eco-industrial parks, to develop good models for circular-economy activity and industrial symbiosis within and between sectors.
7. Facilitate the creation of Nordic public-private partnerships within key branches of industry, bringing the largest industry players together with leading knowledge institutions, investors, and regional and local governments. Already established cooperation structures (such as the Nordic Circular Hotspot) could serve as a base.
8. Continue supporting joint Nordic RDI that carries knowledge and ideas forward into practice and creates market-viable solutions.
9. Consider using the Nordic region as a test bed for fast-track implementation of certain policies and practices.

To support the circular transition in the bioeconomy domain, we recommend the following to the Nordic Council of Ministers:

1. Support the development of regional innovation ecosystems based on sustainable and circular bioeconomy-related practices.
 - a. Top up national innovation funding for developing these ecosystems with support targeted at Nordic-level networking and exchange of knowledge between ecosystems.
 - b. Enhance Nordic exchange of information via digital platforms and new

service-business models, as a means to enhance the use of side streams.

2. Accelerate the development of large-scale circulation of bio-based materials.
 - a. Create a Nordic roadmap that covers how to develop well-functioning recycling schemes and where the countries might be able to draw on cross-border co-operation or joint technology development.
 - b. Launch and co-ordinate national and Nordic pilot programmes for testing of prospective circular-economy facilities.
 - c. Facilitate dialogue on regulation for recycling of novel materials.
3. Establish dialogue on the Nordic policy level to address blue bioeconomy operations.
 - a. Co-operate on proactive and visually dynamic mapping of ocean resources, including ideas as to possible uses and about opportunities for increased value.
 - b. Work toward incentives and enforcement of the requirements in all parts of the Nordic region, so that by-products of fishing operations are brought to shore, appropriately.
 - c. Develop policies that support aquaculture rooted in sustainability (incl. with regard to nutrient circulation).
 - d. More fully develop enabling regulation for the use of alternative and novel ingredients in food applications and for other purposes.

To support the circular transition in the food and beverages sector, we recommend the Nordic Council of Ministers to:

1. Develop common reporting frameworks for food loss.
 - a. Define system boundaries, definitions, and methods that make it possible to share and compare data on food loss and waste (total and per-capita figures) along the whole food chain.
 - b. Co-ordinate common target-setting for reducing food waste and food loss, for 2025 and 2030.
2. Take the lead alongside public authorities to address food waste and ensure its reduction.
 - a. Develop requirements and incentives for bringing class II vegetables into retail environments and professional kitchens.
 - b. Make public tenders contingent on meeting concrete demands for waste-prevention measures and for reporting of related progress data.
3. Establish a common stance on the Nordic policy level with regard to EU regulation of food waste and novel foods.
 - a. Develop quality and safety standards to stimulate the valorisation and utilisation of food products from by-products and food waste.
 - b. Develop mandatory food-loss monitoring and reporting obligations EU-wide in line with the guidelines already set in the delegated act on food-waste measurement.

4. Encourage food's donation and other redistribution for human consumption, with human use given priority over animal feed and over reprocessing into non-food products or energy.
 - a. Develop a code of conduct (or similar articulation of principles) for a more secure food hierarchy in times of rising biogas prices.
 - b. Create economic incentives for donation between food value chain stakeholders and the third sector reliant on voluntary schemes when redistributing surplus food.

To support the circular transition in the building and construction sector, we recommend the Nordic Council of Ministers to:

1. Collaborate on Nordic input to EU initiatives.
 - a. Give joint Nordic input on EU-level initiatives within the Green Deal, such as development of the EU Construction Products Regulation, the EU's building logbook initiative, and the EU sustainable carbon cycles initiative (with support for quantifying the climate benefits of biogenic carbon stores in buildings as the initiative progresses).
2. Continue and expand the knowledge-building and knowledge-sharing work.
 - a. Continue to support sharing of knowledge about circular public procurement through the relevant authorities and encourage the development of best practice for it, moving from discussion to concrete actions.
 - b. Support building a knowledge base covering the possibilities for repurposing buildings and prolonging buildings' useful life, alongside accumulation of knowledge about ownership models and concrete actions for shifting ownership in the Nordics.
 - c. Support knowledge-building and R&D related to refurbished materials and demolition waste.
3. Consider adopting certain EU policies in advance of their EU rollout.
 - a. Investigate whether there are parts of the coming EU strategy for circular construction that could be applied more swiftly in the Nordic region.
 - b. Pilot joint Nordic initiatives that address how regulation or incentives (carrot or stick mechanisms) could be used to ensure that circular strategies get applied and assessed before any demolition decision.
 - c. Develop common Nordic instructions for pre-demolition audits.
4. Take the lead alongside government authorities in target-setting and for circular public procurement in construction.
 - a. Suggest using existing multi-step principles for public procurement to inform common guidelines for the governments.
 - b. Collaborate on developing more detailed target-setting as a next step, even if specific targets may vary between the countries.

To support the circular transition in the mobility, transport, and logistics sector, we recommend the Nordic Council of Ministers to:

1. Give co-ordinated Nordic input to relevant EU policy and strategy initiatives.
 - a. Review and, where appropriate, reinforce Nordic input to relevant EU initiatives at ministerial level.
 - b. Ensure appropriate ongoing Nordic representation in relevant EU-level expert groups such as the Digital Transport and Logistics Forum.
 - c. Establish and reinforce contacts that link such groups' experts with relevant Nordic policymakers.
2. Nurture ongoing RDI activities, especially with regard to autonomous vehicles and electrification but also in relation to (fast, real-time) processing and sharing of data.
 - a. Exploit existing structures and programmes (such as Nordic Innovation).
 - b. Review funding disbursement and the targeting of funds.
3. Standardise the establishment of personal mobility schemes across individual cities, regions, and countries.
 - a. Devise specific guidelines for the associated initiatives.
 - b. Establish regional or national review panels for MaaS initiatives and other infrastructure plans.
 - c. Take advantage of such existing organisational structures as Smart City Networks for this.
4. Consider direct intervention where appropriate so as to harmonise personal mobility or logistics ecosystems and reduce the number of actors involved.
 - a. Identify where operations could be amalgamated or merged to good effect (by reducing counterproductive competition or insulating against economic pressures).
 - b. Investigate and deploy means of encouraging or forcing such consolidation, via provision of specific incentives or awarding/withdrawal of operation licences, permissions, or concessions.
5. More fully embed the requirement for smart logistics in particular and for circular personal mobility (where appropriate) in public procurement criteria throughout the Nordic region.

