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Low-Carbon Circular Transition in the Nordics

Part I. Areas with significant circular transition potential

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Executive Summary

The study was aimed at generating insight on the potential of circular economy in the Nordic region and providing recommendations for unlocking this potential. This report covers the first part of the study, identifying 'areas' (i.e. significant themes) that are seen as particularly important for the circularity transition in the Nordic region.

The study utilised a review of relevant national strategies, roadmaps, and other literature on circular-economy commitments to pinpoint those areas and themes identified as national priorities. The potential areas identified were further analysed with emphasis on developing a sound general understanding of the various areas' potential role in transforming the Nordic countries, for moving toward circular economy. On the basis of the input from stakeholder dialogue, the results of the national studies were aggregated and analysed at Nordic level.

The study revealed that the Nordic countries share several strategic interests when it comes to areas that possess potential for the circularity transition. It should be highlighted that the circularity transition constitutes systemic change that spans many sectors and that the resulting economy emerges in a variety of ecosystems, value chains, and networks wherein materials and value flow through various actors and across traditional industry boundaries. Therefore, the circularity transition potential is not confined to economic activity produced within any specific sector.

A combination considering some key industrial branches together with important drivers of change was chosen. At the core of the identified focus areas are four industry branches – the bioeconomy; the food and beverage industry, real estate and construction; and transport, logistics, and mobility. These were chosen for their considerable material flows and the significant circularity-transition opportunities identified in the analysis. The selection was complemented by two significant drivers of change: digitalisation and new circular business models. The selection of these transition drivers was motivated by their evident role in providing tools for transformative ways of developing circular economy. Together, this selection of areas reflects the cross-cutting nature of the transition opportunities, and it allows for developing more profound insight into emerging circular-economy opportunities.

In the next phase of the work, the aim will be to understand the circularity transition's impacts on the climate, environment, and economy in the Nordic region while also identifying the obstacles to transition. In setting the scope for further study, the aim will be to inspire the most interesting and valuable insight into the dynamics of the circularity transition in the Nordic countries, for breaking new ground beyond traditional classifications.

This study was carried out in 2020-2021 for the Nordic Council of Ministers by Gaia Consulting Ltd, PlanMiljø, the Norwegian Institute for Sustainability Research (NORSUS), RISE Research Institutes of Sweden, and Environice.

Sammanfattning

Studiens målsättning var att bidra till en bättre kännedom om potentialen inom cirkulär ekonomi i Norden och ge rekommendationer för hur potentialen kan förverkligas. Denna rapport beskriver den första delen av studien. Den hade som mål att identifiera fokusområden av särskild vikt för den cirkulära omställningen i Norden.

Studien utgick från en granskning av nationella strategier, färdplaner och andra relevanta dokument som beskriver åtaganden inom cirkulär ekonomi. Denna granskning hjälpte identifiera sådana områden och teman som ingår i de nationella prioriteringarna för cirkulär ekonomi. De identifierade områdena analyserades vidare med tonvikt på att skapa en bättre förståelse för deras roll i den cirkulära omställningen i Norden. Intressentdialog organiserades i länderna för att samla synpunkter på resultaten av de nationella studierna och få inspel för den fortsatta analysen på nordisk nivå.

Studien visar att de nordiska länderna delar många strategiska intressen när det gäller potentialen i den cirkulära ekonomin. Det bör betonas att cirkulär omställning kräver systemförändringar som spänner över många sektorer och att cirkulär ekonomi förverkligas i en mångfald av ekosystem, värdekedjor och nätverk där material och valuta flödar genom olika aktörer och över traditionella branschgränser. Därför begränsas inte den cirkulära omställningspotentialen till ekonomisk aktivitet inom någon specifik industrisektor.

Studien identifierade en kombination av potentiella områden som länkar ett antal betydande industriella sektorer I Norden med centrala drivkrafter för omställning. I kärnan av de identifierade fokusområdena är fyra sektorer – bioekonomin, livsmedels- och dryckesindustrin, fastighets- och byggnadsbranschen samt transport, logistik och mobilitet. Sektorerna valdes på grund av de betydande materialflöden och möjligheter till cirkulär övergång som identifierades i analysen. Valet av fokusområden kompletterades med två centrala drivkrafter för cirkulär omvandling: digitalisering och nya cirkulära affärsmodeller. Dessa drivkrafter för omställning valdes på grund av deras framträdande roll som transformativa redskap i förverkligandet av en cirkulär ekonomi. Urvalet av fokusområden belyser den cirkulära omställningens tvärgående karaktär och möjliggör en mer djuplodande insikt i den cirkulära ekonomins framtida möjligheter.

Nästa fas av arbetet har som målsättning att utreda den cirkulära omställningens effekter på klimat, miljö och ekonomi i Norden samt identifiera existerande barriärer för omställning. Tyngdpunkten i nästa fas av arbetet kommer därför att vara att bidra till intressant och värdefull insikt om dynamiken i den cirkulära omställningen i de nordiska länderna och visa på möjligheterna att bryta ny mark utanför traditionella industrigränser.

Denna studie genomfördes år 2020-2021 för Nordiska ministerrådet av Gaia Consulting, Plan-Miljø, Norsk institutt for bærekraftsforskning NORSUS, Sveriges forskningsinstitut RISE och Environice.

1 Introduction

1.1 Background and objectives

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 resources[1], 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 form[2], value is created in three ways: closing resource loops via reuse and recycling of materials, slowing resources' flow through those loops by designing long-life goods and extending products' service life, and narrowing the resource flows via resource-efficiency[3].

The Nordic region aims to be a forerunner in the transition to circular economy[4]. This transition holds potential to facilitate business development and innovation, reductions in greenhouse gas emissions, positive effects on biodiversity, a cleaner environment (air, water, and soil), increased utilisation per unit of material, and numerous other positive outcomes[5]. 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.

1 IPCC 2019.
2 Bocken et al. 2016.
3 *Ibid.*
4 Nordic Council of Ministers 2021.
5 Ellen MacArthur Foundation 2017.

Box 1: The definition of low-carbon circularity transition in this assessment

A circular economy designs out waste and pollution, keeps products and materials in use, and regenerates natural systems[6]. 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 – including greater resource-efficiency, positive effects on biodiversity, and lower 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 carbon dioxide (CO_2) emissions. However, promoting circular economy is not always obviously consistent with the decarbonisation targets set.

Our project has taken a broad-based approach to the circularity transition by putting emphasis on a systemic understanding of circular strategies for managing materials and products, alongside systems and circular value creation. 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.

The study was aimed at generating insight on the potential of circular economy in the Nordic region and providing recommendations for unlocking this potential. This report covers the first part of the study, identifying 'areas' (i.e. significant themes, further defined in Section 1.3., Box 2) that are seen as particularly important for the circularity transition in the Nordic region. The more specific objectives were to…

- Identify 'areas' with significant circularity-transition potential in the Nordic countries
- Reflect on those 'areas' that hold transition potential in the Nordic context
- Decide on the 'areas' to be included in Part II analysis

This study was carried out for the Nordic Council of Ministers by Gaia Consulting Ltd, PlanMiljø, the Norwegian Institute for Sustainability Research NORSUS, RISE Research Institutes of Sweden, and Environice. The research team and the authors of this report are Päivi Luoma, Susanna Sepponen, Matleena Moisio, Ringa Sirppiniemi, and Mari Hjelt, for Gaia Consulting Oy; David McKinnon, Bjørn Bauer, Kia Egebæk, and Elvira Borgman, with PlanMiljø; John Baxter and Ole Jørgen Hanssen, of NORSUS; Katherine Whalen and Josefina Sallén, with RISE; and Environice's Stefán Gíslason. The study was carried out in November 2020 – April 2021.

6 *Ibid.*

1.2 Circular economy in the Nordic region

Circular economy is high on the political agenda of the various Nordic countries, as it is for the European Union (EU). The European Commission's newly adopted Circular Economy Action Plan is one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth[7]. Focusing on those sectors with the heaviest use of resources and high potential for circularity, such as electronics and information and communications technology (ICT), batteries and vehicles, packaging, plastics, textiles, building and construction, and the food industry (also including water and nutrients), the action plan is aimed at making sustainable products the norm in the EU; empowering consumers and public buyers; ensuring less waste; making circularity work for people, regions, and cities; and spearheading global efforts toward circular economy.

The Nordic countries all have circular economy high on their agenda. Most of these countries have already developed national strategies, roadmaps, and programmes for promoting transition to circularity or are in the process of doing so. Table 1 outlines the history and vision of circular economy in each country.

Table 1. A summary of the history and vision of circular economy in the Nordic countries.

	Brief history	Vision
Denmark	Denmark launched its strategy for circular economy in 2018, in aims of reducing its use of virgin resources and increasing the competitiveness and productivity of Danish businesses. The areas of focus are the circularity 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 entered the consultation phase in late 2020. It describes Danish policy and the concrete efforts rooted in pursuit of a circular value chain, which range from design and consumption mechanism to waste management, from which natural resources are to be returned for new products and materials. The action plan contains, in total, 126 initiatives, many of which are included in the political agreement on the Climate Plan for a Green Waste Sector and circular economy for June 2020 onward.	The advisory board for circular economy developed a vision for Denmark in connection with its mandate to provide insight into the circularity transition. It involves a global lead role for Denmark in the development, implementation, and export of circular solutions by 2030, with Denmark having become known as a hub of circular-economy operations. This entails companies' full integration of circular economy into their business and strategy, alongside the public sector's provision of a supporting framework for circular economy and removal of barriers to its adoption, via such means as using public procurement to promote and support circular products. Citizens should have the opportunity to make circular choices and good information to enable them. In addition, there is general understanding that commercial use of data is a key component of circular business models and a vital enabler for them.

7 European Commission 2020.

Finland	Finland was the first country in the world to publish a national roadmap to circular economy, doing so in 2016[8]. In 2020, a new strategic programme to promote circular economy was developed[9]. Approved by the Government of Finland in April 2021, it sets out objectives and indicators, specifies measures, and allocates the resources necessary for promoting circular economy and achieving systemic change. The transition to circular economy also constitutes a step toward reaching the government's carbon-neutrality target by 2035.	Finland's vision for 2035 entails carbon-neutral circular economy as the foundation for a successful national economy[10]. This features the following elements: 1) sustainable products and services that are mainstream, with the sharing economy being commonplace; 2) future-proof choices that strengthen Finland's fair welfare society; 3) 'more for less', with the use of natural resources being sustainable and materials remaining in circulation longer and more safely; 4) a circular-economy breakthrough via innovations, digital solutions, smart regulation, and responsibility (of investors, businesses, and consumers); and 5) circular economy having solidified Finland's position as a strong player in the global arena and a provider of sustainable solutions for international markets.
Iceland	So far, there is no explicit national strategy for circular economy. The government's five-year state budget plan earmarks some 1.7 billion ISK (roughly 10.5 million euros) for circular-economy initiatives. Almost a third of the total amount will be allocated in the budget for 2021. Details of this plan have not been published, but the main foci are on responsible production and consumption, waste prevention, increased recycling, and more recovery, with the overall objective of sustaining a circular flow of resources as long as possible. In addition, there are several initiatives closely linked to circular economy, including a national waste-management plan, which is currently being updated and should be published in early 2021.	There is no formal vision thus far, and details of the budget plan have not been published. However, the areas of focus are likely to include responsible production and consumption, prevention of waste, increased recycling, and greater attention to recovery, with the overarching objective being to sustain the circular flow of resources as long as possible.
Norway	Norway is currently working on ascertaining which sectors have the greatest potential for improving circularity and on identifying incentives and barriers that could influence introduction of	The national vision will be defined in the national strategy and action-plan work.

8 Sitra 2016.
9 Ministry of the Environment of Finland 2020.

10 *Ibid.*

	circular-economy operations in Norway. The work will form the basis for a national strategy and action plan to be presented by summer 2021.	
Sweden	Sweden introduced its national circular-economy strategy in July 2020. This is an important first step for Sweden's move toward a circular economy and strengthens the circularity initiatives already underway in Swedish society. The strategy is intended to contribute to reaching Sweden's environmental and climate goals, among them the goal of having zero net greenhouse gas emissions by 2045. A follow-up action plan was released at the end of January 2021. This action plan focuses on the four focus areas outlined in the 2020 national strategy and describes more than 100 measures that either have been chosen or are to be decided upon by the government.	The Swedish National Circular Economy Strategy envisions a society in which resources are used efficiently in toxin-free circular flows, replacing new materials. The strategy for achieving this has four main foci, on circular economy 1) through sustainable production and product design; 2) through sustainable ways of consuming and using materials, products, and services; 3) through toxin-free, circular eco-cycles; and 4) as a driving force for the business world and other actors, through measures to promote innovation and application of circular business models.

The transition to circular economy involves activities on several levels, from national and cross-border operations to regional and local ecosystems. It is closely connected to global value chains and not restricted by national borders. Also, diverse digital platforms are emerging that support circular economy by such means as sharing of unused assets.

The circularity transition is supported by many key actors. Individual businesses act on ambitions for implementing circular 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 circularity 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 policy-makers and especially municipalities support circular development within these sectors. At the same time, the role of individuals and households should not be overlooked.

1.3 Methodology and the scope of the study

The study employed a systematic approach to identifying areas with significant circularity-transition potential in the Nordic context, with emphasis given to existing circularity strategies that support the development of a green, competitive, and socially sustainable Nordic region. As the introduction to this report notes, recent years have seen most of the Nordic countries participate actively in extensive national work to identify priorities and areas of focus for such strategies. The project's desk research took advantage of this knowledge base and deepened it through both qualitative and quantitative data analysis, alongside activities with stakeholders in the various

countries. The structure of the analysis work conducted for this study is depicted in Figure 1 and presented in more detail in the following subsections.

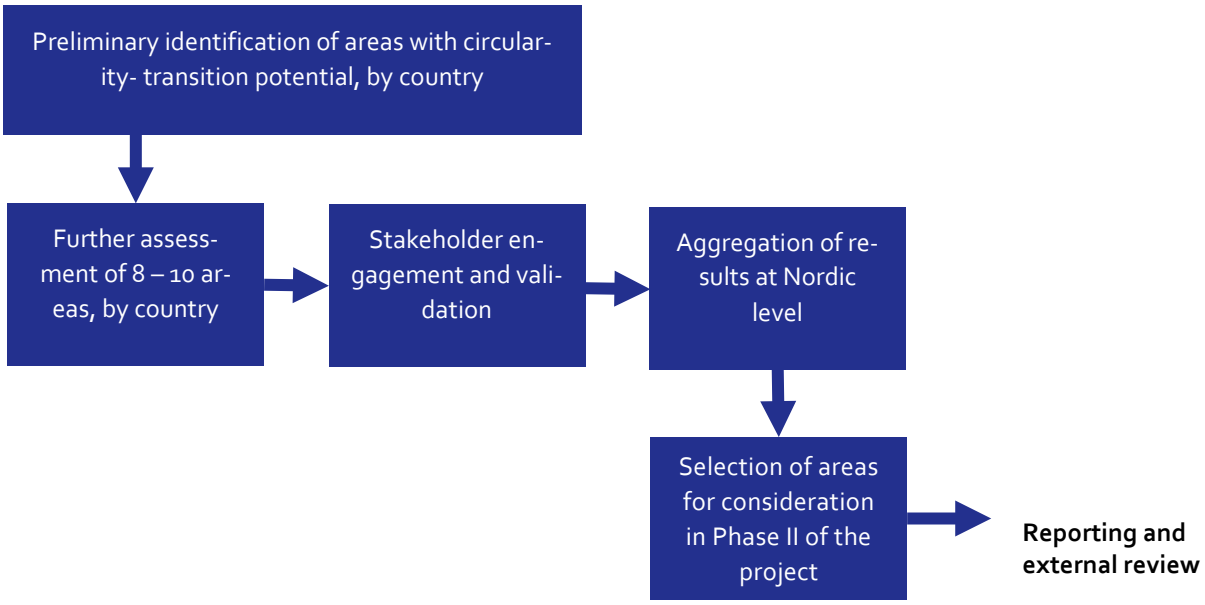

Figure 1. The structure of the work done for the study, including 1) country-specific identification of areas with potential, 2) analysis of 8–10 areas per country, 3) stakeholders' engagement in the discussion, 4) comparison of the results at Nordic level, and 5) the choice of areas for consideration in later phases of the project.

Preliminary identification of areas with circularity-transition potential, by country

The first phase of analysis utilised a review of relevant national strategies, roadmaps, and other literature on circular-economy commitments to pinpoint those areas and themes identified as national priorities. This literature-review work was performed for each of the Nordic countries and autonomous areas (i.e., for Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland, and Åland). By documenting the areas identified and the source and reasoning behind their selection, the team gained a good general understanding of the foci of each country's circularity-transition efforts. The work produced a long list of areas. In this phase, a flexible approach was taken, which entailed mapping the circular-economy areas and themes emphasised in the national documents while preserving the categorisation scheme and wording of the original documents. The understanding of the term 'area' is described in Box 2.

The research team reached agreement early on that the method chosen should consider those of the key branches of industry identified at national level that are of common interest across the Nordic region. They also clarified that the approach to examining these areas should acknowledge the significance of the following factors: those enablers or drivers of change that would be expected to have a large impact on transition within these areas, the actors involved in the transition, and material flows with a significant environmental impact.

Box 2: The definition of circular-economy 'areas' in national policy documents

Throughout the study, we used the term 'area' to denote a group of activities and actors relevant in the circular-economy context. The term, used 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** as drivers of transition that can support achieving circular economy in various industries/sectors.

This broad use of the term 'area' enabled the inclusion of 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.

Further assessment of 8-10 areas, by country

The next stage of work identified preliminary national 'shortlists' of potential areas. The team produced these lists for Denmark, Finland, Iceland, Norway, and Sweden 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. The aim was to select 8–10 areas per country for further assessment. This preliminary selection applied the following criteria:

- ***Potential to support circularity transition in the country:*** Operations in the 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:*** The area is of interest for other Nordic countries too. Attention to this factor is necessary for guaranteeing an opportunity for added value from region-wide collaboration in the selected areas.
- ***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 3.

Box 3: The availability and quality of circular-economy data

Any assessment of the impacts of circularity transition depends partly on the availability of high-quality data. While the Standard Industrial Classification (SIC)[11] 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 CO_2 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 has been confined to qualitative assessment thus far.

The potential areas identified in Denmark, Finland, Iceland, Norway, and Sweden were further analysed in light of the literature and statistical data, with regard to such factors as their characteristics, key figures, and preliminary signs of circularity-transition potential. This process placed emphasis on developing a sound general understanding of the various areas' potential role in transforming the Nordic countries, for moving toward circular economy.

Stakeholder engagement and related validation

National stakeholder workshops were arranged in Denmark, Finland, Iceland, Norway, and Sweden. Annex 2 presents the programme for these virtual workshops, held in January–February 2021, and their participants. 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. For the Faroe Islands, Greenland, and Åland, participants confirmed the view of the national priorities and the input for the region-level discussion by participating in telephone interviews.

11 The study utilised Finland's standard classification of industries (TOL 2008) as its main reference.

Aggregation of results at Nordic level

On the basis of the input from the aforementioned 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. Next, the team formed an integrated view of the various areas' potential contribution to the Nordic region's transition to circular economy. This synthesis and visualisation work was done internally by the research team and discussed with the steering group at an interim meeting.

Selection of areas for inclusion in the next phase of the project

Conclusions and recommendations were prepared in accordance with the insight that emerged during the study of circularity-transition potential in the Nordic region.

For Phase II of the work, the objective will be to understand the impacts of the circularity transition on the climate, environment, and economies in the Nordic region and simultaneously identify the barriers to transition.

The suggestion of areas to be studied further in Phase II was presented at an internal workshop. The project team discussed it and reached agreement with the steering group on this point and with regard to the selection criteria. 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 criteria chosen were the following:

- 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, CO_2 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 circular potential or by opportunities to learn across boundaries between areas and across national boundaries
- 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 scope of the study

The analysis was focused on yielding insight that reveals the potential for circular-economy transition in the Nordic region by identifying a set of areas that hold promise in this regard. The foundations lay mainly in existing work done at national level in the individual Nordic countries, and no attempt was made to cover the full spectrum of potential or the economy as a whole. Our application of quantitative methods for measuring potential came up against multiple challenges related to the complex and inter-sector nature of circular economy – the phenomenon calls for a conceptualisation of areas of circularity opportunity that does not correlate with standard industry-sector classifications. In addition, availability of relevant, comparable data on circular-

economy activities[12] remains highly limited; see Box 3. Therefore, further study too will demand significant reliance on qualitative methods that facilitate scope-setting via consideration of many aspects and approaches that are more meaningful with regard to the circularity transition.

For the initial report, our principal aim has been to characterise current priorities in the Nordic region and identify many of the mechanisms that underlie the circularity transition, thereby paving the way for the in-depth analysis to be conducted in the next phase of the work.

It must be acknowledged also that most of the countries examined are displaying rapid progress in their circularity development and that national and Nordic priorities alike are going to change before the study is complete. Accordingly, the research team consciously chose to leave some latitude in the scope for the coming phases. This should provide flexibility for incorporating newly emerging opportunities into the focus of the work.

2 Areas with circularity-transition potential in the Nordic countries

This chapter presents the areas that the national studies identified as holding potential . These areas were identified primarily in the national strategies listed in Table 1, then elaborated upon in the stakeholder workshops and through the interviews. In Annex 1 to this report, the national studies are documented in detail, with references to all sources.