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Annex 1: Description of the project implementation and methods

The project Low-Carbon Circular Transition in the Nordics: Potential and Needed Action aimed at generating insight as to the potential of circular economy in the Nordic region and providing recommendations for unlocking this potential.

Box 13: The study's key research questions

What areas, industries, and sectors are particularly important for the circular transition in the Nordic countries? What kind of potential exists in these areas?

- What sectors are especially important for the Nordics?
- Can the transition to circular economy lead to changes in key sectors that give the Nordics competitive advantages or other economic benefits? Which sectors are these?
- What does that transition mean for the use of resources in this region? What impacts could it have on, for example, the availability of biomass for other purposes?
- Is there potential for innovation and for intra- and inter-industry symbiosis?
- How does the circular transition influence climate-affecting emissions throughout the life cycle in key sectors?
- What impact does circular transition in the Nordics have on biodiversity?
- What could shifting to circular economy mean for our oceans, waters, soil, and air?

What will it take to unlock circularity potential such that the Nordic region can become a leading region for circular economy and inspire other regions, globally?

- What main conditions are in place that could help us succeed?
- What are the major barriers to releasing the potential identified or other circularity?
- What specific challenges do the Nordics face in relation to the population's geographical distribution, long distances, and varying geography? Might some parts of the region find the transition especially challenging on account of these issues? On the other hand, are there conditions that support the region succeeding especially well?
- What kinds of actions and policy instruments are needed to unlock the potential – in the short, medium, and long term; in the various sectors / branches of industry / locations; and at particular levels (local, national, and region-wide)?
- In what areas might it be easier to identify concrete actions and policy instruments? What areas are especially conflict-ridden in this regard?

The study took a broad approach to circular economy, or CE, defining it in terms of its role in narrowing the loops via resource-efficiency, slowing resource flows through the loops by designing long-life goods and extending products' service life, and closing the loops via reuse and recycling of materials⁹⁰.

In a broad approach of this nature, the 10-rung circularity ladder (see Box 14) offered one guiding framework.

Box 14: The '10-step circularity ladder'

This 10-rung ladder extends the traditional three steps 'reduce, reuse, recycle' with seven further strategies, from smarter creation and use of products, through extending products' and parts' service life, to valuable use of materials.

R0: Refuse – making a product redundant by cancelling its function or by using a radically different product in its place

R1: Rethink – intensifying product use (e.g., via product-sharing or multifunction products)

R2: Reduce – more efficiently using and/or manufacturing products through less use of natural resources and materials

R3: Reuse – reusing a discarded yet still usable product, for a different user pursuing the same purpose

R4: Repair – servicing and repairing a broken or malfunctioning product so as to enable continuing in its original function

R5: Refurbish – modernising and/or refurbishing an older product such that the improved version can serve the product's original function

R6: Remanufacture – using parts of a discarded product in a new product serving the same function

R7: Repurpose – using discarded products or their parts in new products with a different function

R8: Recycle – processing materials either to regain their original high quality, or for lower-quality applications

R9: Recover – incinerating materials to recover their energy

This approach was found suitable specifically for this study in that it puts emphasis on circular strategies (incl. ones for new ownership models and a sharing economy) and offers a means for assessing the quality and value in how materials/products are handled and maintained across the whole economy.

The method comes from PBL Netherlands (2018): 'Circular economy: What we want to know and can measure'. It was adopted also by Norion, Gaia, and NORSUS for the preliminary study of circular economy indicators for NCE in 2020.

90. Bocken et al. 2016.

The general approach selected for the study was based on the following principles:

- Utilising the existing knowledge base in the Nordic countries, through comprehensive desk research into ongoing work in the countries. This ensures that the work is aligned with and efficiently builds further on the priorities set in each national context.
- Systematic qualitative and quantitative analysis enabled data triangulation and guaranteed conclusions produced via transparent, high-quality, and reliable analysis processes.
- Regular dialogue ensured stakeholder engagement over the full course of the project. This included national-level interviews and workshops but also regular communication with the Nordic steering group of the project. Such a setting helps ensure that the analyses and, thereby, the conclusions drawn and recommendations made, are relevant and useful in national and Nordic contexts both.
- Professional and efficient project management ensured that the consortium's cumulative expertise can serve joint interests in the best possible way and that the project results remained timely and were quality-checked before dissemination.

The study was conducted in November 2020 – November 2022 and was composed of three parts, each comprising several specific tasks and reported upon separately. This structure, presented in Figure 4, is elaborated upon in the discussion that follows.