2.1 Denmark

The study of 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.[13]

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 agricultural land constitute opportunities for circularity 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 circularity transition in **the Danish real-estate and construction sector** was found to be considerable**.** While recycling rates are already high, space remains for improvement with regard to high-quality recycling. Several associated activities and initiatives already exist, and there is great interest in adoption of circular methods in this field. Work that is in progress for

12 The data-related challenges have been addressed more thoroughly in such contexts as the preliminary study Indicators on Circular Economy in the Nordic Countries, conducted by Bauer et al. (2020).
13 The national annex for Denmark lists all sources utilised in the analysis. See Annex 1.

further development of standards and building methods should further 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, common 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 waiting to be implemented. The country's SMEs in particular need special support to overcome the obstacles and challenges they face. Ensuring that SMEs and other enterprises can access the knowledge and capital required for investing in circularity transition is a vital component of the shift toward circular economy in Denmark.

Plastic plays 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 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 will be required for harvesting the potential and thus ensuring that plastic becomes an integral part of circular economy rather than a useful material that brings with it a high 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 a 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, thereby, actualising the potential in each of those areas. Broad and deep digitisation is a vital component of making the right decisions that lead toward a circular economy. Here, Danish companies benefit by developing a better understanding of their sourcing, processes, and products; consumers get fuller insight into which products and services are sustainable, how they can reap the most benefit from their disposable income, and ways of optimising their 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 two 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.

2.2 Finland

The study of Finnish priorities produced the following outline of nine key areas among its conclusions.[14]

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 has 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 into the nutrient cycle. Among the

14 The Finnish analysis was prepared mainly on the basis of the strategic programme to promote a circular economy (Government of Finland 2021). All sources used in that analysis are listed in the Finnish national annex. See Annex 1.

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 logistics** is a prerequisite for circular economy, enabling, for example, reverse resource flows. It is necessary to cut emissions, develop efficient transport systems and 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.

Packages represent 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 shows 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 is minimal.

Circular economy disrupts value chains and seizes opportunities for **new business models** and value creation. New business models are 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 be promising and display interesting possibilities.

Digitalisation and data hold power for enabling and driving circular economy. They can aid in narrowing, slowing, and closing 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 good quality are crucial for the source data, and so are efficient management and sharing of data in value networks and ecosystems.

Municipalities have 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 circular economy. Every year, municipalities spend significant amounts on public procurement, where there is considerable room for services and solutions in such fields as energy, water, nutrient cycles, use of waste and side streams, mobility, and ICT. Co-operation between the private and public sector presents further opportunities.

2.3 Iceland

The study of Icelandic priorities led to identification of 12 areas, which are tightly interwoven.[15]

The bioeconomy, with fisheries as the largest contributor, is a sector of 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 makes up 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 high potential for improvement from a sustainability perspective. Certification of building and renovation work is on the rise in Iceland. This phenomenon reflects a growing 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. It is a few companies in this sector that together consume the bulk of the electricity produced in Iceland, and these produce 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 good 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

15 As Iceland does not have a circular-economy strategy, the analysis was performed primarily on the basis of related policy documents and stakeholder interviews. The nation-specific annex for Iceland lists all sources used. See Annex 1.

material for attention here, as the majority of its production, distribution, consumption, and re-use/recycling/regeneration/disposal takes place in 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 to the government for the last couple of years. Likewise, the national stakeholder workshop in February 2021 stressed the importance of plastic waste from agriculture (hay emballage), as a company now gaining prominence in Iceland has set a goal of recycling all this waste, alongside plastic waste form other domestic sources.

Green funding 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 spatial planning. Particularly for detail planning, certain rules could influence choices of materials, and a well-defined framework could enrich urban agriculture and local access to shops and service centres. **Green public procurement** (GPP) is an important enabler, especially with regard to tender criteria. A revised national strategy for GPP has been scheduled for publication in late winter or spring 2021.

2.4 Norway

The study of Norwegian priorities pinpointed six main sectors and two key enablers.[16]

The bioeconomy (agriculture, forestry, and fishery operations) was found to be of considerable importance irrespective of Norway's relatively low gross domestic product (GDP)-to-sector-output ratio, because it is a significant contributor to greenhouse gas (GHG) emissions. The study revealed strong circularity potential through 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 (the food industry as a whole, inclusive of its consumption and waste) are included in consideration, the potential is extremely high.

Operations involving **food and beverages** are the focus of a large sector, particularly in terms of GDP. They exhibit high circularity potential, most often 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 with 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 circularity transition in terms of output, employment, and GHG emissions. This sector's high

16 The primary source utilised in the study for Norway was Deloitte's Study for a National Strategy for Circular Economy, Parts 1–3 (2020). All sources used in the analysis are listed in the Norwegian national annex. See Annex 1.

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 very high 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 circularity-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 (largely linear) economy as it stands but is connected also with the wide scope for change.

The **transport and logistics** sector is hugely important in GHG terms in that 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 a 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 in 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 reference to the pertinent marketplaces. In practice, economic instruments for effectively manipulating markets (shifting tax burdens, increasing the tax applied to certain activities, and granting tax advantages for others) are considered very effective in 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 overall potential is very high and of extensive breadth.

2.5 Sweden

The study of Swedish priorities identified 11 key areas for circular-economy transition.[17]

The bioeconomy: Sweden is rich in natural resources and skilled in refinement/recycling of raw materials, including biomass activities. Moving toward a circular, bio-based economy presents Sweden with 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 bio-based solutions). 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.

Building and construction: Numerous, very different material flows are utilised by the building and construction sector, and the entire life cycle of a building offers a plethora of opportunities to reduce the need for virgin resources and increase resource-efficiency via implementation of circular-economy strategies. The Swedish Circular Economy Strategy stresses opportunities to reduce this sector's emissions, including those from buildings' use.

Food and beverage operations: Although most of the country's food waste is generated by Swedish households during the consumption, opportunities for circular solutions exist along the entire food value chain. Focus should be placed on reducing and reusing 1) 'inevitable food waste' (i.e., what cannot be reused by humans) and 2) 'unnecessary' food waste (i.e., food that could have been used by humans but is left unused).

Manufacturing and process-industry work: Circular production ties in with many of the material flows identified in connection with this sector and presents significant opportunities for reducing resource and energy use. The sector engages in large-scale operations with significant opportunities for increasing circularity. Its connections with many of the flows and its high potential for improved resource and energy use are worthy of attention.

Mobility, transport, and logistics: Transportation that incorporates 'reverse logistics' is a prerequisite for a circular economy; it helps extend the useful life of products and materials. Moreover, transport accounts for a significant percentage of Sweden's CO_2 emissions. Emissions from domestic transport must be reduced by 70% by 2030; this target highlights the significant potential for a circularity transition for mobility. Numerous opportunities for circular mobility solutions exist, related to 1) usage, such as potential for service-based solutions that increase products' utilisation, help extend product lifetimes, and decrease carbon emissions, and to 2) end of life, such as opportunities connected with increased recovery and reuse of materials. One particularly clear opportunity is connected with greater recovery of steel, aluminium, and plastic from end-of-life vehicles, as this is one of the value chains in Sweden where value often fails to be recaptured.

17 The primary source for the analysis related to Sweden was the national strategy for the transition to a circular economy in Sweden (Regeringskansliet 2020). All sources used are listed in the Swedish national annex. See Annex 1.

With regard to **textiles,** 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) represents significant economic and environmental benefits. Recovery of critical materials has been recognised as a priority, and Sweden is in a relatively good position for this. Collection of electrical waste in Sweden is fairly extensive, and, though it is showing a downward trend, there is potential to expand it further, especially with regard to small electronic devices.

Sweden has opportunities to prevent or 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 of focus for the future.

Digitalisation is a powerful enabler that can help make circular material flows and business models possible. It offers great potential in the circularity transition because it affords the optimisation of knowledge, and of sharing it, along the value chain.

Finance is seen as crucial to supporting the transition and enabling new circular business models. All circularity-transition projects and ventures – in industry and in the public sector both – require financing and capital, so this area holds strong potential for influencing circularity.

Public procurement constitutes a significant proportion of Sweden's GDP. There is great potential to stimulate circular-economy 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 generally the largest contributor to greenhouse-gas figures, followed by equipment and materials; however, what is procured varies with the level of government, so this too must be considered.

2.6 The Faroe Islands

The study of Faroe Islands priorities identified the following areas for circularity transition.[18]

The bioeconomy (fisheries, aquaculture, and agriculture): The fishery industry produces around 90% of the exports of the Faroe Islands. Aquaculture is a substantial component of the bio-based industries. Land-based agriculture is important also, with most meat consumption being satisfied by local sources. There is interest in the islands' greater self-sufficiency, an objective that could be supported through technological development of the agricultural sector.

[18] All sources used in the analysis are listed in the Faroese national annex. See Annex 1.

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 grow further. At the same time, experiments with tidal turbines are underway, indicating that technological development may act as an enabler of circularity transition in this field.

Waste streams and recycling: The waste-handling system in the Faroe Islands could be tuned further, to avoid losses of energy and materials. Recycling has recently become available for more categories of material, and a project has been carried out in which citizens were given the material for composting bio-waste at home as compensation for the collection of this class of waste.

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

2.7 Greenland

The study of Greenland's priorities produced the following outline of areas for the circularity transition.[19]

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 to 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 export possibilities for Greenland, since it can support power-to-X activities or be used at data centres that require large quantities of energy.

Waste and recycling: In Greenland's Waste Treatment Strategy, goal 3 is related to circular economy and waste prevention. Specifically, 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 will be implemented to support reaching this goal, including increased sorting of waste, activities for direct reuse, dialogue with relevant stakeholders about packaging, and development of GPP methods.

[19] All sources used in the analysis are listed in Greenland's national annex. See Annex 1.

Packaging: One of the flows given focus in the Waste Action Plan is that 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 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 circularity-transition activities in this sector.

Circular innovation: Innovation and establishment of new technology constitutes an enabler for circularity 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.

2.8 Åland

In the study of Åland's priorities, the following key areas were identified.[20]

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

The construction sector has been identified as the biggest industrial producer of waste. 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 comes bundled with emission challenges and great potential both. With regard to biofuels, electric vehicles, and increased resource-efficiency brought about by digital solutions and marketing-related opportunities, Åland could serve as a testbed for digitalised transport and other solutions.

One of the targets on the development and sustainability agenda is **waste to resources**, and several actions are underway in this regard. Åland's **plastics-industry operations** provide motivation for paying attention to plastics in pursuing circular economy, and **packages (specifically plastics)**

[20] All sources used in the analysis are listed in Åland's national annex. See Annex 1.

and textiles are among the targets under the strategic development goal for sustainable consumption and production patterns.

Digitalisation and open data could be exploited to minimise transport needs. 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 and circular consumption patterns have been identified as a key priority and a source of substantial potential. **Sustainable public procurement** related to, for instance, a sustainable food-process chain and energy procurement for real-estate and other operations is another designated priority that represents potential.

3 Analysis of areas with circularity-transition potential in the Nordic context

The sections below present region-level reflections on the foregoing country-specific overviews of areas with identified circularity-transition potential, The aim here is to take the analysis one step further and identify those areas that are of particular significance and interest with regard to the circularity transition of the Nordic region. This reflection is based on insights connected with similarities and differences between the countries and at the level of sub-regions within the Nordic context. It also elaborates on the potential contribution of specific areas within the system boundaries of the Nordic region.

3.1 Synthesis of the national results

The study revealed that the Nordic countries share several strategic interests when it comes to areas that possess potential for the circularity transition.

Of the sectors identified in the circular-economy strategies and strategic programmes specific to each country, at least the following were stressed in most or all countries: 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 a high degree of similarity across the region, some variations were seen 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 fisheries are seen as part of the food and beverage industry. On the contrary, agriculture forms the core of the bioeconomy in Denmark, and the grouping of industries there reflects that: it is not presented under food and beverages. For Iceland (along with the Faroe Islands and Greenland), the bioeconomy sector consists mainly of 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 content and focus of the manufacturing and process industries too differ from one Nordic country to the next.

The national strategies of a few of the countries point out the importance of specific material flows – namely, packaging, plastics, textiles, and minerals and metals. These flows display some 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. For this study, we have chosen to call these enablers of circular economy.

Table 2 presents the shortlisted areas that were identified in more than one country. For the table, some of the more specific areas have been combined.[21]

Table 2. An overview of the areas with potential that the country-specific studies identified via the national strategies (the 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)

Branch of industry	Denmark	Finland	Iceland	Norway	Sweden	Faroe Islands	Greenland	Åland
The bioeconomy	x	x	x	x	x	x	x	x
Food and beverage industry	x	x	x	x	x			x
Manufacturing and process industries	x	(x)	x	x	x			

[21] The bioeconomy includes Bio-based industries/Agriculture, fishery (Greenland, Faroe Islands), Agriculture, fishery (and forestry) (Åland, Biomass (Denmark), Forest-based loops (Finland), Renewable and biobased materials (including paper products, biomass) (Sweden). Food and beverage industry includes Sustainable food system (Finland, Åland). Manufacturing and process industries include Energy intensive industries (Iceland), Industry (Denmark), Energy and material intensive industry (Finland), Manufacturing and process industry (Norway). Real estate and construction includes Building sector (Åland) and Building and construction (Iceland, Sweden). Circular consumption patterns include New consumption models (Denmark). Digitalisation includes data (Denmark). Green procurement / municipal operations include Sustainable procurement (Greenland), Public procurement (Iceland, Sweden, Åland), Green Public Procurement (Denmark), Municipalities and regions (Finland).

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[22]	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)

Several further key sectors and areas were shortlisted in the national-level analyses. Because these were not present in circular-economy strategies across the Nordic region, they are not presented in the table. These are mining, oil, and gas (Norway); minerals and metals (Sweden); renewable energy (the Faroe Islands and Greenland); waste streams and recycling in general (Iceland, the Faroe Islands, and Åland); clarified responsibilities for waste management (Norway); minimisation of loss along value chains (Denmark); biodegradable waste (Greenland); and (for Norway) enhanced producer-responsibility schemes; well-identified national goals and indicators; and knowledge and competence development. It was acknowledged, however, that these areas constitute important aspects of the Nordic circularity transition.

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

3.2 Similarities and differences within the Nordic region

The stakeholder dialogue during this project revealed a high level of trust in the region's circularity-transition potential and in Nordic co-operation for supporting this transition. It was emphasised that the societies in the Nordic region share significant similarities that influence the opportunities for circularity transition.

The Nordic countries are small open economies that are highly dependent on international trade. Natural resources play a large role in their industry and exports. These countries are similar in their societal structure also, and municipalities' role in their sustainable development and circularity transition is significant. All face the same sustainability challenges related to consumption, energy-intensive value chains, and climate challenges too.

The stakeholder dialogue pinpointed the Nordic region's specific potential connected with high levels of education; advanced know-how, technology, and innovation; and emphasis on digitalisation, open data, and digital solutions both in business and in society as a whole. Nordic circularity-transition potential was seen as significant with specific regard to utilising digitalisation, creating new circular business models, and establishing markets for circular goods and services. It was found that the Nordic countries with their high level of expertise would be suitable testbeds for new circular solutions and pioneering markets.

It was emphasised at the same time that appropriate co-operation platforms and tools are already in place that support joint Nordic development, both linked to the Nordic Council of Ministers and Nordic institutions/networks and involving other networks (e.g., with municipalities and regions, innovation agencies and financiers, and business/industry associations as members). While most of the regulatory issues await resolution on the EU level, the Nordic context can provide fora for reaching common views on such matters as policy development and EU regulation.

In many circular-economy-related areas, there is already ongoing work aimed at tackling some of the issues and priorities raised in this study. For example, circular economy in the construction industry is a current priority in Nordic co-operation, and work is in progress on a sustainable food system, packaging and plastics, textiles, eco-labelling, sustainable consumption, etc. The Nordic vision of an integrated and sustainable region articulates further ambitions connected with ways of supporting 'the green, technological, and digital transformation and the growing bioeconomy'[23].

At the same time, it is important to note that there are significant differences that one must consider when studying circular economy on the Nordic level. The region spans a vast geographical area and exhibits significant geographical and environmental but also socio-economic differences – the Nordic region stretches from sparsely populated Arctic areas in the North to rapidly growing

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centres of urbanisation around capital regions. Furthermore, the national economies and production chains show significant systemic differences that extend far beyond the availability of bio-based resources, and many of the loops have national or regional focus. Especially for the region's vast expanses of sparsely populated land and the smaller island communities, this factor poses serious challenges to attempts at reaching a profitable scale for circular activities.

4 The choice of areas for further study

4.1 Criteria for the selection

Proceeding from the national studies and the synthesis of findings, the team identified a set of areas for further attention. These will be addressed in Phase II of the project, which will evaluate the circularity-transition potential in the Nordic countries in greater depth.

The selection criteria were focused on the added value that the area in question might be able to contribute to the transition to a low-carbon circular economy in the Nordic region:

- Potential in the transition to circular economy (e.g., bringing greater circular value via attention to inner loops that include reuse and extension of service life)
- Potential environmental impact (e.g., via resource savings and CO_2 reductions)
- Possible socio-economic impact (e.g., through growth in business volume and higher employment)
- Potential Nordic synergies from similar areas, sectors, and industries with high circularity potential found across the region and from opportunities to learn across area and country boundaries
- Where measures might show the greatest potential – e.g., circularity potential that could be unlocked through measures that have relatively modest resource demands

The group explicitly recognised that identifying areas with potential involves inherent trade-offs between/among perspectives, especially in relation to…

- Emphasis on the countries' current priorities (elements already articulated strongly in national strategies and programmes) vs. a more forward-looking approach to emerging issues connected with rapidly evolving circular-economy forces
- Working with the data available (which favours studying issues that follow traditional industry boundaries) vs. more holistically tackling the systemic and dynamic nature of

circular economy, which prior work [24] has identified as not meshing well with such classifications

- Emphasis on the entire Nordic region vs. attention to the areas representing the most significant potential even when these might not be relevant for all the countries yet

4.2 Description of the selected areas

We chose a joint approach – i.e., a technique comprising areas of several types, as identified in the previous sections (namely, both branches of industry and enablers) – since that seemed to best reflect the cross-cutting nature of the transition opportunities.

As Figure 2 shows, at the core of this approach are four industry sectors – **the bioeconomy; the food and beverage industry, real estate and construction; and transport, logistics, and mobility**. These were chosen for their considerable material flows and the significant circularity-transition opportunities identified in the analysis. Notwithstanding some differences in industry structure and what the respective operations in these sectors consist of, the countries' economies and societies were deemed to display sufficient similarity that joint analysis should be reasonable and uncover collaboration opportunities. Also, comparative data are available for branches of industry. This further speaks to the value of making them the centre of the further analysis.

The selection of branches of industry is complemented by two significant drivers of change: **digitalisation** and **new circular business models**. The selection of these transition drivers was motivated by their evident role in providing tools for transformative ways of developing circular economy.

24 Bauer et al. 2020.

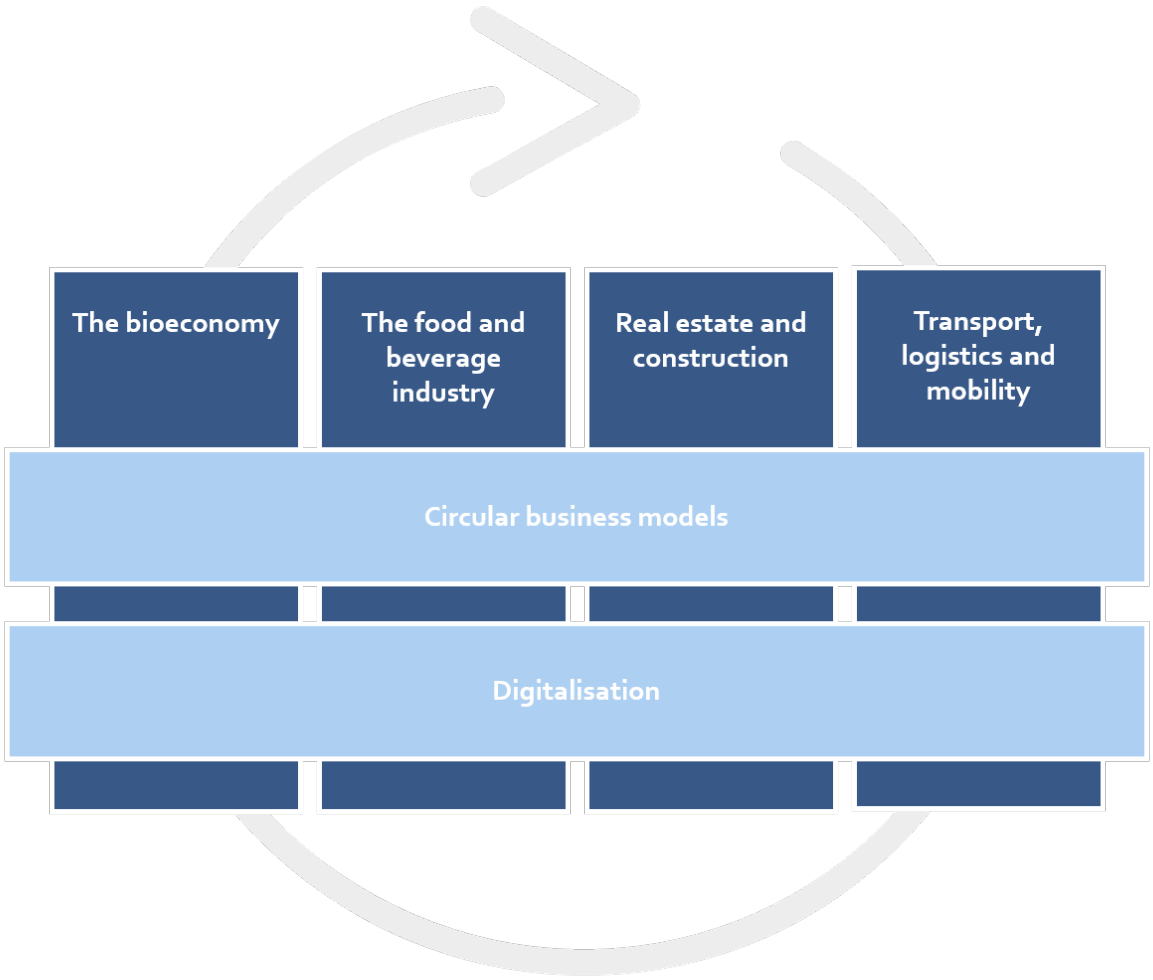

Figure 2. Areas selected for inclusion in the next phase of the project.

Considering these elements together – the four branches of industry plus the two transition drivers – allows us, in the next phase's work, to reflect on the most interesting circularity potential. Examining various combinations of these elements, along with the web of links between them, should permit us to develop more profound insight into emerging circular-economy opportunities and, equally, the dynamism behind the potential impacts of the transition. Because circular-economy business activities are constantly evolving, as are policies and strategies that exert effects on them, flexibility has been incorporated into the approach, to leave room for emergent phenomena and issues. Accounting for these should enable the most useful picture of the circularity transition.

The following discussion describes the reasoning behind the selection of these areas in greater detail.

Branch 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 activities, and aquaculture. As most of this production is for food, there is some overlap with the food and beverage sector.

The reason for choosing this area is that the Nordic countries are rich in bio-based resources and skilled in their management and use. Discussion of climate change, resource scarcity, 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.

The circularity opportunities include replacing non-renewable materials with renewable ones, introducing new biomaterials, developing higher-value novel applications for bio-based materials, implementing better utilisation of side streams, ensuring the reuse of bio-based materials and products, and improving the end-of-life handling of bio-based materials.

The role of digitalisation in this area encompasses seizing opportunities for improving circular design, tracking material flows, optimising side- and waste-stream management, and advancing data-driven precision agriculture and forest management.

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 chemical leasing and sharing of resources).

Branch of industry: The food and beverage sector

The food and beverage sector includes the production and sale of food and beverages. It overlaps to some extent with the bioeconomy sector.

The reason for choosing this area lies in its position as a key resource flow in the Nordic countries and one that generates significant amounts of waste along the value chain from primary producers to final consumers.

The circularity opportunities are connected with, for example, minimising waste and maximising the responsible utilisation of bio-resources for food and beverages, for a move toward more sustainable food production and more sustainable diets.

The role of digitalisation in this area encompasses reducing food waste and other losses in the value chain (both prior to and after consumption) through increased use of data and measurement. Such activities also enable digital platforms for new business models etc.

The role of circular business models in this area includes 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.

Branch of industry: Real estate and construction

Real estate and construction includes buying, selling, and rental activities for land, buildings, and housing, coupled with the building, alteration, and repair of buildings and other structures.

The reason for choosing this area is that it accounts for such a large proportion of materials' consumption, energy use, and waste generation, as well as economic activity, that transforming the sector is a central component of the circular economy. 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.

The circularity opportunities are connected with rethinking the entire life cycle of a building, from reducing the need for virgin resources and increasing in-use energy- and resource-efficiency – by means of good design, choices of materials, project management, and logistics – to optimising initial and final activities such as construction-waste management.

The role of digitalisation in this area entails, among other activities, employing digital tools such as building-information management (BIM) systems and digital material passports, which assist in handling information and tracking the material and energy flows; using robots and 3D printing to contribute to fuller utilisation of reuse and recycling and to cutting construction waste; and applying the Internet of things (IoT) for predictive maintenance etc.

The role of circular business models in this area includes exploiting opportunities for sharing-based business models that increase rates of utilisation of assets that would otherwise go to waste and that maximise existing buildings' value, designing for modularity and disassembly, etc.

Branch of industry: Transport, logistics, and mobility

Transport, logistics, and mobility includes the production, buying, selling, operation, and end-of-life activities associated with all forms of transportation.

The reason for choosing this area is that transport and logistics operations constitute a prerequisite for circular economy, enabling, for example, reverse resource flows. At the same time, domestic transport in the Nordic countries accounts for a significant share of emissions and all countries in the region 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.

The circularity opportunities include such developments as smart mobility and infrastructure, mobility as a service, the smart logistics that circular economy demands, service-based solutions, sharing of otherwise wasted assets, extension of products' useful life, recovery and reuse of materials from vehicles, reductions of carbon emissions, and implementation of logistics-related solutions for the reverse transport flows needed for circular activities that help extend products' and materials' service life.

The role of digitalisation in this area stretches all the way from smart logistics, wherein data solutions enable connections between distinct modes of transportation and storage operations facilitate tracking and minimise transport needs, to MaaS and other smart solutions that take advantage of digital platforms' and process data's potential for shifting incentives from owning personal vehicles to sharing/hiring vehicles or using mass transit.

The role of circular business models in this area is related to MaaS, logistics as a service (LaaS), and other solutions, alongside various kinds of emerging business model in which buying and selling vehicles is replaced with service-based models, hire, and sharing.

Transition driver: Digitalisation

Digitalisation and good availability and use of data are key enablers of circular economy. These support circular activities by enabling, for example, predictive maintenance, sharing-economy flows, and optimisation of side and waste streams' handling. Among the relevant digital technologies are the 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 that supports actions in all of the other areas and, thereby, facilitates unlocking 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.

The circularity opportunities are especially evident with regard to narrowing, slowing, and closing loops of material flows by means such as these: circular design, solid supply-chain management and material-flow management, system optimisation, and sharing of information; great leaps in resource-efficiency via better understanding of the flows of materials and how services get used within the economy; digital platforms for the monitoring, analysis, and documentation of circularity activities; a sound basis for identifying, developing, and promoting new business models and more sustainable consumption; use of data on products' performance for optimising product and service design; and digital platforms and related infrastructure to facilitate sharing of data.

Transition driver: Circular business models

The circularity 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 cycle. These also must incorporate circularity-based thinking into the design of products and services, thereby affording long product service lives and repairable products, which, in turn, enable application of new models of consumption that still facilitate satisfying user and customer demands.

The circularity opportunities lie in such activities as applying leasing- or sharing-based models, utility flows both to and from use points, and take-back schemes; focusing on loops related to materials, with connections along the entire supply chain and offering of repairs and updates, to maintain the value of products and materials; minimising waste and supporting sustainable sourcing; and creating business models based on renewable and regenerative materials. Circular business models built on collaboration and efficiency gains can unlock access to new markets and may increase competitiveness in global markets.

4.3 The role of the selected areas in the Nordic economies

For understanding the importance of the areas identified and of their potential for Nordic circular-economy transition, it is important to be aware of their significance in the individual Nordic economies. Table 3 explains the links that connect the sectors of the Nordic economies with the areas selected for the study, and Figure 3, below that, presents the turnover[25] of the key branches of industry related to the selected areas.

Table 3. The links between classes of operations and selected aspects of circular economy (the five key sectors for the circularity transition are in boldface)

Standard Industrial Classification[26]	Description
A. Agriculture, forestry and fishing	**Accounts for a large proportion of the resource use in two selected areas: bioeconomy operations and the food and beverage industry**
B. Mining and quarrying	Has no strong links to selected areas and is included in the residual category in Figure 3
C. Manufacturing	**Covers manufacturing and circular activities related to all selected areas, especially higher-value products in the bioeconomy and food and beverage fields; materials for real-estate and construction operations; and vehicles for transport, logistics, and mobility**
D. Electricity, gas, steam and air conditioning supply	Shows strong links to value chains in certain selected areas – both real estate and construction activities and the transport, logistics, and mobility area – and is included in Figure 3's residual category
E. Water supply; sewerage, waste management and remediation activities	Has strong links to circular value chains in the various selected areas; covered by the residual category in Figure 3
F. Construction	**Accounts for a considerable proportion of the activities within the selected area 'real estate and construction'**
G. Wholesale and retail trade, repair etc.	Shows strong connections with value chains in the selected areas; included in the residual category in Figure 3
H. Transportation and storage	**Includes most of the activities in the transport, logistics, and mobility selected area**
I. Accommodation and food service activities	Has links to, for instance, circular business models in food and beverage activities; included in Figure 3's residual category
J. Information and communication	Shows strong links as an enabler to value chains in various selected areas, especially with regard to digital solutions, and is covered by the residual category in Figure 3
K. Financial and insurance activities	Shows some links with regard to enabling value chains in selected areas; Included in Figure 3's residual category
L. Real estate services	**Forms the other major contributor to the selected area 'real estate and construction'**

[25] Danmarks Statistik 2021, Statistics Finland 2020, Statistics Iceland 2021, Statistics Norway 2021, Statistics Sweden 2021.

[26] TOL 2008 categories (Statistics Finland)

M.	Professional, scientific and technical activities	Manifests links to value chains in several selected areas; included in Figure 3's residual category
N.	Administrative and support service activities	Is covered by Figure 3's residual category
O.	Public administration and defence etc.	Has links to the selected areas through such activities as green public procurement; included in the residual category in Figure 3
P.	Education	Is covered by Figure 3's residual category
Q.	Human health and social work activities	Is covered by the residual category in Figure 3
R.	Arts, entertainment and recreation	Forms part of Figure 3's residual category
S.	Other service activities	Shows the possibility of links to circular business models; included in Figure 3's residual category
T.	Activities of households as employers	Is included in Figure 3's residual category
U.	Activities of extraterritorial organisations and bodies	Is covered by the residual category in Figure 3
X.	Industry unknown	Is included in Figure 3's residual category

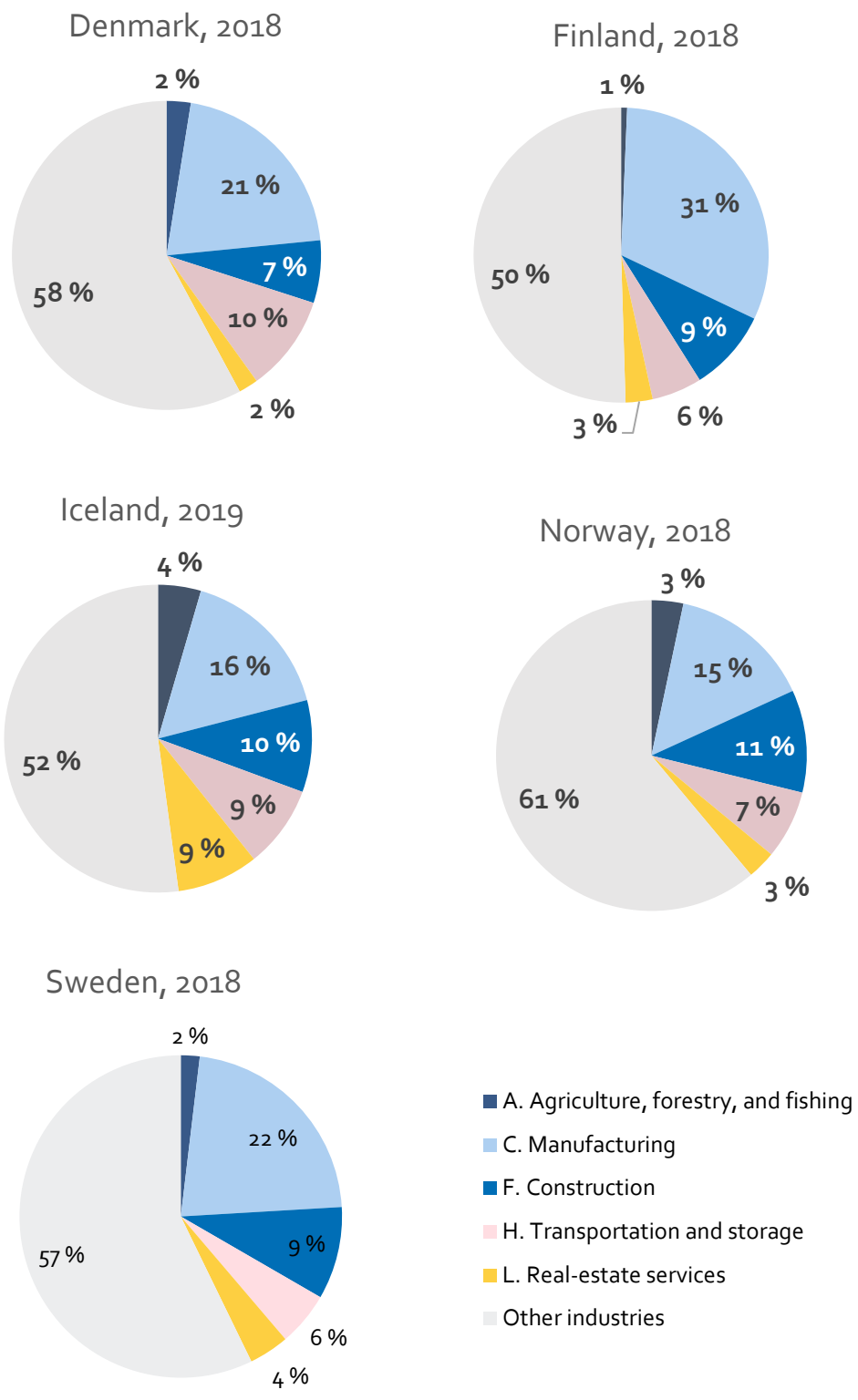

Figure 3. The selected key sectors' share in the various national economies, by total turnover (%). Source: Danmarks Statistik 2021, Statistics Finland 2020, Statistics Iceland 2021, Statistics Norway 2021, Statistics Sweden 2021.

It should be highlighted that the circularity transition constitutes systemic change that spans many sectors and that the resulting economy emerges in a variety of ecosystems, value chains,

and networks wherein materials and value flow through various actors and across traditional industry boundaries. Therefore, the **circularity-transition potential** of the areas identified is not confined to economic activity produced within any specific sector as identified in the Standard Industrial Classification.

Since key economic data are expressed in terms of Standard Industrial Classification categories, however, it is important to form an understanding of how the areas selected for focus with regard to transition tie in with key branches of industry in this regard.

Figure 3 characterises the turnover of the sectors in which the prioritised areas lie in general. These figures represent the full breadth of these sectors' economic activity; they do not account for how large a proportion of this turnover stems from circular economy. The figures' total for manufacturing covers creation of products that display connections with, among other activities, the following prioritised areas: the bioeconomy (especially forest-based loops), food and beverage operations, real estate and construction, and transport-related activities (including logistics and mobility).

Alongside turnover, the relevant sectors' environmental impact was among the main criteria considered. Therefore, the team's analysis of the areas prioritised in each country included gathering data on CO_2 emissions and waste too. It should be noted that said data were obtained for the national priorities, not the branches of industry themselves. Since the countries differ in the scope of their priorities, the figures cannot be used for comparisons of national performance, and they should be taken as rough guidance only.

The data show that the CO_2 emissions related to aspects of transport, logistics, and mobility are particularly high (see Figure 4), while it is the real-estate and construction area that is an especially large contributor to waste generation (see Figure 5).

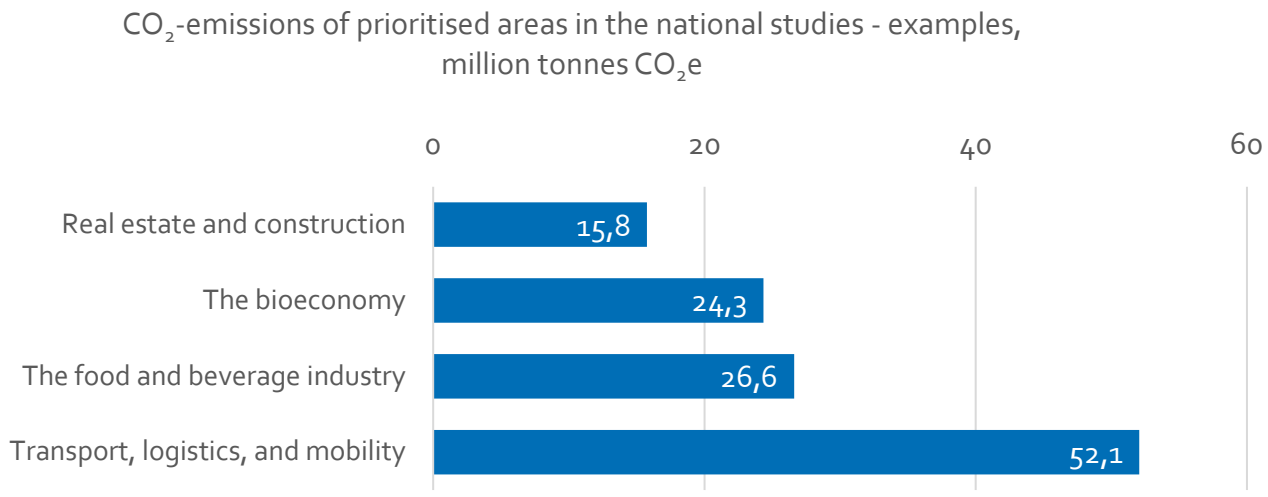

Figure 4. The CO_2 emissions of the selected operations in the Nordic region, in millions of tonnes CO_2-equivalent (CO_2e). All figures are based on data for the national priority areas identified for Denmark, Finland, Iceland, Norway, and Sweden, not on totals for entire sectors. Sources are listed in the national annexes (see Annex 1).

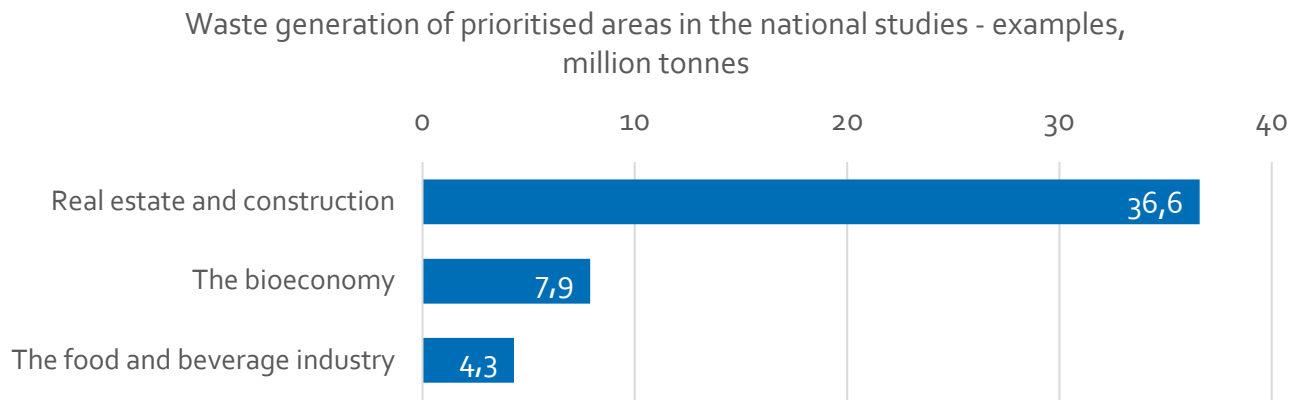

Figure 5. Waste generated by the selected activities in the Nordic region, in millions of tonnes. The figures are based on data for the national priority areas identified in Denmark, Finland, Iceland, Norway, and Sweden, not on sector totals. Sources are listed in the national annexes (see Annex 1).

Despite the limitations of the analysis, one can reasonably claim that the areas selected for study are highly relevant for the Nordic region and that they show vast circularity potential. In the next parts of the work, effort will be directed to further identifying the potential impacts of circularity transition in these areas and how this power can be unleashed.

4.4 Considerations related to the scope of the further analysis

The analysis uncovered a need for in-depth systemic change if true transition is to occur and examined it further. The change required is disruptive in nature, taking place not only within industries' traditional 'borders' (per the Standard Industrial Classification) but also, and more importantly, at interfaces between sectors and in emerging fields of business. This means that the transition's impacts must be identified not merely within specific industries or sectors: even more, they must be found in the diverse value chains and business ecosystems wherein value is created. The shift toward circularity is already transforming the structure and dynamics of the economy in ways that were never visible before.

For Phase II of the work, the aim is to understand the circularity transition's impacts on the climate, environment, and economy in the Nordic region while also identifying the obstacles to transition. Because this transition is disruptive to traditional industrial boundaries, the evaluation of potential impacts must take a forward-looking perspective.

The analysis necessitates examining industry data from selected key sectors for insights related to the potential significance of change for activities carried out in these sectors. At the same time, we will need to remember that both the activities and their impacts are going to affect multiple actors beyond these sectors. For instance, new digital solutions for bioeconomy work will involve the bioeconomy sector directly but also the new service providers, thereby leading to new economic activity; novel workplaces; and ripples that reach numerous aspects of the economy, society, and the climate and environment.

The next parts of the project will consider a host of key players in the circularity transition. After all, this transition involves **business ecosystems** in which actors of very different types engage in creating and sharing value. Private businesses but also public entities, especially **municipalities**, have a large enabling role here, through public procurement and other activities. Green public procurement has a part to play via incentives for using circular business models and products and for focusing on the entire economy and the procurement's life-cycle costs (encompassing maintenance, the full service life, and end-of-life management). Alongside procurement, **new consumption patterns** were found to have a significant role in enabling low-carbon loops. Consumption patterns can be altered through such mechanisms as new service models for design, repair, reuse, and recirculation. Consumption can be influenced further via new models for ownership and transactions in a sharing economy. Also, the role of the **finance sector** in supporting the circularity transition received emphasis in several of the countries. All the actors important for these parts of the picture must be accounted for when **policy-makers** are planning out measures intended to support the transition in their selected areas. The final part of the project, Phase III, will emphasise these factors specifically.

Therefore, in setting the scope for further study, we will need to establish such cases for analysis as can inspire the most interesting and valuable insight into the dynamics of the circularity transition in the Nordic countries, for breaking new ground beyond traditional classifications.

Sources

Bauer, Bjørn; Lander Svendsen, Nina; Borgman, Elvira; Sepponen, Susanna; Luoma, Päivi; and Hansen, Ole Jørgen (2020). *Pre-study: Indicators on circular economy in the Nordic countries*. TemaNord 2020:543.

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Statistics Iceland (Hagstofa Íslands) (2021). 'Framleiðsluuppgjör' ['Production settlement'], at https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor, accessed on 13.4.2021.