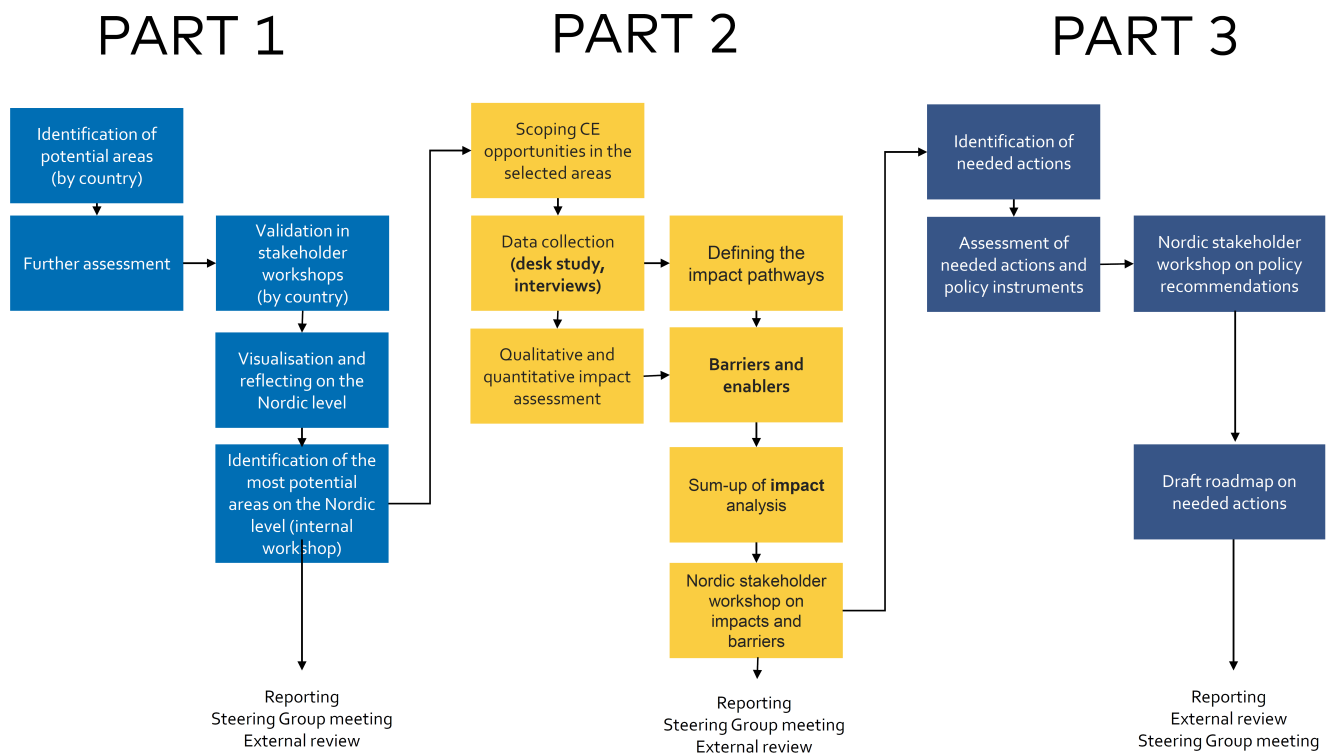


Figure 4. A diagram of the project's structure.

Part I: The areas most relevant for circular transition in the Nordics (11/2020–3/2021)

Part I of the work focused on

- identifying areas with significant circular transition potential in the Nordic countries,
- analysing areas with circular transition potential in the Nordic context, and
- deciding on areas to be included in parts II–III of the work.

Element 1.1: Identification of areas with potential, by country

The method chosen was to conduct a review of national strategies, roadmaps, and other circular economy commitments in each Nordic country and autonomous area specifically (hence covering Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland, and Åland). We chose this approach because of keen awareness that Nordic co-operation should build on existing national priorities and add value to related work.⁹¹

Through the discipline of documenting the areas identified and the rationale behind their selection, along with all sources relied upon, the team obtained a good general picture of the foci of each country's circularity-transition efforts. The work produced the 'longlist' of areas that is presented in full in the nation-specific annexes to the project's first report⁹².

At this point, the team decided to map the circular-economy-associated areas and themes emphasised in the national documents while preserving the categorisation scheme and wording of the original documents. This was done to make sure that the results of phase 1's work would have national relevance yet also accommodate nuanced comparison between the national approaches of the Nordic countries.

For systematic conceptualisation of the results, the 'areas' found in the documents were coded for the relevant industries/sectors, material flows, and enablers/drivers of change. This typology is described in Box 15.

91. The first working paper from this project (Luoma et al. 2021) documents the national studies in detail, with references to all sources.

92. Luoma et al. 2021.

Box 15: The categorisation/coding of circular economy 'areas' in national policy documents

In the entire study, we used 'area' to denote a group of activities and actors relevant in the circular economy context. The term, employed throughout this report, encompasses the following aspects:

1. **Industries/sectors** as groups of businesses with a related primary activity and usually grouped into the same category or sub-category in statistical industry classifications – for example, real estate and construction.
2. **Material flows** as specific loops of material use that are seen as crucial in the context of circular economy (e.g., plastics). These overlap somewhat with industries/sectors.
3. **Enablers or drivers of transition** that support achieving circular economy in various industries/sectors.

This broad use of the term 'area' enabled addressing a wide variety of interpretations of national priorities in the mapping and permitted a broad-based approach to the scale and nature of 'areas', whether involving industries, material flows, or transition-enablers.

Element 1.2: Further assessment of 8–10 areas, by country

The next task was to produce national 'shortlists' of potential areas specific to Denmark, Finland, Iceland, Norway, and Sweden. The aim was to select 8–10 areas per country for further assessment. We created the shortlists by reflecting on the longer lists of potential areas in both an internal workshop and workshops held with key national actors involved in the transition to circular economy.