Statistics Norway (2021). 'Business statistics', at https://www.ssb.no/en/statbank/table/12817, accessed on 13.4.2021.

Statistics Sweden (2021). 'Företagsenhet - Basfakta företag enligt Företagens ekonomi efter näringsgren SNI 2007. År 2000 – 2018' ['Business unit – basic facts on companies connected with their corporate finances, by industry, SNI 2007, for 2000–2018'], at https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__NV__NV0109__NV0109L/BasfaktaFEngs07/, accessed on 12.1.2021

Annex 1. National annexes of analysed areas, by country

Denmark

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Miljøministeriet (2020). Handlingsplan for cirkulær økonomi. National plan for forebyggelse og håndtering af affald 2020-2032, https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/PDF_af_faktaark.pdf	Government plan	The action plan for circular economy describes Danish policy and the concrete efforts based on the circular value chain, which ranges from design and consumption to waste management, from which natural resources are returned to new products and materials. The action plan for the circular economy contains a total of 126 initiatives, many of which are included in the political agreement on the Climate Plan for a green waste sector and circular economy from June 2020. The action plan is in hearing until February 2021.
Finansministeriet (2020). Grønne indkøb for en grøn fremtid – strategi for grønne offentlige indkøb. https://fm.dk/media/18268/groenne-indkoeb-for-en-groen-fremtid-strategi-for-groenne-offentlige-indkoeb_web.pdf	Government plan	The "Green procurement for a green future - Strategy for green public procurement" presents how the public sector should buy greener and thereby help to realize the goal of a 70 % reduction of greenhouse gases by 2030. The strategy is based on three coherent tracks, all of which focus on public procurement areas that today leave a significant climate footprint, including: An implementation track that creates green action now; a development track that creates long-term green action towards 2030; and a track relating to green knowledge and green tools.
Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimpartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	Input to government plan	A detailed report from the partnership on waste, water and the circular economy. This is the primary input into the above Klimaplan for en grøn affaldssektor og cirkulær økonomi.

Regering. (2020). Klimaplan for en grøn affaldssektor og cirkulær økonomi. https://www.regeringen.dk/media/9591/aftaletekst.pdf	Government plan	The climate plan aims at a climate-neutral waste sector in 2030, where incineration and landfill are reduced as much as possible. In future, household waste must be sorted and collected in 10 different fractions via tender. In addition, a ceiling on incineration capacity is introduced in Denmark. If implemented, the new environmental law goals require a change in the organization of the waste facilities in Denmark, which in particular has consequences for municipal ownership.
Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	Government strategy	The government strategy for circular economy describes 17 initiatives in 6 focus areas that combined aim to help the Danish transition to a circular economy. The strategy takes a value-chain approach indicating the importance of businesses, data and digitalization, design, consumption pattens, markets (for recycled materials), and the importance of two specific product categories: biomass and buildings.
Advisory board for cirkulær Økonomi (2018). Anbefalinger til Regeringen. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Advisory_Board_for_cirkulaer_oekonomi_Rapport.pdf	Input to government strategy	In 2016 the Danish government established an advisory board comprised of industry leaders to examine the potentials of circular economy in the danish economy. The results and recommendations of the advisory board were presented in June 2017. This highlighted significant potentials in the food and beverage industry, the construction industry and the manufacturing industry, as well as the role of consumption patterns, design for circularity, enabling recycling and the importance of enabling business to thrive in a circular economy.
Advisory board for cirkulær Økonomi (2018). Målsætninger for dansk erhvervslivs omstilling til en mere cirkulær økonomi i 2030. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/COE_Advisory_Board_for_cirkulaer_oekonomi_Faktaark_C.pdf	Input to government strategy	Annex to the advisory board for Circular economy detailing targets for material productivity, recycling, waste minimization, the sharing economy, and circular consumption. Does not contain, however, any sector-specific targets.
Landbrug Fødevare (2018). Cirkulær bioøkonomi i den danske fødevareklynge. Fra spild til ressource og nye forretningsmuligheder. https://lf.dk/-/media/lf/aktuelt/nyheder/2018/januar/cirkulaer-biooekonomi-landbrug---foedevarer.pdf	Sector report	This report from the Danish Agriculture industry organization indicates the potentials for circular transformation of the sector. Components include a focus on sustainable biomass, the recirculation of nutrients, effective utilization of water resources, and waste reduction/minimization.
Dansk Erhverv (2018). Cirkulær økonomi i handlen.	Sector report	This report from the Danish Business association indicates the importance of retail and

https://www.danskerhverv.dk/contentassets/da5e8ec0678043eea91b4110eb5a9401/cirkular-okonomi-i-handlen.pdf		wholesale in creating opportunities for circular businesses.
Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf	International research report	This case study tool box from the Ellen MacArthur Foundation was developed in cooperation with Danish authorities. It examines a range of circular economy initiatives for their impact on the Danish economy and society, providing an insight into the potential economic and environmental benefits that could be realized towards 2035. It analyses 12 potential sectors for their potentials for circular transition, identifying four – construction, machinery, food and beverages, and hospitals – as particularly relevant.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Food and beverage	Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf	Although by-products are often reused in the Danish food and beverage industry, they are most often utilized in low-value applications. There is a large potential for increasing the value of food and beverage waste flows by implementing more advanced bio-refinery bi-cascading technologies to produce higher-value bio-products. This is a case of building on existing experience and know-how, technology investment and market development.
Construction & real estate	Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	Recycling of construction and demolition waste is particularly prevalent in Denmark, but there is less attention on initiative higher up the value chain. In particular, industrialised production techniques, increasing re-use of components and materials rather than recycling, and designing buildings for increased flexibility in the use phase, as well as re-purposing existing buildings rather than constructing new, provide opportunities for significant increases in circularity of the sector. Selective demolition that preserves value in the materials, components and products in end-of-life buildings is seen as a key process in helping the construction and demolition industry to make more circular use of the sectors

		material use. The way in which the demolition process is conducted has an enormous influence on the value that can be recovered. This is not limited to careful demolition but encapsulates the connection of demolition to design and construction of new and refitting of existing buildings. Increasing traceability of materials from demolition, easing the interface with authorities, and standardizing procedures, are all seen as important steps in the process.
Machinery	Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf	Denmark is not a manufacturing powerhouse, but it does have a significant machinery manufacturing sector, and this could present opportunities for engaging in new approaches and business models for the provision of machinery services. This could involve re-manufacturing of high-value machinery, provision of services under performance contracts rather than machinery sales, and the potential for implementing reverse logistics within the sector.
Bioeconomy: Biomass	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf Landbrug Fødevare (2018). Cirkulær bioøkonomi i den danske fødevareklynge. Fra spild til ressource og nye forretningsmuligheder. https://lf.dk/-/media/lf/aktuelt/nyheder/2018/januar/cirkulaer-biooekonomi-landbrug---foedevarer.pdf	This area covers a multitude of possible initiatives and potential gains. Reduction in food waste is an important step in getting more net value from Denmark's production capacity while minimizing the environmental impacts of the food and beverages value chain and minimize costs. Investigating ways of utilizing Denmark's agricultural land by increasing off-season crops that can be exploited in bio-refinery processes can provide additional high-value products from the sector. The latter must be coupled with an understanding and development of the potential value chains that could benefit from these products and ensure that positive. Focusing on the potentials of the 'biomass' sector can provide a significant boost to the circular transition. Primarily, this involves exploiting the danish agricultural land more effectively to produce biomass year-round, creating a higher volume of biomass that can be utilised in a variety of ways – both to provide input to bio-refining processes, and to create energy and fodder.
Hospitals	Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf	With a large resource footprint and significant centralized purchasing power, hospitals are well placed to make important inroads in the circular economy. In particular, circular procurement can help drive change within relevant services and reduce material and environmental impacts, while streamlined processes

		for recycling within hospital operation could help bring down the linear material throughput within the healthcare sector.
MATERIAL FLOWS		
Packaging	Ellen MacArthur Foundation (2015). Potential for Denmark as a circular economy a case study from: delivering the circular economy – a toolkit for policy makers. https://mst.dk/media/135137/15-11-25-cirkulaer-oekonomi.pdf	Denmark already has a very effective recycling system for beverage packaging, but recycling of other packaging types is currently lagging. In particular, potentials have been identified in improving collection rates and packaging standardization to help increase recycling rates, while bio-based packaging solutions could provide a way to avoid some of the problems associated with plastic packaging, although these have to be developed and implemented so as not to adversely affect recycling of plastic packaging.
Waste and recycling **Battery recycling**	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimpartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	The waste and recycling sector need to be a leading actor in the circular economy. It can provide the raw materials for production of new, more sustainable products, and is decisive in minimising the amount of waste ending in incineration or landfill. By early intervention, streamlined and unified collection systems and advanced sorting and extraction techniques, it can ensure that materials return to productive utilisation. Increase and better recycling will avoid emissions from waste incineration, while maximising the savings from better treatment of biowaste. While recovered materials can be fed into production processes, saving raw materials.
Plastic recycling	Regering. (2020). Klimaplan for en grøn affaldssektor og cirkulær økonomi. https://www.regeringen.dk/media/9591/aftaletekst.pdf	Plastic waste represents a significant share of the CO_2 emissions from the Danish waste incineration sector. By recycling more plastic waste, the CO_2 emissions from waste incineration can be reduced. This is aimed to be achieved by placing specific targets on plastic waste, by implementing a producer responsibility system for packaging waste, by encouraging simplification of the plastic packaging on the market, and by supporting public institutions in procurement of sustainable – easily recycled, long life or containing recycled plastic – products.
Recirculation of nutrients	Landbrug & Fødevarer (2018). Cirkulær bioøkonomi i den danske fødevareklynge. https://lf.dk/-/media/lf/aktuelt/nyheder/2018/januar/cirkulaer-biooekonomi-landbrug---foedevarer.pdf	Ensuring that nutrients in products and lost during production processes are returned to productive agricultural land. This requires a considerable effort to minimise or avoid con-

		tamination with other wastes, creating markets for standardised fertiliser products and recovering nutrients from complex waste streams like waste water sludge.
Increased use of recycled materials in production	Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimpartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	By using a greater share of recycled materials in the production of new products, the use of virgin raw materials can be minimised and replaced by recycled materials, that are associated with smaller environmental costs. This demands an effective market for recycled materials, making use of recycled materials in new products economically attractive. This involved coordination between the waste sector and the manufacturing sector.
Using new materials	Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimpartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	By developing and using new materials it will be possible to avoid many of the hazardous chemicals that are found in products today and that make recycling a costly and uncertain process while the shift to bio-based materials will enable a closed bioeconomy loop.
DRIVERS / ENABLERS		
Data and digitalisation	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	Digitalisation and utilization of the enormous quantity of data produced by everyday activity can help support and drive transition to circular economy. It is anticipated that digitalization and data analysis will help identify and support alternative business models for service provision, including the sharing economy, enable better and more circular design, reduce waste along the value chain, enable smarter consumption, and provide consumers as well as public and private procurers with the information they need to buy sustainable products. Digital solutions could also increase the traceability and sorting of waste materials, allowing better utilization of wastes.
Design	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	Product design is decisive in enabling the transition to a circular economy. It influences the direct impacts from production as well as the potential for recycling through the choice, composition and combination of materials used. Similarly, material choice can also help draw recycled material through the value chain by creating demand for recycled rather than raw materials. Design is also the key factor in defining anticipated product life- times, opportunities for reuse and preparing for reuse, repair and re-manufacturing.
Circular Business models	Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi.	Circular Business models like those associated with the sharing economy and product service

	https://mfvm.dk/fileadmin/user_upload/klimapartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	systems, will help strengthen circular behaviour and minimise the demand for raw virgin materials. This will require coordination and cooperation along value chains.
New consumption models	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	Supporting and driving markets for circular solutions is seen as a vital component of transition to a circular economy. This means that public and private organisations as well as consumers play a central role in signalling demand and creating markets. The public sector, with its large purchasing power, can lead this process, while enabling circular procurement in the private sector will help support businesses and help bind sustainable understanding in the broader economy. Integrating circular choices and understanding in education will provide a new generation of citizens with the necessary tools to make sustainable choices.
Longer product lifespans	Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimapartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	Design plays a decisive role in the transition to a circular economy. By engaging in circular design that facilitates increased reuse and easing reparation and by producing goods of higher quality, the raw material demand for new products can be minimised.
Minimising value chain losses	Regering (2020). Regeringens klimapartnerskaber. Affald og vand, circulaer økonomi. https://mfvm.dk/fileadmin/user_upload/klimapartnerskab_afrapportering-for-affald-vand-og-cirkulaer-oekonomi.pdf	By reducing the loss of material along the whole value chain – from production to distribution, retail and consumption - the demand for virgin raw materials can be minimised. Again, this requires significant coordination from all actors along the value chain.
SMEs	Miljø- og Fødevareministeriet og Erhvervsministeriet (2018). Strategi for cirkulær økonomi: Mere værdi og bedre miljø gennem design, forbrug og genanvendelse. https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Cirkulaer_oekonomi/Strategi_for_cirkulaer_oekonomi.pdf	SMEs often lack the necessary knowledge to adequately address the challenges of the circular economy, even when they would like to be more engaged in sustainable business. Enabling smaller companies to maximise their circular potential is an important component of the move to a circular economy.
Retail and wholesale	Dansk Erhverv (2018). Cirkulær økonomi i handlen. https://www.danskerhverv.dk/contentassets/da5e8ec0678043eea91b4110eb5a9401/cirkular-okonomi-i-handlen.pdf	The retail and wholesale business is the primary interface between consumer and producers, and as such has an important role to play in creating a seamless transition toward circular products and services. This is particularly relevant for helping design consumption models (including providing product service systems), managing their own and minimising the waste and packaging waste flowing through retailers to consumers, and helping to

	redesign products and services that meet consumer expectations while minimising resource use and environmental impacts.

Short list of areas and key figures

The areas seen to be the most feasible for further assessment and their reasoning are listed in Table C. Tables D and E include the detailed analysis of the areas including characteristics and key figures of the area as well as assessing the preliminary circular transition potential.

Table C. Short list of areas for in-depth assessment

Area	Reasoning
Bioeconomy: biomass	Biomass is one of the key focus areas of the current Danish circular economy action plan. This aims to better exploit Danish biomass by investigating emerging technologies that can be used for new bio-based products, increasing recycling of biomass wastes, and recirculating phosphor from sewage sludge treatment. Reducing food waste is also included under this focus area in the current action plan, although in this project is delt with in a separate 'area'.
Buildings and construction	Buildings - their construction, use and eventual demolition - have been identified as one of the most material and energy heavy sectors in not only in most of the national strategies addressing circular economy, but also over the preceding years focus on resource efficiency and sustainable consumption and production. Construction and real estate fills such a large part of material consumption, energy use and waste generation, as well as economic activity, that transforming the sector is a central component of the circular economy.
Food and beverage	Food and beverage production and consumption is a key resource flow, and one which generates significant amounts of waste along the value chain from primary producers to final consumers. It has been identified repeatedly in strategic documents pertaining to circular economy, resource efficiency, and sustainable consumption and production. Minimizing waste and maximizing utilization of bio-resources for food and beverages are vital for the transition to a circular economy, while there are significant social, economic and environmental benefits from moving toward more sustainable food production and more sustainable diets.
Industry	Danish industry is feeds both the domestic and international markets, and manufactures both finished products and intermediate goods. It is both a significant national employer, an important part of the economy, and generator of a significant portion of wastes. Furthermore, these wastes are typically of a technical nature (as opposed to bio waste from agriculture or mineral wastes from construction) and therefore these wastes already represent a loss of value. While some corners of Danish industry are world-leaders in efficiency, others lag significantly – this is particularly true of SMEs.
Potentials in these six key areas need to be unlocked. The following enablers are considered vital to the ongoing transition to a circular economy in Denmark.	
Textiles	Although Denmark does not produce significant volumes of textiles – with few textile raw materials and high labour costs – it does have a significant design industry and Danish consumers buy more textiles per capita than most others. Subsequently, they also generate significant quantities of textiles waste. Much of this 'waste' is suitable for re-use, but ends in disposal channels, representing a significant loss of valuable materials.

Plastic	Plastic is the focus of a wide variety of initiative linked to circular economy thinking, both within Denmark and more broadly. The government has placed increasing focus on addressing plastic and plastic waste, as has the EU and multitude Danish and international NGOs. The work in this area seeks to address the entire plastics value chain, from primary producers, to designers, retailers, consumers (private consumers and those businesses using plastic components), and the waste and recycling industries.
Circular business models	Circular transition requires new ways of providing products and services that maintain value for longer and facilitates better end of life treatment. This places businesses at the center of the transition to a circular economy, and draws on new ways of analyzing and using data along the lifecycle, integrating circular thinking into the design of products and services, facilitating long product lifetimes and repairable products, as well as enabling new models of consumption that satisfy service demands. This is a core component of the government strategy for a circular economy.
Green public procurement	Public (and private) procurement is seen as a powerful leaver for pulling industry toward more circular solutions by creating a large, stable market for circular products and services, and leading by example by creating new consumption norms. Despite significant efforts, implementing sustainable criteria in public procurement procedures has been challenging, as such, must of the potential remains untapped.
Data and digitalisation	More and better use of data and digitalization is seen as a core element that supports all of the other enabling areas and thus achieving the potential in each of the areas. The creation and distribution of new data on products, services, processes, raw materials and usage patterns will facilitate and support innovation across the board, by supporting better understanding of the flows of materials and use of services within the economy. It will provide a more robust basis for identifying, developing and promoting more circular solutions, and enable a clear understanding of the environmental, social and economic effects from activities within the economy.
Minimising loss along value chains	Coordination along the value chain is critical for minimising losses and waste and reducing the environmental impact of products and ensuring that the final product or service is transparent. There remains significant potential in utilising by-products from one manufacturing process as input to another manufacture process. Cooperation along and agility of value chains are also essential for the development of circular business models and circular products.

Table D. Key figures of the areas[27]

	Turnover[28] (million EUR)	Employment[29]	CO_2 emissions[30] (million	Waste amount[32] (million tonnes) (waste treatments in the footnote)	Categories in the statistical classification (TOL 2008)

[27] Data from year 2018
[28] Danmarks Statistik (2021). Generel firmastatistik efter tid, branche (DB07 127-grp) og enhed. https://www.statistikbanken.dk/statbank5a/default.asp?w=1280, accessed 02.02.2021
[29] Danmarks Statistik(2021). Generel firmastatistik efter tid, branche (DB07 127-grp) og enhed . https://www.statistikbanken.dk/statbank5a/default.asp?w=1280, accessed 02.02.2021
[30] Danmarks Statistik (2021). DRIVHUS - Drivhusgasregnskab (i CO2-ækvivalenter) efter tid, branche og emissionstype https://www.statistikbanken.dk/DRIVHUS accessed 02.02.2021
[32] Danmarks Statistik (2021). AFFALD02: Generation efter branche og behandling. https://www.statbank.dk/statbank5a/SelectVarVal/Define.asp?Maintable=AFFALD02&PLanguage=0 accessed 03.02.2021

			tonnes CO_2e[31])		
Buildings and construction	37 161 60 757	143 029 224 889	1.642 10.303	5.084 071[33]	41000, 42000, 43001-2 9. +23002, 35002-3, 36000, 68001-3, 81000
food and beverage sectors	66 930 79 855	166 259 198 295	2.191 14.444	1.126 553 1.456 117	10001-5, 11000, 46003, 47001-2, 56000 +01000
Industry	79 334	209 406	1.381	0.630 665	20-33, (-23002), 45002
Bioeconomy: biomass	23 987	48 168	14.222	0.582 069	01000, 02000, 03000, 16000, 37000, 46002
Plastic[34]	3 097	11 384	0.053	0.039170	22000
Textiles[35]	972	2 940	0.016	0.006944	13150
Total economy	568 087	2 283 406	**[N/A]**	**[N/A]**	

Descriptions of the areas

Bioeconomy: Biomass

Description of the area	The Danish bioeconomy is closely connected to the food sector and built on biomass resources primarily from agriculture, forestry and the fisheries. In 2018, 28% of the Danish DMC was made up by biomass. Residual products such as agricultural by-products, waste from food processing, wood chips etc. hold great potential as resources in the circular economy. Denmark also has a significant bio-cluster around high-value bio products – that feeds into the medicine and brewing industries in particular. In addition, bioenergy makes up 2/3 of the renewable energy usage on Denmark[36]. The Danish Advisory Board for circular economy calls for a more prominent place for higher value utilisation of Danish biomass through, for example, researching and developing the burgeoning biorefinery industry. [37].
Existing activities and initiatives	The Danish Advisory Board for circular economy has made four recommendations related to biomass in their recommendations for the government. 1) Promote the framework conditions for biorefinery. 2) Establish new supply chains for crops that use photosynthesis better 3) Optimise the use of animal products 4) Reduce food waste. As a part of the Circular Economy Action Plan, the government wishes to establish incentives for increased use of sewage sludge as fertilizer.

[31] Including CO_2-fos, CH_4, N_2O, HFC, PFC, SF_6.
[33] (excluding soil) recycled: 4 521 560 (89%), incinerated: 297 208 (6%), Landfilled: 265 304 (5%)
[34] part of 'Industry'
[35] part of 'Industry'
[36] Danish Energy Agency, (2020). Fakta om bioenergi i Danmark, https://ens.dk/ansvarsomraader/bioenergi/bioenergi-i-danmarkx
[37] Advisory Board for cirkulær økonomi, (2017). Anbefalinger til regeringen. https://www.regeringen.dk/cirkulaer-oekonomi/#:~:text=Advisory%20Boardet%20blev%20nedsat%20i,gevinster%20for%20milj%C3%B8%20og%20klima.

	The National Bioeconomy Panel supports the government in the field of bioeconomy. There primary focus and recommendations fall within promoting bio-refining, utilisation of bi-based wastes and the development of the appropriate framework conditions to support bio-refining and utilisation. In addition, it calls for focus on Nordic cooperation to exploit synergies and exchange competencies.
Potential opportunities and benefits	Increased recirculation of nutrients can harvest value from existing biomass sources and decrease pressure on mineral nutrient sources. Diverging biomass streams from bioenergy production, for example by using currently unused protein biomass as fodder for animal production, is another opportunity that sustains biomass value. Increasing biomass production by using more efficient crops and production methods. Focusing on high yield crops and production systems can increase biomass production in Denmark by 50%[38].
Enablers and challenges	An incentive structure to promote biorefinery uses is one of the enablers, together with development and expansion of biorefinery technology. Challenges include policy structures, hereunder classifications of residual products, and usage of residual products for agricultural purposes[39]. This means that the existing policy landscape surrounding the handling and treatment of biomass needs a comprehensive review to ensure that it supports rather than hinders the development of promising bio-based solutions. The technology for many of the most innovative and interesting solutions are in their infancy. There can also be significant challenges to further exploitation of biomass – particularly in relation to using agricultural land to create products rather than nutrition.
Preliminary assessment of the circular transition potential	Biorefinery methods, development of bioproduction methods and nutrient recycling from biowaste to agricultural land are opportunities for the circular transition in the biomass sector. The potential is high, and technological development and political will point towards an ongoing transition in this sector.

Food and beverage sector

Description of the area	The food and beverage sectors are especially relevant in connection to land use and climate impacts. They play an important role in the Danish economy as they export large amounts of products to the international market. Consumers were responsible for 36% of the food waste in 2018, in relation to the food loss throughout the whole production chain.
Existing activities and initiatives	Reports have been made on how to motivate reduction of food waste among Danish consumers, and what measures that have proven to be most economically and environmentally efficient. Moreover, the Danish Environmental Protection Agency have supplied funding to a number of activities focused on reducing food loss, as well as funded food consultants for commercial kitchens to prevent food waste in that sector[40].

[38] Advisory Board for cirkulær økonomi, (2017). Anbefalinger til regeringen. https://www.regeringen.dk/cirkulaer-oekonomi/#:~:text=Advisory%20Boardet%20blev%20nedsat%20i,gevinster%20for%20milj%C3%B8%20og%20klima.
[39] COWI, (2015). Analyse af det regulerings- og støttemæssige landskap for biomasseanvendelse. https://mst.dk/media/91725/cowi_2015_analyse-af-det-regulerings-og-stoettemaessige-landskab-for-biomasseanvendelse.pdf

[40] The Danish Environmental Protection Agency (2020). Mindre madspild, https://mst.dk/affald-jord/affald/affaldsforebyggelse-strategi-aktiviteter/mindre-madspild/

Potential opportunities and benefits	Increased application of biorefinery methods is a big opportunity for the Danish bioeconomy. Biomass can be refined into high value products such as protein, lipids, sugar and methane[41]. Change of production methods is another important part of the circular transition. Winter crops, nutrient recycling (through for example compost or sewage sludge) and machines running on renewable energy reduces the greenhouse gas emissions and the pressure on natural nutrient cycles while utilising energy in the most optimal way. Reduction of food waste and loss is another opportunity for economic and environmental savings. This can be achieved for example through food sharing activities and changes in consumption patterns.
Enablers and challenges	Developments in technology and accessibility, increased demand for biomass and education on food waste and preservation all serve as enablers. The main challenges for biorefinery developments are accessible technology and a complex regulatory landscape. Challenges regarding reduction of food loss and waste relate to consumer behaviour, specifically habits to make small and frequent purchases, and preferences regarding the appearance of products. The produce and retail sector also carry responsibility with regards to for example misleading "best before" dates and wanting to maximise sales turnover.
Preliminary assessment of the circular transition potential	Food and beverage sectors have a high transition potential. Many opportunities lie in development of technology and adoption of sustainable production methods, and 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 can lie in policy and regulations, common practices, culture and behaviour.

Industry	
Description of the area	The Danish industry, seen in a wide context, is highly relevant for the circular transition in Denmark. Danish companies produce a wide range of consumer goods, but are also key players in the production of intermediary goods that feed into Nordic, European and global supply chains.
Existing activities and initiatives	Denmark is a pioneer of Industrial Symbiosis, with the Kalundborg Industrial symbiosis area conserving significant water, energy and materials by sharing and fully exploiting process by-products and waste heat and water. The Danish Authorities run substantial funding programmes for improving efficiencies and developing environmental technologies (MUDP – the miljøteknologis udviklings- og Demonstrationsprogram; the GUDP - grønt udviklings- og Demonstrationsprogram; the EUDP - energiteknologis udviklings- og Demonstrationsprogram; the Innovation fund, the Danish Green Investment Fund and; the Market Maturity fund). Danish Industry, the industry body representing the broad range of Danish industries, support and provides a platform for innovation and cooperation.
Potential opportunities and benefits	More than half of the production expenses in Danish industry are made up by material costs[42], but it has been estimated that the industry can decrease material costs by 21 billion dkk per year by broad adoption of already existing technologies[43]. Making better and more efficient use of input materials, ensuring that process energy and water are conserved and

[41] Advisory Board for cirkulær økonomi, (2017). Anbefalinger til regeringen. https://www.regeringen.dk/cirkulaer-oekonomi/#:~:text=Advisory%20Boardet%20blev%20nedsat%20i,gevinster%20for%20milj%C3%B8%20og%20klima.
[42] The Danish Government (2018) Strategi for cirkulær økonomi, https://www.regeringen.dk/media/5626/strategi-for-cirkulaer-oekonomi_web.pdf
[43] Advisory Board for cirkulær økonomi, (2017). Anbefalinger til regeringen. https://www.regeringen.dk/cirkulaer-oekonomi/#:~:text=Advisory%20Boardet%20blev%20nedsat%20i,gevinster%20for%20milj%C3%B8%20og%20klima.

	utilised, rather than allowed to dissipate, and minimising waste throughout the production value chain through increasingly efficient design and optimised processes. Opportunities include shifting from a product based to a more service-based industry. Focusing on circularity is an advantage on the market today, as it can reduce production costs, and at the same time give access to new customers or markets. While transition is underway in many of Denmark's largest companies, SMEs have so far found it more challenging to adapt practices, processes and products to the circular economy and these remain a key area of focus in the coming years.
Enablers and challenges	A circular transition in the industry is enabled by circular business models, circular business communities, incentives through public procurement, product innovation, sustainability standards and label, increased traceability of materials and chemicals. Many companies still lack knowledge and competencies on the circular agenda. This is true especially for SMEs.[44]. They also have additional challenges concerning working capital and costs.
Preliminary assessment of the circular transition potential	There is huge untapped potential in Danish Industry – particularly as so much of the required technology is already developed and waiting to be implemented. SMEs in particular need special support to overcome the obstacles and challenges they face. Ensuring that SMEs and enterprises have access to the knowledge and capital to invest in a circular transition is a vital component of the transition to the circular economy in Denmark.

Real estate and construction

Description of the area	Real estate and construction have a large footprint in terms of resource consumption and greenhouse gas emissions. This goes for the sourcing of building materials, construction, maintenance, and operation. In Denmark, the construction industry is responsible for 40% of the total waste generation which corresponds to around 5 mio. tons.[45]
Existing activities and initiatives	Approximately 36% of construction waste is already recycled[7] (and a further 52% downcycled). The share of construction that is sustainability certified (through BREEAM, DGNB, LEED, The Nordic Swan) has been increasing in the past few years, for example, there was an 8% increase between the years 2017 and 2018[7]. Several initiatives are mentioned in the Danish Strategy for Circular Economy[46]. First, the Danish government has established a voluntary sustainability score to promote recycling of materials and resource efficiency[47]. Second, they wish to increase the use of selective demolition methods, where material value is conserved which makes it more suitable for reuse. They also wish to establish a tracking system for construction waste in relation to this, and develop standards for building passports and demolition.
Potential opportunities and benefits	Higher rate of reuse and recycling increases value retention in the loop and decreases greenhouse gas emissions. Circular design methods, such as design for disassembly enables material reuse at the end-of-life state for buildings. New building techniques, for example 3D printing and module construction can produce more efficiently. Material substitution and reducing waste can reduce the climate and material footprint.

[44] The Danish Government (2018). Strategi for cirkulær økonomi, https://www.regeringen.dk/media/5626/strategi-for-cirkulaer-oekonomi_web.pdf

[45] Miljøstyrelsen (2020). Handlingsplan for cirkulær økonomi, https://mim.dk/media/217317/pdf_af_faktaark.pdf

[46] The Danish Government (2018). Strategi for cirkulær økonomi, https://www.regeringen.dk/media/5626/strategi-for-cirkulaer-oekonomi_web.pdf

[47] Danish Transport, Construction and Housing Authority (2020). Den frivillige bæredygtighedsklasse, https://baeredygtighedsklasse.dk/1-Formaalet-med-klassen/Formaalet-med-baeredygtighedsklassen#de-baerende-principper

Enablers and challenges	Use of digital tools such as BIM and digital material passports in the construction sector enables efficient handling of information and tracking of material and energy flows. Education within the industry is another enabler. Public procurement creates incentives for higher level of circularity in construction methods. Challenges may be unwillingness to change construction methods, policy barriers, communication and collaboration between different parts of the supply chain, safety concerns about reused and recycled materials, risk of socio-economic loss.
Preliminary assessment of the circular transition potential	There is high potential for circular transition in the Danish real estate and construction sector. Despite already high recycling rates, there is space for improvement in increasing high-quality recycling. A number of activities and initiatives already exist, and there is high interest for adoption of circular methods in the industry. Work in progress with currently development of standards and building methods will further accelerate the transition in the coming years.

Textiles

Description of the area	In 2016, there was a Danish textile consumption of around 85 000 tonnes. Approximately 90% of the total consumption is made up by household consumption. The national consumption numbers have been stable at this magnitude for the past decade. 36 000 tonnes used textiles were collected from households in 2016, and 60% of these textiles were exported for reuse (70%) and recycling (19%). The rest of the textiles are incinerated or end up in land use, and this accounts for a loss estimated to be 12-15 million euro[48].
Existing activities and initiatives	Textile waste will be a part of the new, more streamlined, municipal waste collection method from households, starting in 2022, this is with the aim to increase collection of used textiles close to the household[49]. Another initiative is through public procurement, where the government will establish a partnership with public institutions to investigate requirements and models for green textile use[50].
Potential opportunities and benefits	Increasing waste sorting can diverge textiles from the mixed waste stream which has many benefits. Opportunities through which this can be achieved include separation directly from the households or through sorting in the waste processing. Concrete examples that can be mentioned are door-to-door collection in households and municipal separation from bulky waste.
Enablers and challenges	A challenge in textiles from industry and other sectors that are not household related, is that there is a low demand for reuse of discarded textile products. Products such as uniforms and linen, that are used at a higher degree in the industry than in households, do not have a high value at the second-hand market, and there may also be policy barriers towards reusing them[51]. Economic support for collection of low-quality textiles for textile recycling can be an enabler to divert textiles from incineration, as this textile fraction is particularly likely to end up in mixed waste. Another enabler, relating specifically to industrial textile waste, is public procurement contracts with clauses that bind the contractor to sort the textiles for reuse and/or recycling at the end-of-life stage. Increased opportunities for direct reuse, for example within the municipalities, can be another enabler. Textile-tt-textile recycling is pointed out as one of the big opportunities for a more circular textile sector in the future, and technological devel-

[48] The Danish Environmental Proteciton Agency (2018). Mapping of textile flows in Denmark. https://www2.mst.dk/Udgiv/publications/2018/08/978-87-93710-48-1.pdf
[49] The Danish Goverment (2020). Klimaplan for en grøn affaldssektor og cirkulær økonomi.
[50] Danish Ministry of Finance (2020). Grønne indkøb for en grøn fremtid.
[51] The Danish Environmental Proteciton Agency (2018). Mapping of textile flows in Denmark. https://www2.mst.dk/Udgiv/publications/2018/08/978-87-93710-48-1.pdf

	opments that allow higher quality textile recycling at a lower price is an opportunity that sustains the value in the material. However, this requires more holistic transformations in the textile industry, and it may be a longer process[52].
Preliminary assessment of the circular transition potential	The textile industry in Denmark is relatively small compared to other industry sectors; although there is a significant textile design industry, very little textile production takes place in Denmark. However, the Danish consumption of textiles per capita is among the highest in the world, and subsequently is one of the largest generators of textile waste per capita. Reducing the generation of textile waste and making better use of the waste generated are the two areas where circular potential is highest. These demand broad and complex efforts to influence both designers, importers and not least consumers, while simultaneously spurring technology that can maintain value in used textiles for longer.

Plastic

Description of the area	Plastic is a useful material for many purposes, but it is also one of the materials with the largest environmental footprint. The largest source of CO_2 emissions from waste incineration in Denmark comes from plastic waste, and it emits about 1,3 million tons CO_2 per year. In 2018, 25% of plastic waste was collected for recycling, and it is estimated that 7,5% was actually recycled.
Existing activities and initiatives	The government published a plastic action plan in 2018 where they state the vision for circular plastic consumption[53]. Plastic is also one of the focus points in the government's action plan for circular economy from 2020, in which the government has set up a goal to diverge 80% of plastic waste from waste incineration by 2030[54]. Five indicators have been developed to monitor the development of consumption and recycling of plastic towards national and EU goals. The Danish government party and opposing parties made an agreement in 2020 on a "Climate Plan for a Green waste sector and Circular economy". The plan includes standardised household waste sorting and a number of other initiatives for increased plastic recycling and reduced incineration. The government has set aside a budget for chemicals in plastics and in PVC specifically as a part of the political agreement on a common effort on chemicals in 2018-2021[55].
Potential opportunities and benefits	Increased reuse and recycling of plastic will reduce emissions of greenhouse gases, which is required to reach the Paris agreement's targets. There will be strong competition in the reuse and recycling sector in the coming years, and green, innovative waste handling methods are sought after. Having developed these will be an advantage on the market. Increasing reuse of plastic and more and better recycling is key, which will demand cooperation throughout the supply chain and designing plastic solutions with this in mind.
Enablers and challenges	In general, the waste framework conditions need to be updated to support reuse and recycling as opposed to incineration. Enablers include more systematic waste collection, higher and supply as well as demand for recycled plastic and technology that supplies cleaner plastic materials at the end of the recycling process.

[52] The Danish Environmental Proteciton Agency (2018). Mapping of textile flows in Denmark. https://www2.mst.dk/Udgiv/publications/2018/08/978-87-93710-48-1.pdf

[53] The Danish Government, (2018). Plastik uden spild – regeringens plastikhandlingsplan. https://www.regeringen.dk/media/6017/regeringens_plastikhandlingsplan_web_final.pdf

[54] The Danish Government, (2020). Handlingsplan for cirkulær økonomi - National plan for forebyggelse og håndtering af affald 2020-2032.

[55] The Danish Government, (2018). Strategi for cirkulær økonomi, https://www.regeringen.dk/media/5626/strategi-for-cirkulaer-oekonomi_web.pdf

	A current challenge is the lack of knowledge on plastic products that are used in Denmark, and enabler would therefore studies that collect knowledge on what plastic types that are used for what purpose in Denmark.
Preliminary assessment of the circular transition potential	Plastic plays an important role in enabling much of what we consider the modern world, but plastic products (including packaging) are seldom designed with end-of-use in mind. Ensuring that plastic products maintain value (either as a material or a product) after the first use is a key goal and a huge potential. Developments in technology and logistics will be necessary, as will design for end of life, which is currently lacking. A combination of regulation and cooperation will be required harvest the potentials in ensuring that plastic becomes an integral part of the circular economy rather than a useful material with a high environmental burden.

Circular businesses

Description of the area	Resource efficiency is generally high in the Danish industry, and many of the larger companies have already caught on to the potential in circular business models. Circular businesses can take many different forms, and there is no one-size-fits-all solution. A key trait of a circular business is that it seeks to understand and take responsibility for the environmental impacts that they have both up and down stream – the processes that feed the business and the direct and indirect impacts of their products, particularly including how they are managed once the original customer no longer needs them.
Existing activities and initiatives	Circular business models are highlighted in the Strategy for circular economy though three initiatives 1) Promote business development in SMEs 2) Establish one entry to the public sector for circular businesses 3) Increase the opportunity for funding for circular business models. A Danish committee is currently part of the development of an international circular economy business model standard. The standard is intended to support businesses in implementing circular economy in their strategies and business models[56].
Potential opportunities and benefits	Many types of business models can be applied that would support the circular transition. Examples include leasing or sharing models, buying utility, take-back systems, focusing on looping materials, connecting the supply chain and offering repairs and updates. Using these models can increase the utility rate of materials and decrease the time that products or buildings are left unused. This allows a higher resource efficiency. Circular business models can give access to new markets, and they will be competitive on the global market in sectors such as waste, construction, and bioeconomy the future.
Enablers and challenges	Access to education and consultation is a vital component, especially for SMEs. Most SME owners have excellent knowledge of their own processes and customer needs, but lack the capacity to engage fully along their supply chain and assess the potential impacts of changes to current practices. Promotion of circular business models in SMEs also be supported through direct funding and consultancy, as many small companies lack sufficient capital and knowledge to act, even if they have the desire.

[56] Dansk Standard (2020)- Cirkulær økonomi (S-863). https://www.ds.dk/da/udvalg/kategorier/samfund/cirkulaer-oekonomi

	On the flip side, there can be resistance in the form of reluctance to "changing a winning concept" among business owners. There can also be regulatory barriers to circular businesses, particularly where take-back is concerned, but also with regards to handing secondary materials or by-products as process inputs.
Preliminary assessment of the circular transition potential	Widespread transition of business practices to help maintain value in products and materials, minimise waste and support sustainable sourcing, has massive potential for Danish businesses – not only in terms of reduced environmental costs, but also in reduced financial costs and better returns. Step-by-step improvements can go a long way to shifting businesses in the right direction and open up new opportunities for collaboration and efficiency gains.

Digitalisation

Description of the area	Capitalising on the wealth of data that is already generated, and facilitating the generation of new and valuable data that provide insight into the materials, processes and products that shape our environment can help drive circular transition. In particular, it can help trace products through a value chain – ensuring transparency of input materials and production practices; enable better waste prevention and management – by helping to track and better understand product lifecycles; enable smarter business decisions, making the economic advantages of sustainable solutions even starker; better analytics, better data, more data, sensor-fed decision making. Digitisation is inevitable and should be capitalised on to ensure that it works for the transition to a circular economy. Internet of Things, Big Data and sensor technology are examples of digital tools that are relevant for businesses, the public sector and private citizens.
Existing activities and initiatives	In the Strategy for Circular Economy it is stated that the Danish Government wishes to support the digital circular opportunities through commercial use of data and challenges. They will analyse what type of data that is most relevant for circular business models and examine whether this data can be made available to businesses[57]. The Danish Government published a Strategy for Denmark's digital growth in 2018[58]. Another initiative, mentioned in the Action Plan for Circular Economy, is the development of a digital reporting system for sharing economy[59].
Potential opportunities and benefits	In addition to existing data flows and digital solutions, access to performance data and environmental data is further enabled through collection methods such as Internet of Things and remote sensing. Making intelligent use of this data requires use of big data analytics and other data processing techniques. Combined, this allows all stakeholders to make more informed decisions that can decrease the environmental footprint of our activities and support circular economy transition. Digital passports, robots and 3D printing can contribute to increased reuse and recycling and reduced waste. These technologies are highly relevant in the construction sector and they can have an impact in other sectors as well.

[57] The Danish Government (2018). Strategi for cirkulær økonomi, https://www.regeringen.dk/media/5626/strategi-for-cirkulaer-oekonomi_web.pdf

[58] Ministry of Industry, Business and Financial Affairs (2018). Strategy for Denmark's Digital Growth https://eng.em.dk/media/10566/digital-growth-strategy-report_uk_web-2.pdf

[59] The Danish Government (2020). Handlingsplan for cirkulær økonomi - National plan for forebyggelse og håndtering af affald 2020-2032.

Enablers and challenges	Digitisation is itself a key enabler of circular decisions, by providing transparent, timely information to those who need it. Technology is developing quickly, with the Internet of Things and big data analytics being implemented However, there are a variety of barriers to broader digitalisation, and to the utilisation of the data generated. Data pertaining to products and materials while in the production value chain can be business sensitive, while data on product usage and disposal can infringe the privacy rights of consumers.
Preliminary assessment of the circular transition potential	Broad and deep digitisation is a vital component of making the right decisions toward a circular economy. Danish companies can benefit by developing a better understanding their sourcing, processes and products, consumers get a better insight into what products and services are sustainable, how to get the most benefit from their disposable income, and how to optimise their consumption, and the waste management sector can gain better control of the materials they collect, enabling higher quality reuse and recycling.

Green procurement and Life Cycle costing

Description of the area	Procurement in the Danish municipalities, regions and state is made up by around 185 billion kronors each year, and in 2019 it resulted in twelve million tons of CO_2 emissions[60]. Green and total economic procurement is high on the agenda in Denmark as a tool to reduce greenhouse gas emissions and promote the transition towards circular economy.
Existing activities and initiatives	The government published a strategy for Green Public Procurement in 2020, which outlines the way forward for procurement in the public sector and presents a number of concrete initiatives[61]. Procurement is also a part of the Strategy for Circular Economy, in which it is stated that the government wishes to promote circular procurement and increase the focus on total economy in public procurement. One example of how circular procurement is promoted is through the Forum for Sustainable Procurement, and the Partnership for Green Public Procurement, through which tools and consultancy is provided for public and private companies[62].
Potential opportunities and benefits	Green procurement supports the circular market and provides incentives for development of circular business models and products. Purchasing green products can increase durability and lifetime, which can reduce procurement costs and environmental impact. Focusing on total economy in the procurement process moves the focus from the procurement cost to the total cost for procurement, maintenance, operation, and end-of-life treatment. Using this method provides a perspective that can take the long-term costs into account, and account for the environmental impact of the procurement over time.
Enablers and challenges	Enablers relate to building knowledge for purchasers on the economic and environmental opportunities that lie in circular procurement, as well as concrete knowledge on requirements and tenders that promote circularity.