As for scope, the research team agreed to consider at least those of the key branches of industry identified at national level that are of common interest across the Nordic region. A further criterion is that national shortlists should consider those enablers or drivers of change that would be expected to have a large impact on transition within these areas, as well as material flows with a significant environmental impact. The following more detail-level criteria were applied:

- **Potential to support circular transition in the country** (scale: high–medium–low): Operations in this area can significantly support reaching circularity-related objectives and obtaining greater value from the resources – by, for example, avoiding waste, extending service lives, and replacing resource use with alternative approaches (such as service use).
- **Relevance for other Nordic countries** (scale: high–medium–low): This area is of interest for other Nordic countries too. Attention to the shared-relevance factor is necessary for guaranteeing an opportunity for added value from region-wide collaboration in the areas selected.
- **The feasibility of assessing/quantifying the potential**: It must be possible to establish links between the relevant area and existing (national and other)

reliable data sources, to prevent the areas articulated from overlapping significantly or being mutually incompatible and to enable the next steps in the study to quantify their circularity-transition potential. Challenges related to the availability and quality of circular economy data are elaborated upon in Box 16.

Box 16: The availability and quality of circular economy data

Any assessment of the impacts of circular transition depends in part on the availability of high-quality data. While the SIC⁹³ provides reliable basic figures for predefined industries, the numbers say little about the industries' circular nature. Likewise, the statistics available do not facilitate analysis of activities that take place at interfaces between traditional industries or in cross-sector business ecosystems.

In the first stage of the work, key industry data were gathered at national level for the industries and sectors identified. Among these figures, which also serve as input to the next parts of the project, are turnover, employment, and CO₂ emissions.

When compiling the data, the study team had to wrestle with the possibility of variations between countries in the data categories' definitions. Some calibration was performed, to ensure comparable data for the industries selected. These decisions included considering national factors, for appropriate delimitation of the areas.

Quantitative key indicators were not compiled for the material flows or cross-cutting enablers identified in the study, as these have no direct links to the SIC scheme and since no comprehensive studies with reliable data for the whole Nordic region were found. To avoid significantly overlapping or mutually incompatible data, the analysis of these areas was confined to qualitative assessment in the relevant part of the study.

93. The study utilised Finland's standard classification of industries (TOL 2008) as its main reference.

The areas identified in Denmark, Finland, Iceland, Norway, and Sweden as meriting consideration for their potential were further assessed in light of the literature and statistical data. This process placed emphasis on developing sound general understanding of the various areas' potential role in transforming the Nordic countries, for moving toward circular economy. The factors described and assessed were

- characteristics,
- key figures,
- existing activities and initiatives,
- potential opportunities and benefits,
- enablers and challenges, and
- preliminary assessment of the circular transition potential.

The results of that analysis are reported upon in depth in the first report from the project⁹⁴.

Element 1.3: Stakeholder engagement and related validation

Stakeholder engagement was one of the key pillars of the work throughout the study. In part I, national stakeholder workshops were arranged for Denmark, Finland, Iceland, Norway, and Sweden. For the Faroe Islands, Greenland, and Åland, participants confirmed the team's view of the national priorities and the input for the region-level discussion by participating in telephone interviews. In total, about 50 organisations participated in part I's workshops and interviews.

The aims for the workshops were to inform key stakeholders about the project, to involve them in the process, and to foster buy-in that supports the results' usability. The workshop participants discussed the preliminary findings and conclusions from the national desk-study work, and input was gathered for the Nordic-region-level analysis, to inform policy-recommendation efforts. The programme for each of these virtual workshops, held in January–February 2021, is presented in Table 5. Workshop and interview participation are characterised in Annex 3.

94. Luoma et al. 2021.

Table 5: The programme of the national stakeholder workshops, January–February 2021

Denmark, 28.01.2021	Introduction to the project Orientation to the workshop Interactive session 1: Selecting areas to be addressed Interactive session 2: Evaluating the areas selected Interactive session 3: Feedback on the various areas Concluding remarks
Finland, 10.2.2021	2:00pm: 'Tervetuloa ja tavoitteet' 2:15pm: 'Kiertotalouden mielenkiintoiset alueet Suomessa' 2:45pm: 'Pohjoismainen kiertotalouspotentiaali' 3:20pm: 'Yhteinen keskustelu' 3:50pm: 'Yhteenvetoa ja seuraavat askeleet' 4:00pm: 'Tilaisuus päätty'
Iceland, 16.2.2021	10:00am: 'Kynning á verkefninu' 10:10am: 'Kynning á fyrstu niðurstöðum samantektar um helstu tækifæri hringrásarhagkerfisins á Íslandi' 10:30am: 'Umræða um þessar fyrstu niðurstöður' a) Hvaða hugmyndir/vangaveltur vöknudú við kynninguna? Hversu miklu máli skipta viðkomandi svið/atvinnugreinar fyrir möguleikana á umbreytingu í átt að hringrásarhagkerfi? b) Hvað vitum við um tækifærin sem liggja í þessum atvinnugreinum? 11:15am: 'Ábendingar fyrir næstu skref í verkefninu' a) Stutt kynning á helstu niðurstöðum frá hinum löndunum fjórum b) Umræða: Hvaða svið væru áhugaverðast að skoða sameiginlega fyrir öll Norðurlöndin? Hvar liggja stærstu tækifærin til að hafa áhrif og/eða hverjar eru stærstu hindranirnar? 12:00pm: 'Málstofulok'
Norway, 5.2.2021	Round-table introductions of participants Brief presentation of the project Facilitated discussion Summary and wrap-up
Sweden, 4.2.2021	9:30am: 'Introduktion till projektet och preliminära resultat' 9:50am: 'Diskussion kring preliminära resultat (bikupa)' 10:05am: 'Gemensamdiskussion kring preliminära resultat' 10:30am: 'Paus' 10:35am: 'Gemensamdiskussion fortsatt' 11:15am: 'Diskussion kring nordisk potential och uppsummering' 11:30am: 'Slut'

Element 1.4: Aggregation of results on the Nordic level

On the basis of the input from the above-mentioned workshops and interviews, the results were aggregated and analysed at Nordic level. Similarities and differences between countries were considered, as were the contributions of specific areas to the Nordic region as a whole. The following factors were considered in aggregate wherever possible: turnover, CO₂ emissions, waste, and qualitative data related to several elements. Proceeding from the aggregate analysis, the team formed a holistic view of the various areas' potential contribution to circular economy transition for the Nordic region as a whole.