[60] The Danish Government (2020). Grønne indkøb for en grøn fremtid, https://fm.dk/media/18268/groenne-indkoeb-for-en-groen-fremtid-strategi-for-groenne-offentlige-indkoeb_web.pdf
[61] The Danish Government (2020). Grønne indkøb for en grøn fremtid, https://fm.dk/media/18268/groenne-indkoeb-for-en-groen-fremtid-strategi-for-groenne-offentlige-indkoeb_web.pdf
[62] Forum for bæredygtige indkøb (2020). POGI, https://ansvarligeindkob.dk/

	There are challenges related to data availability for procurement, as data has to be readily available and reliable when comparing procurement options. Challenges may also include lacking communication between buyer and seller before the deal. In addition, defining circularity as a competitive criteria in relation to price is also a challenge that will need long-term work and commitment. Finally, experience indicates that implementing any form of sustainable procurement is challenging, and there is significant practical momentum behind existing practices and holding short-term costs as the deciding factor in procurement decisions.
Preliminary assessment of the circular transition potential	Green procurement is high on the agenda in Denmark, and it seen as one of the main tools for the public sector to push for a circular transition. The public sector can be one of the primary drivers for the transition to a circular economy by using its purchasing power to support circular solutions – products, service, and product service systems – and create a market that benefits from economies of scale.

Reducing losses in value chain

Description of the area	Coordination along the value chain is critical for minimising losses and waste and reducing the environmental impact of products and ensuring that the final product or service is transparent. There remains significant potential in utilising by-products from one manufacturing process as input to another manufacture process. Cooperation along and agility of value chains are also essential for the development of circular business models and circular products.
Existing activities and initiatives	There are increasing efforts of tracking resource flows in the value chain, for example in the construction, textile and plastic sector, to examine whether by-products can flow as materials into production streams[63]. Also, several examples of industrial symbiosis already exist in Denmark. Kalundborg symbiosis is the world's first industrial symbiosis, and it is based on the exchange of water, waste and materials[64]. Another industrial symbiosis park is located in Frederikssund[65]. Companies can receive financial support for products and methods that support resource efficiency. One way is by applying for funding from the Danish Business Authorities through the Green Conversion fund or through the Green Industrial Symbiosis fund[66].
Potential opportunities and benefits	A case study on Danish SMEs showed that companies were able to save money on waste disposal and material purchases while increasing resource efficiency. The savings potential from industrial symbiosis has been valued to 410 million Danish kroner in the capital region of Copenhagen. There are also environmental benefits regarding use of harmful chemicals, material use, water consumption and climate impact. It has been estimated that the Kalundborg symbiosis has saved annual emissions of 635 000 tonnes CO_2[67].

[63] Regionernes videnscenter (2020). Kortlægning af ressourcestrømme for sten, grus og sand – råstoffer og genanvendeligt byggeaffald https://www.miljoeogressourcer.dk/filer/avjinfo/176/8095_Milj___og_ressourcer_4_2020_2_WEB.pdf
[64] Kalundborg Symbiosis (2021). Kalundborg Symbiosis http://www.symbiosis.dk/en/#
[65] Gate 21 (2021). Industriel symbiose https://www.gate21.dk/en-groen-forretningsplan/industriel-symbiose/
[66] The Danish Environmental Protection Agency (2015). Stærkere uden spild https://mst.dk/media/90180/casesamling-staerkere-uden-spild.pdf
[67] Concito (2018). Grøn vækst og symbioser. https://concito.dk/sites/concito.dk/files/media/document/Gr%C3%B8n%20v%C3%A6kst%20og%20symbioser_0.pdf

Enablers and challenges	Mitigating losses in the value chain can be enabled through increased mapping and monitoring of material streams. An opportunity in this context is material tracking technologies that are currently under development, that can provide information on the material as they move through the value chain[68]. There are currently challenges regarding information transition along the value chain, which can also be linked with different incentives for stakeholders along the chain. Systemic solutions and partnerships across industries could target these problems and enable improved communication. There is also a need for support and incentives from public institutions. Public institutions can have the overview of the physical and social business climate in a region, and may therefore often can play a key role in establishing cooperation between stakeholders.
Preliminary assessment of the circular transition potential	Supply chain losses represent a great potential that can in many cases be harvested though increasing efficiency and better coordination. These are especially relevant for value chains that are mostly within Denmark: the construction and food industries are prime examples, but the same principle applies for all industries operating within the country.

Country-specific sum-up

Table F. Preliminary assessment of the circular transition potential

Area	Preliminary assessment of the circular transition potential
Bioeconomy: Biomass	Biorefinery methods, development of bioproduction methods and nutrient recycling from biowaste to agricultural land are opportunities for the circular transition in the biomass sector. The potential is high, and technological development and political will point towards an ongoing transition in this sector.
Food and Beverage	Food and beverage sectors have a high transition potential. Many opportunities lie in development of technology and adoption of sustainable production methods, and 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 can lie in policy and regulations, common practices, culture and behaviour.
Industry	There is huge untapped potential in Danish Industry – particularly as so much of the required technology is already developed and waiting to be implemented. SMEs in particular need special support to overcome the obstacles and challenges they face. Ensuring that SMEs and enterprises have access to the knowledge and capital to invest in a circular transition is a vital component of the transition to the circular economy in Denmark.
Real estate and construction	There is high potential for circular transition in the Danish real estate and construction sector. Despite already high recycling rates, there is space for improvement in increasing high-quality recycling. A number of activities and initiatives already exist, and there is high interest for adoption of circular methods in the industry. Work in progress with currently development of standards and building methods will further accelerate the transition in the coming years.

[68] Ellen Macarthur Foundation (2015). Potential for Denmark as a circular economy. A case study from: delivering the circular economy – a toolkit for policy makers. https://www.ellenmacarthurfoundation.org/assets/downloads/20151113_DenmarkCaseStudy_FINALv02.pdf

Textiles	The textile industry in Denmark is relatively modest compared to other industry sectors; although there is a significant textile design industry, very little textile production takes place in Denmark. However, the danish consumption of textiles per capita is among the highest in the world, and subsequently is one of the largest generators of textile waste per capita. Reducing the generation of textile waste and making better use of the waste generated are the two areas where circular potential is highest. These demand broad and complex efforts to influence both designers, importers and not least consumers, while simultaneously spurring technology that can maintain value in used textiles for longer.
Plastic	Plastic plays an important role in enabling much of what we consider the modern world, but plastic products (including packaging) are seldom designed with end-of-use in mind. Ensuring that plastic products maintain value (either as a material or a product) after the first use is a key goal and a huge potential. Developments in technology and logistics will be necessary, as will design for end of life, which is currently lacking. A combination of regulation and cooperation will be required harvest the potentials in ensuring that plastic becomes an integral part of the circular economy rather than a useful material with a high environmental burden.
Circular businesses	Widespread transition of business practices to help maintain value in products and materials, minimise waste and support sustainable sourcing, has massive potential for danish businesses – not only in terms of reduced environmental costs, but also in reduced financial costs and better returns. Step-by-step improvements can go a long way to shifting businesses in the right direction and open up new opportunities for collaboration and efficiency gains.
Data and digitalisation	Broad and deep digitisation is a vital component of making the right decisions toward a circular economy. Danish companies can benefit by developing a better understanding their sourcing, processes and products, consumers get a better insight into what products and services are sustainable, how to get the most benefit from their disposable income, and how to optimise thier consumption, and the waste management sector can gain better control of the materials they collect, enabling higher quality reuse and recycling.
GPP	Green procurement is high on the agenda in Denmark, and it seen as one of the main tools for the public sector to push for a circular transition. The public sector can be one of the primary drivers for the transition to a circular economy by using its purchasing power to support circular solutions – products, service, and product service systems – and create a market that benefits from economies of scale.
Minimising value chain losses	Supply chain losses represent a great potential that can in many cases be harvested though increasing efficiency and better coordination. These are especially relevant for value chains that are mostly within Denmark: the construction and food industries are prime examples, but the same principle applies for all industries operating within the country.

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Finland

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas[69]

Source	Status of the source	Short content
Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	National strategic programme (approved by Finnish Government in January 2021)	A national strategic programme coordinated by the Ministry of Environment and Ministry of Economic Affairs and Employment. Includes focus on following themes: Real estate and construction, Energy and material intensive industry, Municipalities and regions, Emerging service business models and technologies, Digitalisation, and Circular consumption.
Sitra (2016). Leading the cycle, Finnish road map to a circular economy 2016-2025. https://www.sitra.fi/hankkeet/kierrolla-karkeen-suomen-tiekartta-kiertotalouteen-2016-2025/	National road map	A national roadmap facilitated by Sitra, the Finnish Innovation Fund. Identified four focus areas: sustainable food system, forest-based loops, technical loops, and transport and logistics. They all have mutual synergies, and as a joint theme also digital and service centred circular economy was pointed out.
Business Finland (2020). Bio and Circular Finland Program 2019-2022. https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland	National innovation programme	A EUR 300 million innovation programme (share of innovation funding EUR 150 million) by Business Finland to develop competitive Finnish bio and circular based solutions and ecosystems for global success.

Table B. Preliminary identification of areas

Area	Source	Why seen important in the national context?
INDUSTRIES / SECTORS		
Sustainable food system	Sitra (2016). Leading the cycle. Finnish road map to a circular economy 2016-	A sustainable food system was identified as an area in which Finland possesses strong expertise and wants to be involved in developing an even

[69] In addition to these national programmes and roadmaps, there are several other (sectoral) programmes and roadmaps linked to circular economy, e.g. Action Plan on Nutrient Recycling/circle 2019-2030, Plastics Roadmap for Finland, National Waste Plan (to be updated in 2021) and National Bioeconomy Strategy (to be updated in 2021). In 2020, 13 low carbon road maps of different sectors were published. Furthermore, Energy and climate strategy, Medium-term Climate Change Policy Plan (KAISU), National Biogas Programme, Climate Food Programme, National Battery Strategy, Roadmap for Fossil-free Transport, Sustainable Taxation Roadmap and the Sustainable Growth Program for the Transport Sector are in preparation or to be executed.

	2025. https://www.sitra.fi/hankkeet/kierrolla-karkeen-suomen-tiekartta-kiertotalouteen-2016-2025/	more sustainable overall system. Circular opportunities identified include organic recycled nutrients, minimizing food waste, and supporting biogas and other renewable energy in agriculture.
Real estate and construction	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654 Business Finland (2020). Bio and Circular Finland Program 2019-2022. https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland	A large share of steel, concrete, wood, and plastics flows through this area. The area consumes about half of the resources and produces about a third of the CO_2 emissions in the world. Keeping the material in usage can reduce the CO_2 emissions significantly. So far focus has been mainly on construction waste, but the potential is in thinking the whole life cycle including new business models like sharing.
Bioeconomy: Forest-based loops	Sitra (2016). Leading the cycle. Finnish road map to a circular economy 2016-2025. https://www.sitra.fi/hankkeet/kierrolla-karkeen-suomen-tiekartta-kiertotalouteen-2016-2025/ Business Finland (2020). Bio and Circular Finland Program 2019-2022. https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland	As one of the key sectors in the Finnish industry, the forest-based industry has already long been developing circular solutions e.g. utilising side streams, to make better use of natural resources. Specific consideration is given to maximizing the value of forest-based products and services, supporting renewability in public procurement, demonstrating bio-based products and services, and supporting wood construction. The Bio and Circular Finland Program points out the need to utilise the knowhow of Finnish wood construction to provide lower CO_2 solutions and enable constructions waste circulation solutions.
Energy and material intensive industry	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	A substantial share of Finnish export industry is energy and material intensive, and solutions have been developed already long in e.g. sustainable materials and energy-efficient clean technology solutions. However, there is still extensive untapped potential in turning linear flows to circular. Circular solutions can reduce both costs and CO_2 emissions in manufacturing. So far, only a part of society and companies recognize the big picture of the circular transition and related opportunities.
Transport and logistics	Sitra (2016). Leading the cycle. Finnish road map to a circular economy 2016-2025. https://www.sitra.fi/hankkeet/kierrolla-karkeen-suomen-tiekartta-kiertotalouteen-2016-2025/	Transporting people, things, raw materials, side streams and all kinds of materials is the requirement for the circular economy. Specific consideration was given on seamless and smart transport by developing service-based transport system and encouraging sustainable biofuels.
MATERIAL FLOWS		
Packages	Business Finland (2020). Bio and Circular Finland Program 2019-2022.	Packages are one of the interesting material flows in terms of reuse, recycling, and waste management as well as new renewable packaging materials. Circular design opens up new opportunities

	https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland	for smart use of materials. As well, there is a strong expertise on new packaging materials in Finland. The Bio and Circular Finland Program has been aiming at gaining solutions to zero (plastic) waste with collecting, recycling, and reusing plastics. Furthermore, changes in Finnish waste legislation and taxation have been proposed.
Textiles	Business Finland (2020). Bio and Circular Finland Program 2019-2022. https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland	Textiles are one of the interesting material flows in terms of reuse, recycling, and waste management as well as new renewable materials. There is a strong expertise in wood-based value chains that provide future opportunities for textile production. The Bio and Circular Finland Program has been aiming at providing solutions to recycle textiles and provide bio-based textile fibres to transform textile industry to be more sustainable.
DRIVERS / ENABLERS		
Municipalities and regions	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	Municipalities and regions have a remarkable role in planning and implementing infrastructure and related services such as energy, water, nutrient recycling, waste and side streams, and mobility. They can support circular economy, for example, through planning, collaboration, piloting, and public procurement.
Circular business models	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	Circular business models relate to new ways of servitisation, sharing, and looping. Servitisation refers to business models where the ownership and responsibility of the whole life cycle of a product or service remains with the producer, such as product/material/performance as a service – models, leasing, and guarantee systems such as long-time warranties, deposit refund systems etc.
Digitalisation	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	Digitalisation and data are identified as important enablers and drivers of circular economy and the related systemic change. Digital infrastructure is seen to be needed to support the transition.
Circular consumption	Government of Finland (2021). New directions. The strategic pro-gramme to promote a circular economy. https://julkaisut.valtioneuvosto.fi/handle/10024/162654	In Finland, half of the value added in the Finnish economy comes from the consumer markets, and a huge part of emissions stem from individual and households' consumption. Therefore, an increased focus on sustainable circular solutions to consumers and by consumers is needed. These may include prolonging the life cycle of products and services by e.g. design and repair, or finding new solutions for e.g. ownership and shared use of products and services.

Short list of areas and key figures

The areas seen to be the most feasible for further assessment and their reasoning are listed in Table C. Tables D and E include the detailed analysis of the areas including characteristics and key figures of the area as well as assessing the preliminary circular transition potential.

Table C. Short list of areas for in-depth assessment

Area	Reasoning
Bioeconomy: Forest-based loops	Forest-based loops have been identified as a strong area for bio-based innovation in Finland, where the circular economy provides still untapped potential. The area is relevant for other Nordic countries, as well. The area links to specific statistical classifications indicating availability of statistical data.
Real estate and construction	Real estate and construction has a remarkable role in the flows of steel, concrete, wood, and plastics nationally and globally, as well as in generating emission, and where huge potential lies in low-carbon circular solutions. The area is relevant for other Nordic countries, as well. The areas links to specific statistical classifications indicating availability of statistical data.
Sustainable food system	A sustainable food system has been identified in Finland as an area in which Finland already possesses strong expertise, and where huge untapped potential lies in developing an even more sustainable overall system. The area is relevant for other Nordic countries, as well. The area links to specific statistical classifications (food and beverage) indicating availability of statistical data.
Transport and logistics	Transporting people, things, raw materials, side streams and all kinds of materials is a requirement for the circular economy, and is emphasized in the national circular development in Finland. The area is relevant for other Nordic countries, as well. It links to specific statistical classifications indicating availability of statistical data.
Textiles	Textiles are one of the interesting material flows in terms of reuse, recycling, and waste management as well as new renewable materials. There is a strong expertise in wood-based value chains that provide future opportunities for textile production. The area is also relevant for other Nordic countries. Availability of statistical data is limited.
Packaging	Packages are one of the interesting material flows in terms of reuse, recycling, and waste management as well as new renewable packaging materials. Circular design opens up new opportunities for smart use of materials. There is also a strong expertise on new packaging materials in Finland. The area is also relevant for other Nordic countries. Availability of statistical data is limited.
Circular business models	Circularity and digitalisation create new business opportunities for i.e. servitisation. Circular economy relies on services, creating new business opportunities while also changing the business logic of old practices. The area is relevant for other Nordic countries, as well. Availability of statistical data is limited.
Digitalisation	Digitalisation and data are important enablers and drivers of circular economy and the related systemic change. Digital infrastructure should be in place support the transition. The area is relevant also for other Nordic countries. Availability of statistical data is limited.
Municipalities and regions	Municipalities and regions have a remarkable role in planning and implementing infrastructure and related services such as energy, water, nutrient recycling, waste and side streams, and mobility. They can support circular economy, for example, through planning, collaboration, piloting, and public procurement.

	The area is relevant also for other Nordic countries. Availability of statistical data Is limited,

Table D. Key figures of the areas[70]

	Turnover[71] (million EUR)	Employment[72]	CO_2 emissions[73] (million tonnes CO_2e[74])	Waste amount[75] (million tons) treatments in the footnote)	Categories in the statistical classification (TOL 2008)
Real estate and construction	50 150	194 000	1.611[76]	15.715[77] (only F)	L Real estate, F Construction
Bio-based solutions / Forest-based loops (forest sectors)	32 908[78]	36 000	3.302	5.110 (only C16-18)	C 16-17 Forest industry, A02 Forest management and harvesting
Sustainable food system (food and beverage sectors)	11 000[79]	70 000[80]	7.933	0.650 (only C10-11)	A01 Crop and animal production, hunting and related services, A03 Fishing and aquaculture, C10-11 Manufacture of food, beverages and tobacco
Transport and logistics	23 112	123 000	10.520	not available	H Transportation and storage
Total economy	**420 258**	**1 496 000**	**60.3**	**128,252**	

[70] Data from year 2018
[71] Statistics Finland (2020). Yritykset https://www.tilastokeskus.fi/tup/suoluk/suoluk_yritykset.html, accessed 11.11.2020
[72] Statistics Finland (2020). Yritykset https://www.tilastokeskus.fi/tup/suoluk/suoluk_yritykset.html, accessed 11.11.2020
[73] Statistics Finland (2020). Suomalaisten kasvihuonekaasupäästöt kasvoivat vuonna 2018 – epäpuhtauspäästöt jatkoivat laskuaan. https://www.stat.fi/til/tilma/2018/tilma_2018_2020-10-01_tie_001_fi.html, accessed 11.11.2020
[74] Including CO_2-fos, CH_4, N_2O, HFC, PFC, SF_6
[75] Statistics Finland (2018) Liitetaulukko 1. Jätteiden synty toimialoittain 2018, 1 000 tonnia. https://www.stat.fi/til/jate/2018/jate_2018_2020-06-17_tau_001_fi.html, accessed 11.11.2020
[76] Low carbon road map for construction industry estimated the real CO_2e emissions to be 17,1 million tonnes. Source of about a third of the climate emissions in Finland. Operational energy consumption in buildings accounts for 75 % of the emissions. Half of the last quarter originates from building materials and the other half mainly from construction site operations and transports. Source: Confederation of Finnish Construction Industries (2020), Low carbon road map for construction industry, https://www.rakennusteollisuus.fi/globalassets/ymparisto-ja-energia/vahahiilisyys_uudet/rt-low-carbon-roadmap-summary-2020-08-20.pdf.
[77] 18 % of all waste generated in Finland, out of which 73 % comes from excavation. Of total waste, including soil materials, over 60 % ends up in landfills or refuse heaps and 35 % is incinerated. Source: Sitra (2015). The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf
[78] Luonnonvarakeskus (2020) Metsäteollisuuden liikevaihto Suomessa. http://statdb.luke.fi/PXWeb/pxweb/fi/LUKE/LUKE__04%20Metsa__08%20Muut__Metsateollisuus/10.10_Metsateollisuuden_liikevaihto_Suomessa.px/?rxid=37351054-dec1-4d3a-9964-7e4fad7f285c, accessed 11.11.2020
[79] Statistics Finland (2021) ritykset toimialoittain (yritysyksikkö), 2017-2019. http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__yri__yrti__yri/statfin_yrti_pxt_11d5.px/, accessed 19.1.2021
[80] Statistics Finland (2021) ritykset toimialoittain (yritysyksikkö), 2017-2019. http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__yri__yrti__yri/statfin_yrti_pxt_11d5.px/, accessed 19.1.2021

Descriptions of the areas

Bioeconomy: forest-based loops

Description of the area	Includes a wide range of industrial and production sectors and activities based on wood or forests, e.g. the processing of forest biomass for forestry, energy, chemical or food industries, and production processes based on wood raw material[81]. Forest sector is one of the industries that use the most materials in Finland, and most of the products are exported [82]. New commercial products, services and co-operation models as well as the development and implementation of digital technologies will create global competitiveness[83].
Existing activities and initiatives	Climate road map for forest industries[84] introduced by Finnish Forest Industries in 2020 supporting Finland's goal of carbon neutrality in 2035. Carbon road map for sawmill industry[85] introduced by Finnish Sawmill Association in 2020 supporting Finland's goal of carbon neutrality in 2035. Ministry of the Environment runs a wood construction programme (2016-2022) which aims to grow and diversify the use of wood and its value added. The programme supports Finland's bioeconomy strategy[86].
Potential opportunities and benefits	The resource scarcity has turned biobased materials into a topic of international interest on a completely new level, and Finland is at the forefront as an innovator[87]. Efficient application of the circular economy approach is crucial to the profitability of companies in the pulp and paper industry, due to their large material flows and energy-intensity[88]. Opportunities in forest-based loops include new materials & products, replacing fossil raw materials, sustainable biobased solutions, and side stream cycles as well as reducing material consumption and increasing recycling by circular design. Circular economy is estimated to have potential added value of around EUR 220-240M for pulp and paper industry in Finland. The best opportunities are in closing the loops of fibres and better utilization of side streams.[89] It also is estimated that enhanced material efficiency in the forest industries would bring EUR 613M in GDP in 2030 in forest management and industry, where new technologies would raise productivity[90].
Enablers and challenges	Enablers: strong forest cluster, competence and education, demand for specialized and eco-friendly products, increased use for forest by-products in other value chain Challenges: regulation development, piloting and demonstration opportunities

[81] Ministry of Agriculture and Forestry (2020). Metsäbiotalous, https://mmm.fi/biotalous/vihrea-biotalous?p_p_id=com_liferay_journal_content_web_portlet_JournalContentPortlet_INSTANCE_BbP8mUNugJIL&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&_com_liferay_journal_content_web_portlet_JournalContentPortlet_INSTANCE_BbP8mUNugJIL_languageId=fi_FI

[82] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instruments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016. https://tietokayttoon.fi/documents/10616/2009122/25_Kiertotalous+Suomessa.pdf/5a942ae7-9ec8-4b54-a079-f99c8ba2f8f1?version=1.0

[83] Circular economy roadmap

[84] Finnish Forest Industries. (2020). Vihreä ja vireä talous – metsäteollisuuden ilmastotiekartta, https://global-uploads.webflow.com/5f44f62ce4d302179b465b3a/5fae9c3de86a240e06b76565_Metsa_Esite_Email.pdf

[85] Finnish Sawmill Association & Natural Resources Institute Finland. 2020. Ilmastoviisas sahateollisuus – sahateollisuuden hiilitiekartta -raportti. https://sahateollisuus.com/wp-content/uploads/2020/06/st_hiilikartta_raportti.pdf

[86] Ministry of Environment. (2020). Puurakentamisen ohjelma. https://ym.fi/puurakentaminen

[87]Sitra, 2016. Leading the cycle: Finnish road map to a circular economy 2016-2025, https://media.sitra.fi/2017/02/28142644/Selvityksia121.pdf

[88] Sitra, (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

[89] Sitra, (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

[90] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instruments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016. https://tietokayttoon.fi/documents/10616/2009122/25_Kiertotalous+Suomessa.pdf/5a942ae7-9ec8-4b54-a079-f99c8ba2f8f1?version=1.0

Preliminary assessment of the circular transition potential	Bio-based solutions, namely forest-based loops, have been identified as a strong area of expertise in the circular economy in Finland. The resource scarcity has turned biobased materials into a topic of international interest, and Finland is at the forefront as an innovator. Opportunities include new materials and products, replacing fossil raw materials, sustainable biobased solutions, and side stream cycles as well as reducing material consumption and increasing recycling by circular design. Circular economy is estimated to have potential added value of around EUR 220-240M for pulp and paper industry in Finland.

Real estate and construction

Description of the area	Includes buying, selling, and renting land, buildings, and housing as well building, alteration, and repair of buildings and constructions. In terms of volume, the construction sector is the largest individual consumer of raw materials in Finland[91]. A large share of steel, concrete, wood, and plastics flows through this area. Generating 16 million tonnes of waste per year, it is also the second largest producer of waste[92].
Existing activities and initiatives	Government programme includes a goal to decrease the carbon footprint of living and construction[93]. Promoting the recycling of materials and circular economy is among the measures. The strategic programme to promote a circular economy will include measures towards the goals of a low carbon real estate and construction sector.[94] Finland has prepared climate and low carbon roadmaps in several sectors, among these: Finland has prepared climate and low carbon roadmaps in several sectors, among these low carbon road map for construction industry[95] introduced by the Confederation of Finnish Construction Industries in 2020 supporting Finland's goal of carbon neutrality in 2035. Green Building Council Finland[96] is a non-profit association that gathers and refines the know-how of sustainable development of the building and construction industry. It has organized circular economy projects with Sitra[97] (over 100 experts in the built environment have participated) to share experiences and develop circular economy expertise and best practices..
Potential opportunities and benefits	So far focus has been mainly on construction waste, but the potential is in the whole life cycle[98]. Opportunities include improving the utilisation rate of real estate by making it easier to alter its use and introduce space sharing (maximising the value of existing building stock)[99]. In addition, exploitation of materials could be

[91] Sitra, (2015). The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf
[92] Sitra, (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf
[93] Programme of Prime Minister Sanna Marin's Government, (2019). https://valtioneuvosto.fi/en/marin/government-programme
[94] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018
[95] Confederation of Finnish Construction Industries, (2020). Low carbon road map for construction industry, https://www.rakennusteollisuus.fi/globalassets/ymparisto-ja-energia/vahahiilisyys_uudet/rt-low-carbon-roadmap-summary-2020-08-20.pdf
[96] Green Building Council Finland, (29.1.2021). Front page, https://figbc.fi/en/
[97] Green Building Council Finland, (29.1.2021). Kiinteistö- ja rakennusalan ammattilaisten kiinnostus kiertotalouteen kasvaahttps://figbc.fi/kiinteisto-ja-rakennusalan-ammattilaisten-kiinnostus-kiertotalouteen-kasvaa/
[98] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018
[99] Sitra, (2015). The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

	made easier still at the end-of-life phase. Smart building solutions powered by digitalisation are also an interesting opportunity to extend the lifetime and reduce consumption[100]. Government, municipalities and companies implementing financial incentives would create competition for circular solutions. Changes in waste legislation could act as an incentive in preventing waste.[101] The opportunities of a circular economy for Finland report by Sitra in 2015[102] identified EUR 255 million annual value (by 2030) of improved utilization of building stock in the construction sector. The low carbon road map for construction industry in 2020 estimated EUR 10-20 Mrd. needed by 2050 to transform the existing building stock to energy-efficient and low in emissions[103]. Although use of recycled materials was identified as a potential measure, its impact was not specifically assessed. There is business growth potential in the solutions and services linked to maximising the value of existing building stock (over 80 % of fixed capital base in Finland consists of building and infrastructure), end-of-life management, lifetime extensions, and smart buildings.
Enablers and challenges	Enablers: Competence development, sharing of best practices, technological development, public procurement, collaboration of public and private actors, planning reform to maximise the value of existing building stock, regulations on building techniques and design that promote the principles of circular economy, digitalisation Challenges: Lack of expertise and experience, risk avoidance of the actors, established supply chains, processes, and practices, strong role of public actors (might also be an enabler), lack of joint vision, slow renewal, the design and building phases should take more account of demolition
Preliminary assessment of the circular transition potential	In terms of volume, the construction sector is the largest individual consumer of raw materials in Finland. A large share of steel, concrete, wood, and plastics flows through this area. Generating 16 million tonnes of waste per year, it is also the second largest producer of waste. Circular economy is an increasingly interesting opportunity including improving the utilisation rate of real estate, exploitation of materials in the end-of-life-phase (including use of recycled materials in construction), and smart building solutions to extend life-time and reduce resource consumption.

Sustainable food system (food and beverages sectors)

Description of the area	Includes primary production, industry, retail, restaurants and households. Food is one of the most significant drivers for the environmental impacts of consuming and preventing food waste has been thoroughly researched in Finland[104]. In Finland, the yearly food waste is estimated to be 400-500M kg, and food loss

[100] See, for example, the ecosystem for smart building data https://www.businessfinland.fi/en/whats-new/news/2020/new-ecosystem-for-smart-building-data/

[101] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[102] Sitra, (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

[103] Confederation of Finnish Construction Industries, (2020). Low carbon road map for construction industry, https://www.rakennusteollisuus.fi/globalassets/ymparisto-ja-energia/vahahiilisyys_uudet/rt-low-carbon-roadmap-summary-2020-08-20.pdf

[104] Berg, A.,Räisänen, M. &Salo, H.(edit.). 2020. Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.

	and waste is estimated to produce approximately 1 000 M CO_2-ekv kg yearly[105]. Circular economy in food systems means preventing waste, better recycling, and sustainable handling of nutrients[106]. The food value chain includes two factors crucial to the circular economy: how well the original raw material is utilised – whether for its primary purpose or as production side streams – and the way in which nutrients are reintroduced into the nutrient cycle[107].
Existing activities and initiatives	Natural Resources Institute Finland run a Food loss tracking and roadmap project (2018-2020) and follow-up project Food and Loss Monitoring 2020[108]. Food loss roadmap, which was created together with the food industry, was published in January 2021[109]. In the action plan for circular economy (2017) it is stated that the amount of food loss is decreased by legislation and material efficiency agreements. The national waste plan proposes action[110]. Finland has prepared climate and low carbon roadmaps in several sectors, among these: Climate road map for agriculture[111] introduced by The Central Union of Agricultural Producers and Forest Owners (MTK) in 2020 supporting Finland's goal of carbon neutrality in 2035. Low carbon road map for food and drink industries[112] introduced by Finnish Food and Drink Industries in 2020 supporting Finland's goal of carbon neutrality in 2035. Low carbon road map for hospitality industry[113] introduced by The Finnish Hospitality Association MaRa and Service Union United PAM in 2020 supporting Finland's goal of carbon neutrality in 2035. In line with the Government Programme, the Ministry of Agriculture and Forestry is preparing a Climate Food Programme[114] aimed to support the transition of society towards a climate-sustainable food system. The project was launched in the beginning of 2020.

[105] Natural Resources Institute Finland (2020). Ruokahävikki ja ruokajärjestelmän kiertotalous. Retrieved from https://www.luke.fi/tietoa-luonnonvaroista/ruoka-ja-ravitsemus/ruokahavikki/

[106] Ympäristötiedon foorumi. (2015). Kiertotalous ja ruoka. HENVI Policy Brief 3. HENVI Science Day 2015.

[107] Sitra, (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

[108] Berg, A.,Räisänen, M. &Salo, H.(edit.). (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.

[109] Natural Resources Institute Finland. (2021). Tiekartta. Retrieved from https://www.luke.fi/ruokahavikkiseuranta/tiekartta/

[110] Berg, A.,Räisänen, M. &Salo, H.(edit.). (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.

[111] Lehtonen, H., Saarnio, S., Rantala, J., Luostarinen, S., Maanavilja, L., Heikkinen, J., Soini, K., Aakkula, J., Jallinoja, M., Rasi, S., Niemi, J. (2020). Maatalouden ilmastotiekartta – Tiekartta kasvihuonekaasupäästöjen vähentämiseen Suomen maataloudessa. The Central Union of Agricultural Producers and Forest Owners (MTK), https://www.mtk.fi/ilmastotiekartta

[112] Finnish Food and Drink Industries. (2020). Elintarviketeollisuuden tiekartta vähähiilisyyteen. https://www.etl.fi/media/aineistot/nettisisaltojen-liitteet/elintarviketeollisuuden-tiekartta-vahahiilisyyteen.pdf

[113] Descombes, L., Saario, M & Heikinheimo, E. (2020). Matkailu- ja ravintola-alan tiekartta vähähiilisyyteen. Gaia Consulting Oy commissioned by The Finnish Hospitality Association MaRa and Service Union United PAM. https://tem.fi/documents/1410877/17156670/Matkailu+ja+ravintola-alan+hiilitiekartta+-+loppuraportti+29.4.2020.pdf/a54f1cf9-93f8-8bf8-1658-bd62b1c97d30/Matkailu+ja+ravintola-alan+hiilitiekartta+-+loppuraportti+29.4.2020.pdf?t=1604910530763

[114] Ministry of Agricultre and Forestry, (2021). Climate Friendly Food Programme. https://mmm.fi/en/climatefriendlyfoodprogramme

	The Government has entered a (voluntary) material efficiency commitment with the food and trade sectors to reduce the environmental impact of food production, distribution and consumption[115]. Ministry of Environment has published an Action Plan on Nutrient Cycle 2019-2030[116]. It aims to enhance utilizing biomass nutrients, decrease the nutrient emissions to water and air, develop new business, and support the cycle with policy instruments.
Potential opportunities and benefits	So far, the focus has been on the food waste but there is potential in the whole value chain. Due to the scale of the food industry, side streams and waste utilization represent an interesting opportunity, e.g. animal by-products and their use, even in the most technologically challenging solutions such as protein use in non-food industrial applications.[117] Other opportunities include new concepts of food production (technology, product development, service), decreasing food loss and waste (including service models, packaging and logistics), new sources of protein (fishery) and plant-based food[118]. It has been estimated that reducing food waste would bring EUR 226M in GDP in 2030, domestic fishmeal production and increasing fish farming EUR 233M, and farming broad beam EUR 82M[119]. The estimated saving potential in the food value chain if the average food waste would be halved in both households and food services is EUR 150-200M[120]. It has been estimated that enhancing the nutrient cycle and increasing biofuel production would bring a minus EUR 4M effect in GDP in 2030[121]. The key growth areas are reclamation and recycling of nutrients, organic waste treatment, and optimization of nutrient use.[122] Sitra, on the other hand, has estimated that the yearly potential of the nutrient cycle (in the researched areas) is EUR 0,5B by 2030.[123] Nutrient flows are the biggest in food production and consumption (incl. waste treatment and sewage treatment). There is potential on nutrient recycling in such biomasses as manure, excess grass from agriculture, sludge from wastewater treatment plants, bio waste from households,

[115] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[116] Ministry of Environment, (2019). Ravinteiden kierrätyksen toimenpideohjelma 2019-2030, https://ym.fi/documents/1410903/38439968/Ravinteiden-kierratyksen-toimenpideohjelma-2019-2030-allekirjoitettu-D7F9043A_0090_4785_B029_9C119B566BDD-146284.pdf/3896ea79-abd4-8d86-7b1f-6e615e6fe054/Ravinteiden-kierratyksen-toimenpideohjelma-2019-2030-allekirjoitettu-D7F9043A_0090_4785_B029_9C119B566BDD-146284.pdf?t=1603260574640

[117] Sitra (2015) . The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

[118] Gaia Consulting and Tempo Economics (2017). Growth and employment from sustainable solutions –A study into the dynamics of growth and employment in the bioeconomy, cleantech and circular economy. Publications of the Ministry of Economic Affairs and Employment 39/2017.

[119] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instruments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016. https://tietokayttoon.fi/documents/10616/2009122/25_Kiertotalous+Suomessa.pdf/5a942ae7-9ec8-4b54-a079-f99c8ba2f8f1?version=1.0

[120] Simons M, et al. Economic instruments in value chains of circular economy. Publications of the Government´s analysis, assessment and research activities 54/2018

[121] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instruments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016. https://tietokayttoon.fi/documents/10616/2009122/25_Kiertotalous+Suomessa.pdf/5a942ae7-9ec8-4b54-a079-f99c8ba2f8f1?version=1.0

[122] Gaia Consulting and Tempo Economics. (2017). Growth and employment from sustainable solutions –A study into the dynamics of growth and employment in the bioeconomy, cleantech and circular economy. Publications of the Ministry of Economic Affairs and Employment 39/2017.

[123] Sitra (2015). The opportunities of a circular economy for Finland, https://media.sitra.fi/2017/02/28142449/Selvityksia100.pdf

	side flows from food industry and sludge from forest industry. Such biomasses are estimated to be 21M tonnes a year.[124]
Enablers and challenges	Enablers: public procurement, sharing economy, new business concepts, investments to unleash the potential, regulation Challenges: attitudes and habits of the general public, technological challenges in use of sidestreams, un-organic fertilizers cost little on the global market
Preliminary assessment of the circular transition potential	The food value chain includes two factors crucial to the circular economy, namely how well raw materials are utilised (whether for its primary purpose or as production side streams) and the way in which nutrients are reintroduced into the nutrient cycle. Circular opportunities identified include organic recycled nutrients, minimizing food waste, and supporting biogas and other renewable energy in agriculture. In Finland, the yearly food waste is estimated to be 400-500M kg, and food loss and waste is estimated to produce approximately 1 000 M CO_2-ekv kg yearly.

Transport and logistics

Description of the area	Includes transporting people, products, materials (including raw materials, side stream materials, etc.)[125]. Transport and logistics are a prerequisite for circular economy, enabling, for example, reverse resource flows[126]. However, there is a need for reduction and efficiency in transport flows. Circular actions for transport are lowering emissions, developing efficient transport systems and logistics, and supporting innovative transport services.
Existing activities and initiatives	Ministry of Transport and Communications has developed a road map for fossil-free transport in 2020[127], describing the development trends in emissions from domestic transport, the emissions reduction targets and the target years 2030 and 2045 considering the various ways to reduce emissions. National Growth Programme for the Transport Sector 2018-22 will be updated as the Sustainable Growth Programme for the Transport Sector[128]. Climate road map for transport and logistics[129] introduced by seven associations[130] was presented in 2020 supporting Finland's goal of carbon neutrality in 2035. Finland aims for fossil-free transport by 2045[131]. Domestic CO_2 emissions of transport were

[124] Ministry of Environment, (2019). Ravinteiden kierrätyksen toimenpideohjelma 2019-2030, https://ym.fi/documents/1410903/38439968/Ravinteiden-kierratyksen-toimenpideohjelma-2019-2030-allekirjoitettu-D7F9043A_0090_4785_B029_9C119B566BDD-146284.pdf/3896ea79-abd4-8d86-7b1f-6e615e6fe054/Ravinteiden-kierratyksen-toimenpideohjelma-2019-2030-allekirjoitettu-D7F9043A_0090_4785_B029_9C119B566BDD-146284.pdf?t=1603260574640

[125] Sitra, (2016). Leading the cycle: Finnish road map to a circular economy 2016-2025, https://media.sitra.fi/2017/02/28142644/Selvityksia121.pdf

[126] Sitra, (2016). Leading the cycle: Finnish road map to a circular economy 2016-2025, https://media.sitra.fi/2017/02/28142644/Selvityksia121.pdf

[127] Andersson, A., Jääskeläinen, S., Saarinen, N., Mänttäri, J, Hokkanen, E. (2020). Fossiilittoman liikenteen tiekartta -työryhmän loppuraportti. Publications of the Ministry of Transport and Communications 2020:18, https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162516/LVM_2020_18.pdf?sequence=1&isAllowed=y

[128] Lausuntopalvelu.fi, (2020). Liikennealan kestävän kasvun ohjelma https://www.lausuntopalvelu.fi/FI/Proposal/Participation?proposalId=7d7be169-4d91-429e-883a-188188c45041

[129] Vasara, Lehtinen & Laukkanen. (2020). Tie vähähiiliseen liikenteeseen – Liikenteen ja logistiikan tiekartta. Loppuraportti. Pöyry, http://www.palta.fi/wp-content/uploads/2020/06/Tie-v%C3%A4h%C3%A4hiiliseen-liikenteeseen_Liikenteen-ja-logistiikan-tiekartta_Loppuraportti.pdf

[130] Service Sector Employers Palta, Finnish Freight Forwarding and Logistics Association (FIFFLA/SHLL), The Finnish Information Centre of Automobile Sector, Association of Logistic Enterprises in Finland, Finnish Public Transport Association, the Finnish Bus and Coach Association, and Intelligent Transportation Society of Finland – ITS Finland.

[131] Pedersen, J. L., Bey, N., Friis Gerholt, S., Rohde, R., Ødegård Berg, H., Almqvist, M., ... Gísla-son, S. (2020). The Road towards Carbon Neutrality in the different Nordic Countries(Te-maNord). Copenhagen: Nordisk Ministerråd. https://doi.org/10.6027/temanord2020-527

	11,3M tonnes in 2019[132]. More than 90% of emissions from domestic transport are generated by road traffic.[133] The emissions ought to be reduced 50 % by 2030 and to 0 by 2045[134].
Potential opportunities and benefits	The potential for circular transport is noteworthy: it is estimated that new transport mechanisms can grow GDP by EUR 479M by 2030[135]. There are plentiful opportunities in transport and logistics, i.e. sharing transport resources and combining different transport possibilities, MaaS, the sharing economy, and optimised and clean transport, sustainable liquid biofuels[136] and transport technologies. Reverse logistics solutions to raise the level of logistics capacity utilisation, replacement of fossil fuels with renewable and non-fossil alternatives, and optimisation of transport routes and material flows. Digitisation will be a key enabler as passenger transport moves towards smart, easy-to-use transport that is based on sharing and services (MaaS) – and subsequently much more resource-efficient.[137] Building transport infrastructure provides opportunities for recycling materials and utilizing regional material flows[138].
Enablers and challenges	Enablers: sharing economy, digital knowhow and its use in logistics Challenges: profitable business models for smart solutions
Preliminary assessment of the circular transition potential	Transport and logistics are a prerequisite for circular economy, enabling, for example, reverse resource flows. There is a need to lower emissions, develop efficient transport systems and logistics, and support innovative transport services. Circular opportunities include sharing transport resources and combining different transport possibilities, Mobility-as-a-Service (MaaS), the sharing economy, transport optimization, sustainable liquid biofuels and transport technologies. The potential for circular transport is noteworthy: it is estimated that new transport mechanisms can grow GDP by EUR 479M by 2030.