Element 1.5: Selection of areas for inclusion in the next phase of the project

The suggestion on areas to be studied further in part II was elaborated upon in an internal workshop by the project team, using the set of criteria presented in Box 5.

Box 17: Criteria in the selection of 'areas' for further study

Giving special attention to the value that the relevant areas might be able to contribute to the transition to a carbon-free circular economy in the Nordic region, the project participants agreed that all entities chosen for further study should score 'high' on a rough high–medium–low scale for the following set of criteria:

- Potential in the transition to circular economy (e.g., in relation to yielding higher circular value via a focus on 'inner loops' that involve a longer service life and reuse)
- Potential environmental impact (through resource savings, CO₂ reductions, etc.)
- Potential socio-economic impact (e.g., in terms of business-volume growth and employment effects)
- Potential region-level synergies represented by similar areas, sectors, and industries that show high circularity potential or by opportunities to learn across boundaries between areas and across national borders
- Where measures might have the most potential (e.g., untapped circularity opportunities that could be accessed via means that entail relatively little expenditure of resources)

The team's deliberation ultimately yielded a matrix encompassing four sectors of industry (the bioeconomy; the food and beverages sector; building and construction; and the mobility, transport, and logistics sector) and two drivers of change (data plus digitalisation and new circular business models). Then, this selection of areas for further study was presented to and endorsed by the steering group. Conclusions and recommendations from phase 1 were prepared in accordance with the insight that emerged in that part of the study and were carried forward to the next steps in the project.

Element 1.6: Reporting and external review

The findings were summed up in a final report on part I and subjected to external review. Again, meetings were held with the steering group throughout the work. The most important of these were in December 2020 (kick-off) and March 2021 (the final meeting).

Part II: The areas most relevant for circular transition in the Nordics (5/2021–2/2022)

Part II of the work focused on

- assessing the major impacts of the transition in the selected areas and
- identifying and assessing the main barriers to releasing the potential.

Element 2.1: Refining the framework for part II in line with part I's results

The next portion of the study proceeded on the basis of the four areas of industry and the two change-drivers identified in part I of the work. Our hypothesis was that potential with specific relevance for circular transition can be found at the nexus of these areas, in releasing mechanisms for circularity that could be expected to have broader impacts within and across the sectors. We therefore chose an approach of building strong cases that illustrate these mechanisms and their potential impacts on the fields of industry identified in part I, to form a basis for further study. The purpose for examining these cases was to afford interesting and valuable insight highlighting the dynamism of the circular transition in the Nordics, by pointing to various sorts of mechanisms for realising the transformation. The topics at the core of the cases, which we denote as circular economy opportunities, were selected from among the interesting examples identified in the part I report.

The case studies were meant to serve as inspiration with regard to mechanisms that the Nordic countries can support for unlocking the potential of circular transition in a sustainable and well-integrated Nordic region.

The project team agreed early on that the CE opportunities selected for analysis need to be focused enough to enable in-depth description. At the same time, they must be sufficiently relevant and significant as examples of how to unleash the potential amid strivings toward circular transition. These issues were discussed with the steering group, and a set of criteria was created to facilitate choosing the most suitable CE opportunities for the case studies.

Element 2.2: Selecting specific CE opportunities for case-study attention

Part I of the study included dozens of examples of circular transition's operation in the selected areas. These examples were compiled into a longlist.

The project team designed an iterative approach to select the cases for analysis, utilising the knowledge gained by each team member through the national studies conducted in part I. The method consisted of

- a. further elaborating on the set of criteria used for choosing the areas in part I (see Box 17), resulting in the description in Table 6;
- b. qualitatively assessing the CE opportunities against these criteria through a series of three joint work sessions of the team to ensure that only examples with high impact were chosen: firstly, the longlist of examples was narrowed down to a preliminary set of 11 CE opportunities⁹⁵; secondly, these were discussed and rated (for low/medium/high impact) against the criteria developed by each team member, and the reasoning thoroughly discussed in the team; and, finally, the results were calibrated jointly in the team and the eight highest-rated opportunities selected; and
- c. refining the scope of the set of cases chosen, so as to ensure a diversified case selection that brings understanding of the various paths and tools for executing the circular transition and covers the areas of study sufficiently.

95. These are 1) wood-based textile fibres, with focus on supply chains' optimisation; 2) new value chains for ocean biomass; 3) digital marketplaces for side streams promoting new uses; 4) precision agriculture and aquaculture for a sustainable food-supply chain; 5) new business models and digital platforms for the minimisation of food loss and other waste; 6) buildings' information-management systems and digital product passports; 7) sharing of business models, for an increased rate of utilisation of those assets used; 8) IoT solutions and predictive maintenance; 9) mobility as a service, with passenger-transport focus; 10) logistics as a service; and 11) reverse logistics with focus on recovery and reuse of materials from vehicles.

Table 6: The criteria employed in selection of the case-study topics

Criterion	Description and operationalisation
Relevance for the Nordic region	The broader areas of study identified in part I were all found relevant for all of the Nordic countries. In the selection of case studies, topics were elaborated upon and qualitatively assessed in terms of 1) their relevance for several countries (in light of national priorities), 2) the significance of their role in Nordic national or regional economies, 3) their role in dealing with challenges that are significant for many Nordic areas, and 4) strategic relevance in terms of scalability of models or transferability and potential application in other sectors or contexts.
Significance in the circular transition	Circular economy is defined in terms of the ability to slow, narrow, and/or close resource loops. Candidate topics for case studies were assessed qualitatively in terms of potential contributions in this respect, with emphasis on novel, innovative, and scalable solutions for the future. The aim was to showcase concrete examples of circularity mechanisms that could be of more general significance in the transition also.
Nordic collaboration potential	The Nordic countries are small economies, so advancing circular practices here requires co-operation. One of the main aims set for the study as a whole is to develop insight as to collaboration opportunities and policy recommendations. Possible case-study topics were qualitatively assessed for their Nordic collaboration potential, defined as volume potential (with similar examples in several Nordic countries) or comparison/complementarity potential (opportunities to learn across area and country boundaries).
Climate and environmental impacts for the Nordic region	It is crucial to support a circular green transition that reduces economic activities' climate and environment footprint. The Nordic countries need actions that aid in decoupling economic activities from resource use, thus decreasing the burden on the environment and climate. Prospective topics for case studies were qualitatively assessed with a view to the potential for reducing the need to extract natural resources, preserving biodiversity, and reducing emissions and waste.
Socio-economic impacts for the Nordic region	The aim of a green, competitive, and sustainable Nordic region implies that the socio economic impacts of the circular transition need to be kept in mind. A just transition must consider how various regions within the Nordics might be affected by the transformation of industries. The candidate topics were assessed qualitatively in light of the expected positive impacts on national and regional employment developments, alongside the societal impacts on such factors as health, welfare, and education.
Business potential for the Nordic region	Competitive Nordic circular economy demands transformation that boosts business development and growth. Possible topics for case studies were qualitatively assessed in terms of potential to increase 1) the expected volume of business development and growth over a relatively short time horizon and 2) innovativeness and the possibility of creating new circular business models or better use of data and digitalisation.

The central output of the project team's stepwise work process was the choice of eight distinct kinds of CE opportunities, which were presented to the steering committee and accepted as the scope for part II of the study:

1. Closed-loop wood-based textile solutions
2. New applications for ocean biomass
3. Predictive management supporting circular food-chain solutions
4. New business models and digital platforms for the minimisation of food loss
5. Models for increased (re)utilisation of buildings
6. Digital platforms supporting circular economy
7. Smart mobility solutions
8. Circular transport logistics

Element 2.3: Conducting case studies, including impact and barrier assessment

We conducted the case studies by using desk-study work, complementary interviews where relevant, and the expertise of the project team. The team utilised the material reviewed in part I, pertinent recent studies and reports, and statistics provided by the national statistics bureaux. All case studies encompassed 1) description of scope and the case's significance for the circular transition; 2) the current state of the opportunities in the Nordics; 3) future potential, with special attention to key trends in circular development; 4) general impacts of the opportunities with regard to business, socio-economic development, the climate, and environmental factors; 5) and the main barriers to scaling of the opportunities, with focus on regulatory, technological, market, and cultural hurdles, alongside tentative ideas for how to eliminate the barriers, as a foundation for part III of the study (the stage scheduled for 2022).

The descriptions of the impact pathways in the case studies were based on their role in narrowing, slowing, or closing resource loops:

- Direct impacts of narrowing loops through resource-efficiency can be estimated in light of such factors as the volume of natural resources going into the processes and the material costs.
- Direct impacts of closing the loops via recirculation can be calculated in relation to the volume of waste, the material quantities entering reuse or recirculation, etc.
- Slowing the loops by means of longer-term value creation in the 'inner loops' increases the value created per unit of material (including value produced in new business growth) and indirectly affects both the virgin-material needs at the beginning of the cycle and the end-of-life waste generation.
- Also, employment, the development of residential areas, health and welfare considerations, and education all play their own role.

Most of the circular solutions encompass quite complex processes, with which new operation models transform the whole value chain, so any impact-assessment models employed should cover many distinct factors. Also, when it comes to the longer-term climate and environmental impacts, in combination with the socio-economic impacts of industrial transformation, an in-depth impact assessment would necessitate highly complex modelling of multiple branches of industry and several geographic regions.

For the purposes of this study, impacts were assessed qualitatively from the data available, with regard to their direction (positive/negative), pathway (direct/indirect), volume (high/medium/low), significance (high/medium/low), and duration (short-term/long-term/permanent).

Impacts were divided into the rough categories of

1. business impacts, such as innovation and new business development;
2. climate and environmental impacts (e.g., CO₂ reductions; resource savings; and changes in the quality of oceans, other bodies of water, soil, and air); and
3. socio-economic impacts (such as total growth in business or economic volume.

Studying the impact pathways also assisted in identification of barriers to circular economy. The barriers found were categorised into

- **regulatory barriers**, which encompass both lack of laws/regulations and hindrance-creating ones, along with conflicts of regulatory instruments between sectors or countries;
- **market barriers**, such as high investment costs and low raw-material prices;
- **technology barriers**, among them lack of such elements as data, demonstration projects, and circular design; and
- **cultural barriers**, such as rigid linear value chains, problematic company culture, and low consumer awareness.

Throughout the study, we recognised boundaries imposed by climate and environmental targets also, since the circular transition must be implemented such that it is aligned with meeting the targets. These boundaries were not, however, addressed as direct barriers to transition.

Element 2.4: Examining stakeholder engagement and validating the results

A workshop was held online for discussing the impacts and barriers and for validating the results of part II. Its target group consisted of key stakeholders from each country and in Nordic co-operation. The aim was to inform key stakeholders about the project, to involve them in that process, and to foster buy-in that supports the results' usability. The workshop participants discussed the preliminary findings and conclusions from part II, and input was gathered for articulation of conclusions.

The workshop, held online on 14 October 2021, had 22 participants.

The agenda for the workshop was the following:

1. Introduction to the project
2. Presentation of the circular economy opportunities identified and discussion
3. The next steps in the project
4. Discussion and conclusions

The organisations participating are listed in Annex 3.

Element 2.5: Analysing and summarising the findings at Nordic scale

The lessons learnt from the case studies were summed up on the Nordic level, and the team analysed the key implications within the selected areas of study. This portion of the study served as the starting point for part III, in which barriers and, addressing these, enabling actions and policy instruments were further assessed and developed.

Element 2.6: Reporting on the study and incorporating external review

The findings were summed up in the final report on part II and subjected to external review. Meetings were held with the steering group throughout the project work. For part II, the most important of these were held in May 2021 (for kick-off), August

2021 (related to the selection of cases), November 2021 (for discussing the tentative results and agreeing on adjustments called for by the external review), and February 2022 (on part II's final report).

Part III: Identifying the action needed and formulating policy recommendations (3–10/2022)

Part III of the work focused on

- assessing what measures and policy instruments are needed to release the identified potential and
- drafting policy recommendations

Element 3.1: Identifying the actions required

To further analyse barriers to circular transition identified and to collect more knowledge of the action needed to remove them, the team held a series of events to stimulate stakeholder dialogue (mini-workshops on each sector and interviews) in spring 2022.

The agenda for the mini-workshops was the following:

1. Introduction to the project
2. Presentation of the potential identified and barriers to change in the sector
3. Actions for releasing the potential (with focus on Nordic level)
4. Summing up and the next steps

Because the workshops attracted participants in only low numbers, the set of workshops was complemented by one-on-one interviews delving into the following key questions:

1. Which of the barriers identified [presented in the workshop/interview] do you see as the most crucial to remove / find solutions for?
2. What other barriers to circular transition of the sector have you identified?
3. In your opinion, what key actions are needed for accelerating the circular transition in the sector?

In total, approximately 55 stakeholder representatives were consulted through the workshops and interviews. The project team made sure that, for each of the countries (Denmark, Finland, Iceland, Norway, and Sweden) and each sector, stakeholders were consulted from the relevant industries / industry associations and from the research sector and/or the government. In addition, the team had the opportunity in Norway to utilise findings from a parallel project on similar topics. For the Faroe Islands, Greenland, and Åland, we ensured that stakeholders were

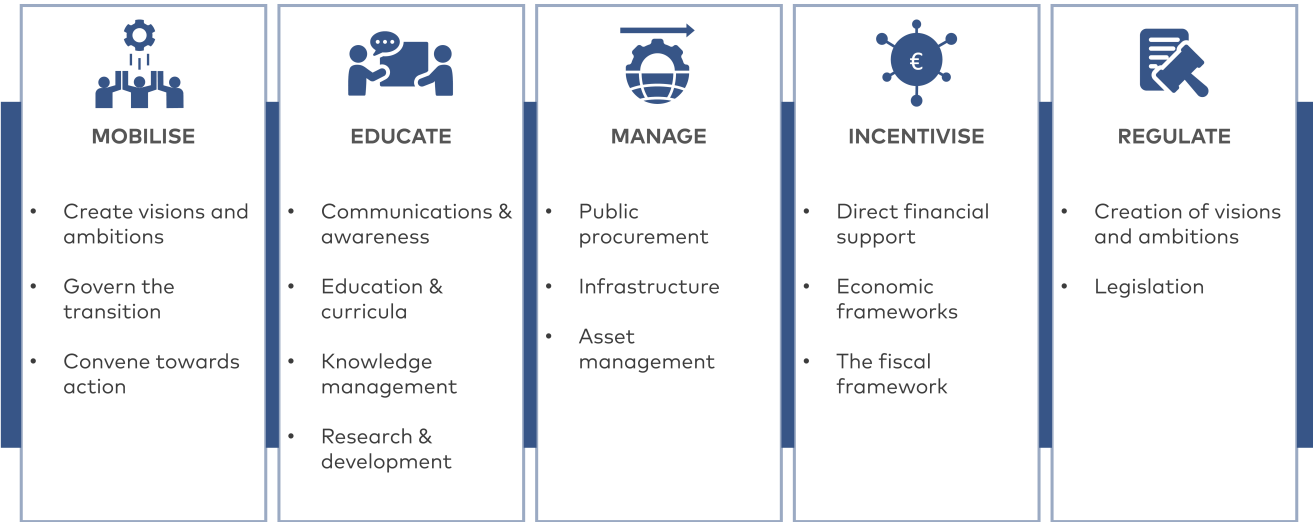
informed and invited to comment on the topics. The aim behind this was to ensure that national developments in each country were taken into account.

Element 3.2: Assessing the actions and policy instruments required

Prioritisation of the required actions was handled by the project team. The analysis for this was based on the input from the stakeholder dialogue, complemented by the knowledge that team members had gathered through parts I–II with regard to the gaps in circular economy development.

In this part of the work, specific actions were further concretised, into policy-instrument recommendations describing what the authorities can do to support the actions identified and, thereby, release the potential. Attention was given to instruments that can be brought into real-world use and that enable the actions needed. These might take the form of regulations, producer-responsibility schemes, fees, or other mechanisms. Instruments can be assessed at several levels (local, national, and regional).

To systematise the multiple kinds of policy instruments available in a manner that affords easy understanding, the study borrowed from the framework presented by Circle Economy for national policy instruments, adapting it specifically to Nordic co-operation. This framework's structure comprises three tiers, where the key function that policy can play is on Tier 1, key policy directions are articulated on Tier 2, and Tier 3 is the level of specific policy instruments. For our study, tiers 1–2 were adopted directly from the pre-existing framework⁹⁶, while Tier 3 was adjusted to reflect the set of policy instruments available to the Nordic Council of Ministers.



The framework is borrowed from the Circle Economy's national policy framework and adapted to the Nordic level. See <https://www.circle-economy.com/resources/the-national-policy-instrument-framework>

Figure 5. The project's adapted policy-instrument framework.

96. Circle Economy 2021.

The framework facilitated systematic conceptualisation of the actions identified. Using this framework made it easy to pinpoint where Nordic actions are already under way and where opportunities lie dormant.

Element 3.3: Holding a Nordic stakeholder workshop on policy recommendations

The analysis of policy instruments and development of policy recommendations was discussed further with stakeholders involved in the relevant national and Nordic-level actions. A final Nordic workshop was organised for 1 September with representatives from the various Nordic countries and sectors. There were 28 participants.

Workshop agenda, 1.9.2022

1:00pm: Welcome

1:10pm: Introduction to the project on circular transition in the Nordics, 2020–2022

Initial results and key issues identified

1:30pm: Instructions for the group work

1:35pm: Group work session

2:55pm: Break

3:10pm: Summary of the group work

3:30pm: Summing up and discussion of the results and the way forward

4:00pm: Thanks and parting

Element 3.4: Preparing a draft roadmap for the required actions

Proceeding from the findings from part III's analysis, the project team reached consensus on a set of recommendations through internal analysis workshops. These were structured into a set of general recommendations and sector-specific recommendations speaking to the required actions we identified. Actions were prioritised and assessed for their importance and feasibility both, with the team elaborating on the costs and benefits of each. This process gave focus to actions wherein Nordic co-operation could play a role through the various types of policy instruments examined.

Element 3.5: Reporting on the results and arranging for external review

The final element comprised summing up the findings by means of this final report, which represents the culmination of the entire project, and subjecting them to external review. Meetings were held with the steering group throughout part III: in March 2022 (kick-off), June 2022 (reporting on progress), and October 2022 (for discussing the final results and the external review and agreeing on finalisation of the report).

Annex 2: Key sources in phase 1's identification of focal areas (2020)

Denmark

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Finland

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Annex 3: Stakeholder involvement

For assurance that the recommendations to the NCM reflect the key stakeholders' needs in the best way possible, stakeholders from all Nordic countries were involved throughout the project's process. The main steps in that dialogue are summarised below.

Participation in national stakeholder workshops or the equivalent, January–February 2021

Denmark (workshop, 28.1.2021)	Technical University of Denmark The Danish Business Authority Aalborg University The Danish Agriculture & Food Council (L&F) The Environmental Protection Agency The Confederation of Danish Industry The Danish Construction Association
Finland (workshop, 10.2.2021)	The Association of Finnish Municipalities Business Finland The Finnish Environment Institute (SYKE) Motiva Ltd Natural Resources Institute Finland (Luke) Statistics Finland The Finnish Innovation Fund Sitra
Iceland (workshop, 16.2.2021)	The Ministry for the Environment and Natural Resources The Farmer Association FENÚR (the national waste association) Green Building Council Iceland Green by Iceland KMPG The Association of Aluminum Producers The Association of Local Authorities The Travel Industry Association (SAF) The Financial Services Association (SFF) Fisheries Iceland (SFS) The Environment Agency

Norway (workshop, 5.2.2021)	Norsk Industri (the Federation of Norwegian Industry) The Eyde Cluster Avfall Norge The National Centre for Circular Economy (NCCE) Statistics Norway (SSB) The Ministry of Climate and Environment (KLD) The Federation of Norwegian Enterprise (Virke) Samfunnsbedriftene, the organisation for social enterprises SINTEF Nordic Innovation
Sweden (workshop, 4.2.2021)	Circular Sweden IVL Swedish Environmental Research Institute The Swedish Environmental Protection Agency Lund University IDC West Sweden and Circular Hub Cradlenet ReSource Återvinningsindustrierna The City of Gothenburg The Region of Skåne The Confederation of Swedish Enterprise The National Agency for Public Procurement Research Institutes of Sweden (RISE)
Åland (interviews)	Landskapsregeringen
Faroe Islands (interviews)	
Greenland interviews)	

Participation in the Nordic stakeholder workshop held on 14.10.2021

Circular Sweden

The Danish Agriculture & Food Council (L&F)

The Danish Business Authority

Dansk Industri

The Finnish Forest Industries Federation

The Icelandic Association of Local Authorities

IVL Swedish Environmental Research Institute
KPMG Iceland
The Finnish Ministry of the Environment
Motiva, the Finnish state company for sustainable development
Norsk Industri
The Norwegian Centre for Circular Economy
SFF Finance Iceland

Mini-workshops and interviews in the third part of the study

In all, 29 stakeholder representatives participated in the mini-workshops, and 31 stakeholder representatives were interviewed, with the following organisations among those:

Business Finland
The Confederation of Danish Industry
Cradlenet
The Danish Agriculture & Food Council (L&F)
Forum Virium
Green Building Council Finland
Green Building Council Iceland
Hólar University
Hopp
ITS Finland
Landbrug&Fødevar
Natural Resources Institute Finland (Luke)
Matis
The Finnish Ministry of the Environment
The Ministry of Food, Agriculture and Fisheries of Denmark
Research Institutes of Sweden (RISE)
Roskilde University
SINTEF
Skanska
Volvo Group
VTT Technical Research Centre of Finland Ltd

Participation in a Nordic policy workshop held on 1.9.2022 as part of sub-study III

Cradlenet

The Danish Business Authority

The Danish Housing and Planning Authority

Digipolis

FIGBC

The Finnish Environment Institute (SYKE)

Grænni Byggð, or Green Building Council Iceland

Green Building Council Finland

IVL

Lifestyle & Design Cluster

The Finnish Ministry of the Environment

MiXi ry

The Nordic Circular Hotspot

Nordic Innovation

Research Institutes of Sweden (RISE)

SFMCON ApS

Statistics Finland

Members of Sweden's recycling industry

The Chemical Industry Federation of Finland

The Danish construction federation

The Finnish Forest Industries Federation

The Natural Resources Institute Finland (Luke)

About this publication

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