Textiles

Links to the following sectors: Bio-based solutions / Forest-based loops (forest sectors)

Description of the area	Includes production, logistics, use and recirculation or disposal of textiles. In a circular textile ecosystem, discarded textile products and materials are kept in reuse and recycling loops, which maintains the value of the products and materials as high as possible for a maximum period of time.[139] The consumption of textiles is increasing in the global perspective. The environmental effects of the textile industry are significant. Textiles are the fourth biggest part of

[132] Jääskeläinen, S. (2020). Logistiikan päästöjen vähentäminen. PowerPoint presentation. Ministry of Transport and Communications. https://sahateollisuus.com/wp-content/uploads/2020/06/Logistiikan-p%C3%A4%C3%A4st%C3%B6jen-v%C3%A4hent%C3%A4minen-20200617.pdf

[133] Andersson, A., Jääskeläinen, S., Saarinen, N., Mänttäri, J, Hokkanen, E. (2020). Fossiilittoman liikenteen tiekartta -työryhmän loppuraportti. Publications of the Ministry of Transport and Communications 2020:18, https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162516/LVM_2020_18.pdf?sequence=1&isAllowed=y

[134] Jääskeläinen, S. (2020). Logistiikan päästöjen vähentäminen. PowerPoint presentation. Ministry of Transport and Communications. https://sahateollisuus.com/wp-content/uploads/2020/06/Logistiikan-p%C3%A4%C3%A4st%C3%B6jen-v%C3%A4hent%C3%A4minen-20200617.pdf

[135] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instru-ments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016.

[136] Gaia Consulting and Tempo Economics (2017). Growth and employment from sustainable solu-tions –A study into the dynamics of growth and employment in the bioeconomy, cleantech and circular economy. Publications of the Ministry of Economic Affairs and Employment 39/2017.

[137] Sitra, (2016). Leading the cycle: Finnish road map to a circular economy 2016-2025, https://media.sitra.fi/2017/02/28142644/Selvityksia121.pdf

[138] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instru-ments and modelled impacts by 2030. Publications of the Government´s analysis, assessment and research activities 25/2016.

[139] Heikkilä, P. and Pitkänen, M. (Ed.). (2019). Telaketju: Towards Circularity of Textiles. VTT Technical Research Centre of Finland. VTT Research Report No. VTT-R-00062-19.

	consumption[140]. In Finland, 7oot of textiles are purchased every year. Roughly the same amount is disposed yearly.[141] Utilizing textile waste is minimal. In Finland, about a fifth end up in separate collection, and most of used textiles (80%) are burned for energy[142]. Only 1,5 % of clothes are recycled[143].
Existing activities and initiatives	The Government programme of 2019[144] states that it shall be examined whether Finland can begin the separate collection for textiles states in the EU directive on waste 2018/851 earlier than the directive's target year of 2025. Low carbon road map for textile industry[145] introduced by the central organization for textile, clothing and fashion companies, Finnish Textile and Fashion, was published in 2020 supporting Finland's goal of carbon neutrality in 2035. The National Waste Plan[146] will be updated during 2020. Reforms in waste legislation (2019, 2020, 2021).
Potential opportunities and benefits	Many of chemical and thermal recycling technologies are currently in development stage, for example cotton recycling via cellulose carbamate technology. Chemical and thermal processes are typically available only on a lab or pilot scale, and value chains are partly missing. Further development work and investments are thus needed in recycling technologies before whole value chains would be commercially available.[147] Other opportunities include new textile materials, overall model for textile cycle, and textile rent services[148]. There is a significant market potential in mechanic recycling of textile waste. A preliminary estimate for the yearly market potential is EUR 60-120M and 150-300 persons employed yearly, with EUR 20-30M first phase investments[149]. It is estimated that textile reuse and increasing the recycling of plastics, electronic waste and construction waste can grow GDP in Finland by EUR 87M by 2030[150]. Enhancing reusage of textiles gives the greatest environmental benefits. Recycling (especially chemical) is almost as beneficial. The instruments to enhance recycling must be chosen so that they do not lessen the reuse of textiles.[151]

[140] Berg, A.,Räisänen, M. &Salo, H.(edit.). (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.
[141] Dahlbo, H. ym. (2015). Tekstiilien uudelleenkäytön ja tekstiilijätteen kierrätyksen tehostaminen Suomessa. Suomen ympäristö 4/2015. Ministry of Environment.
[142] Berg, A.,Räisänen, M. &Salo, H.(edit.). (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.
[143] Ympäristö.fi (2015). Rikkinäisille tekstiileille erilliskeräys, tekstiilit pois jätevoimaloista uudelleenkäyttöön ja kierrätykseen. Press release, https://www.ymparisto.fi/fi-FI/Kulutus_ja_tuotanto/Jatteet_ja_jatehuolto/Rikkinaisille_tekstiileille_erilliskeray(33234)
[144] Berg, A.,Räisänen, M. &Salo, H.(edit.). (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.
[145] Gaia Consulting Oy & Suomen Tekstiili ja Muoti ry. (2020). Hiilineutraali tekstiiliala – tiekartta. https://stjm.s3.eu-west-1.amazonaws.com/uploads/20200610133352/STJM-Hiilineutraali-tekstiiliala-tiekartta_FINAL.pdf
[146] Ministry of Environment, 2021. National waste plan. https://ym.fi/en/national-waste-plan
[147] Heikkilä, P. and Pitkänen, M. (Ed.) (2019). Telaketju: Towards Circularity of Textiles. VTT Technical Research Centre of Finland. VTT Research Report No. VTT-R-00062-19.
[148] Business Finland (2019) BIO AND CIRCULAR FINLAND PROGRAM - SAVING THE WORLD WITH BIO AND CIRCULAR SOLUTIONS IS HIGH VALUE BUSINESS FOR FINLAND. Powerpoint presentation, https://teknologiateollisuus.fi/sites/default/files/file_attachments/outi_suomi_bf_ohjelma_ja_rahoitus_24.4.pdf
[149] Berg, A.,Räisänen, M. &Salo, H.(edit.) (2020). Kiertotalouden tieto käyttöön. Kahdeksan keskeistä teemaa ja uudet tietotarpeet. Reports of the Finnish Environment Institute 6/2020.
[150] Seppälä, J. et al. (2016). Circular economy in Finland –operational environment, policy instru-ments and modelled impacts by 2030. Publications of the Government's analysis, assessment and research activities 25/2016.
[151] Dahlbo, H. ym. (2015). Tekstiilien uudelleenkäytön ja tekstiilijätteen kierrätyksen tehostaminen Suomessa. Suomen ympäristö 4/2015. Ministry of Environment.

Enablers and challenges	Enablers: international interest, product policy (green labels, public procurement), emerging value chains, customer interest in transparent value chains, and ethical questions, instruments to enhance recycling Challenges: fast fashion, difficulties with utilising used textiles, current state of ethical questions on global value chains, making big investments in recycling technologies profitable (possibility to collect big and homogenous material flows), diffusion of actors
Preliminary assessment of the circular transition potential	Textiles are one of the interesting material flows in terms of reuse, recycling, and waste management opportunities as well as introduction of new renewable materials (including wood-based textiles). There is a strong expertise in wood-based value chains that provide future opportunities for textile production. New textile waste management options and value chains are emerging. In Finland, 70ot of textiles are purchased every year. Roughly the same amount is disposed yearly. Utilizing textile waste is minimal. In Finland, about a fifth end up in separate collection, and most of used textiles (80%) are burned for energy. Only 1,5 % of clothes are recycled.

Packaging

Links to the following sectors: Real estate and construction, Bio-based solutions / Forest-based loops (forest sectors), Sustainable food system (food and beverage sectors), Transport and logistics

Description of the area	Including development and replacement of packaging materials with circulated or more sustainable materials, as well as the recirculation and disposal of materials. Focus on plastics: Gain solutions to zero plastic waste with collecting, recycling, and reusing plastics. Focus in the Finnish strategies on solutions to zero plastic waste with collecting, recycling, and reusing plastics. Furthermore, changes in Finnish waste legislation and taxation have been proposed. The EU plastic strategy estimates that the EU area loses about 95 % of the value of plastic packages (EUR 70-105B yearly) due to insufficient recycling and reuse[152]. A significant portion of collected waste material is used in energy production[153]. In Finland, the amount of packaging waste is approximately 80ot yearly. The amount of packaging materials is expected to grow in every category which grows their economic potential. The total amount of packages is expected to grow 1,4 % a year in 2021-2030. The total recycling rate for packaging waste was 61 % in 2015.[154]
Existing activities and initiatives	The Finnish beverage package return system is considered a working example of circular economy. There is also a package tax for beverage packages[155]. The Ministry of the Environment concluded a Green Deal agreement[156] with the Federation of Finnish Commerce in 2016 to implement the EU Directive on packaging and packaging waste by a voluntary agreement. The target is to decrease the usage of plastic bags in Finland. A Green Deal[157] was also concluded on construction plastics in 2020.

[152] Tikkanen, S. et al. (2018) A review of potential economic instruments for circular economy.Publica-tions of the Government´s analysis, assessment and research activities 4/2018.

[153] Simons M, et al. (2018) Economic instruments in value chains of circular economy. Publications of the Government´s analysis, assessment and research activities 54/2018

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[155] Tikkanen, S. et al. (2018) A review of potential economic instruments for circular economy.Publications of the Government´s analysis, assessment and research activities 4/2018.

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[157] Ministry of Environment, (2021).Rakentamisen muovitiekartta, https://ym.fi/rakentamisen-muovitiekartta

	An expert group formed by the Ministry of Environment published a plastics roadmap in 2018 called Reduce and Refuse, Recycle and Replace – the Plastics Roadmap for Finland[158]. The Plastics Roadmap i.e. identifies measures used to reduce the harm caused by plastic waste and litter, improve the efficiency of plastics recovery, recycling and product design, creating conditions for investments and innovations in the circular economy. The Ministry of Environment also published a separate plastics roadmap for the construction industry in 2019.[159]
Potential opportunities and benefits	It is estimated that the Finnish packaging industry ought to focus in product development in new bio- and mixed material products, solution-based products and in resource efficiency by lighter packaging materials, optimizing the size of the package, minimizing the waste and by innovative solutions.[160] Currently, the producer responsibility system is focused on the waste flows of industry and retail. By developing the system, collecting of packaging material can be enhanced in many sectors. The industry and retail recycling rate can be raised and the system should be extended to customer packaging.[161] Other opportunities include replacing fossil based materials with biobased materials; enhancing recyclability of plastic products; chemical & mechanical recycling; new packaging materials, and recycling solutions for packaging[162]. The circular economy potential of plastic packaging in Finland is EUR 100-140M and the growth potential is EUR 60-80M. The potential will grow larger if the nearby areas' waste flows are also considered.[163]
Enablers and challenges	Enablers: circular design, sustainable supply chains, reverse logistics, innovations, public opinion , RDI Challenges: behaviour of general public, material flows from the consumers, household waste management organised by municipalities, low capacity of recycling and producing from recycled materials insufficient information of waste flows and the materials in the flows, need for investments
Preliminary assessment of the circular transition potential	Packages are one of the interesting material flows in terms of reuse, recycling, and waste management opportunities as well as introduction of new renewable packaging materials. It links to many of the sectors described above. In Finland, the amount of packaging waste is approximately 800t yearly. The total amount of packages is expected to grow 1,4 % a year in 2021-2030. The circular economy potential of plastic packaging in Finland is EUR 100-140M and the growth potential is EUR 60-80M.

Circular business models

Links to the following sectors: Real estate and construction, Bio-based solutions / Forest-based loops (forest sectors), Sustainable food system (food and beverage sectors), Transport and logistics

[158] Muovitiekartta.fi (2021). In brief, https://muovitiekartta.fi/in-brief/

[159] Ministry of Environment, (2021).Rakentamisen muovitiekartta, https://ym.fi/rakentamisen-muovitiekartta

[160] Tikkanen, S. et al. (2018) A review of potential economic instruments for circular economy.Publica-tions of the Government's analysis, assessment and research activities 4/2018.

[161] Simons M, et al. (2018) Economic instruments in value chains of circular economy. Publications of the Government's analysis, assessment and research activities 54/2018

[162] Business Finland (2019), BIO AND CIRCULAR FINLAND PROGRAM - SAVING THE WORLD WITH BIO AND CIRCULAR SOLUTIONS IS HIGH VALUE BUSINESS FOR FINLAND. Powerpoint presentation, https://teknologiateollisuus.fi/sites/default/files/file_attachments/outi_suomi_bf_ohjelma_ja_rahoitus_24.4.pdf

[163] Simons M, et al. (2018) Economic instruments in value chains of circular economy. Publications of the Government's analysis, assessment and research activities 54/2018

Description of the area	Circular business models relate to new ways of servitisation, sharing, and looping. Servitisation refers to business models where the ownership and responsibility of the whole life cycle of a product or service remains with the producer, such as product/material/performance as a service – models, leasing, and guarantee systems such as long-time warranties, deposit refund systems etc.
Existing activities and initiatives	The strategic programme on circular economy aims at supporting new attractive service business models. The programme proposes Finland develop economic incentives and supportive legislation for e.g. real - time and financial control, based on volumes of use of shared resources. The programme further aims at supporting the acceleration of e.g. repair, chemical leasing, and other industrial holistic service models. Servitisation is already broadly used in e.g. the manufacturing industry. In 2018, Sitra, Technology Industries of Finland and Accenture published a Circular Economy Playbook for Finnish SMEs[164] presenting circular economy business models for the manufacturing industry. The development and utilisation of circular business models is often closely linked to business ecosystems development, where certain competencies, infrastructure and resources, products and services can be shared. Business Finland's Bio and Circular Finland program[165] supports the development of competitive bio and circular economy ecosystems that offer solutions to global environmental challenges and hold potential for significant global markets.
Potential opportunities and benefits	The circular economy relies on services and brings a wide diversity of new business opportunities, from specialised expert services related to product research, development, design and production, to installation and maintenance work, repair, and waste management services. For example, product-as-a-service business models make it possible to improve resource efficiency, as the manufacturer's revenue is not tied only to the sale of products but to the provision from benefits to the customers.[166] The development of especially product-as-a-service business models are enabled by e.g. digital solutions. The share of services in the gross value added of the national economy is currently in the range of 70 %, and in gross terms, exports of services have doubled from 2010 to 2019, currently accounting for more than 30 % of Finland's total exports[167]. It is foreseen that in a circular economy, the share of services will further increase.
Enablers and challenges	Enablers: Legislation, financial markets, public procurement, digitalisation, ecosystems, expertise and knowledge exchange Challenges: Profitability, non-transparency of pricing, difficulties to attract investments, long-term dependency relations between producers, service providers and end users, needed change of mindset
Preliminary assessment of the circular transition potential	Circular economy disrupts value chains and opening opportunities for new business models and value creation. Emerging business models include servitisation, sharing, and

[164] Sitra (19.9.2018) Circular economy business models for the manufacturing industry https://www.sitra.fi/en/publications/circular-economy-business-models-manufacturing-industry/

[165] Business Finland. (2021). Global Growth from Bio and Circular Economy. Retrieved from https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland

[166] Finnish Government (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[167] Finnish Government (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

	looping changing, for example, the ownership of materials and products. Sharing economy and platform economy are interesting opportunities. Sharing economy and platform economy includes interesting opportunities.

Digitalisation

Links to the following sectors: Real estate and construction, Bio-based solutions / Forest-based loops (forest sectors), Sustainable food system (food and beverage sectors), Transport and logistics

Description of the area	Digitalisation and data are key enablers and drivers of circular economy. They can help in narrowing, slowing, and closing material flows, for example, by extending product lifetimes. It can be useful in a variety of functions including circular design, supply chain management, material flow management, system optimisation etc. Data availability and quality are crucial, as well as efficient management and sharing of data in value networks and ecosystems[168].
Existing activities and initiatives	The strategic programme includes actions for defining, collect and opening up data of importance for the circular economy, introducing measurements and monitoring of digital data in support of circular economy, promoting digital infrastructures in the circular economy, and related regulation both nationally and internationally.[169] Sitra's IHAN project[170] aims to lay the foundation for a fair data economy. Different innovation platforms such as CEP Circular Economy Service Platform exist[171].
Potential opportunities and benefits	Data supports circular economy by enabling, for example predictive maintenance, sharing economy, and side and waste stream optimization. It can also disrupt value creation, business models, and consumption to be more sustainable. Relevant digital technologies include, among others, IoT, AI and machine learning, and blockchain. Sharing of data through different platforms and product biographies can further increase the opportunities.[172] When it comes to applying the carbon law, the digital sector has the potential to directly reduce fossil fuel emissions 15% by 2030 and indirectly support a further reduction of 35% through influence of consumer and business decisions and systems transformation[173]. Digital technologies will be an essential driver of decarbonisation and cost savings across industries, enabling great gains in material, energy, process and logistical efficiency. Digital solutions can nudge and support the transition from infrastructure dominated by cars to those based on varied modes of transport.[174]
Enablers and challenges	Enablers: Strong ICT sector, enhanced material efficiency, the role of the public sector, data availability, data quality, data sharing, open standards and interfaces, open data platforms

[168] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[169] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[170] Sitra (2021) Fair Data Economy. Retrieved from https://www.sitra.fi/en/topics/fair-data-economy/#business-models

[171] Clic Innovation (2021) Circular Economy Service Platform. Retrieved from https://clicinnovation.fi/project/cep/

[172] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[173] Falk, Johan et al. (2020). , Exponential Roadmap 1.5.1. Future Earth. Retrieved from https://exponentialroadmap.org/wp-content/uploads/2020/03/ExponentialRoadmap_1.5.1_216x279_08_AW_Download_Singles_Small.pdf

[174] [174] Falk, Johan et al. (2020). , Exponential Roadmap 1.5.1. Future Earth. Retrieved from https://exponentialroadmap.org/wp-content/uploads/2020/03/ExponentialRoadmap_1.5.1_216x279_08_AW_Download_Singles_Small.pdf

	Challenges: Data availability, data quality, data sharing, data ownership, trust, common rules of game
Preliminary assessment of the circular transition potential	Digitalisation and data are key enablers and drivers of circular economy. They can help in narrowing, slowing, and closing material flows, for example, by extending product lifetimes. It can be useful in a variety of functions including circular design, supply chain management, material flow management, system optimisation etc. Data availability and quality are crucial, as well as efficient management and sharing of data in value networks and ecosystems. It is estimated that globally the digital sector has the potential to directly reduce fossil fuel emissions 15% by 2030 and indirectly support a further reduction of 35% through influence of consumer and business decisions and systems transformation.

Municipalities

Description of the area	Municipalities and regions have a significant role in promoting and designing services that support circular economy. Municipalities spend EUR 20B in public procurement every year. Such services and solutions can be in the fields of energy, water, nutrient circles, waste and side streams, mobility and ICT.[175] Community planning and zoning are municipalities' key instruments to promote circular economy. Their role as an education provider is also important in teaching the people on circular economy practices.[176]
Existing activities and initiatives	National Public Procurement Strategy (2020)[177] aims to increase the level of ecological, social and economic responsibility in public procurement and promote the achievement of ecological, social and economic goals in society. It supports circular economy and Finland's carbon neutral target of 2035. The strategic programme aims at strengthening the circular economy of municipalities and regions should be strengthened, e.g. municipal strategies, establishing a knowledge network to support municipalities and regional ecosystems, and directing funding to municipal and regional ecosystem work. Municipalities and regions have also set up networks for circular activities. The Association of Finnish Local and Regional Authorities[178] provides a list of interesting circular actions taken by municipalities and rewards the "Circular Municipality of the Year" yearly. Together with Sitra, the AFLRA has collected interesting actions also in a project in 2018[179]. In 2020, Motiva Oy published a Playbook for Fair Circular Economy[180] aimed at municipalities' work.

[175] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[176] Finnish Government,(2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta+-+Ehdotus+kiertotalouden+strategiseksi+ohjelmaksi.pdf/ad875da1-f4c4-aec4-4fe0-f17df9746383?t=1610462062018

[177] Government of Finland (2020). National Public Procurement Strategy identifies concrete ways in which public procurement can help achieve wider goals in society, https://valtioneuvosto.fi/en/-/10623/national-public-procurement-strategy-identifies-concrete-ways-in-which-public-procurement-can-help-achieve-wider-goals-in-society

[178] The Association of Finnish Local and Regional Authorities. (13.9.2019). Kiertotalous. Retrieved from https://www.kuntaliitto.fi/yhdyskunnat-ja-ymparisto/ymparisto/kiertotalous

[179] Sitra (2021). Kuntien kiinnostavimmat kiertotalousteot. Retrieved from https://www.sitra.fi/hankkeet/kuntien-kiinnostavimmat-kiertotalousteot/#mista-oli-kyse

[180] Motiva. (3.11.2020). Reilu kiertotalous kunnissa. Retrieved from https://www.motiva.fi/julkinen_sektori/reilu_kiertotalous_kunnissa.

Potential opportunities and benefits	New ways of cooperation between private and public sector are needed to reach circular economy. Municipalities and regions play an important role in creating an enabling environment.[181] Municipalities can create new markets for circular solutions, connect actors, and act as test-beds. Public data bases are an important knowledge base for other sectors' development.[182]
Enablers and challenges	Enablers: public procurement, capacities, learning curve, strategic commitment, resources, collaboration, sharing of best practices, public-private partnerships Challenges: Capabilities and know-how, available resources, funding
Preliminary assessment of the circular transition potential	Municipalities have a significant role in enabling, promoting, and designing infrastructure, platforms, and services for circular economy. Urban planning is one of the municipalities' key instruments to promote circular economy. Municipalities spend EUR 20B in public procurement every year. Such services and solutions can be in the fields of energy, water, nutrient circles, waste and side streams, mobility and ICT. Cooperation between private and public sector opens up further opportunities.

Country-specific sum-up

Table F. Preliminary assessment of the circular transition potential

Area	Preliminary assessment of the circular transition potential
Bioeconomy / Forest-based loops	Bio-based solutions, namely forest-based loops, have been identified as a strong area of expertise in the circular economy in Finland. The resource scarcity has turned biobased materials into a topic of international interest, and Finland is at the forefront as an innovator. Opportunities include new materials and products, replacing fossil raw materials, sustainable biobased solutions, and side stream cycles as well as reducing material consumption and increasing recycling by circular design. Circular economy is estimated to have potential added value of around EUR 220-240M for pulp and paper industry in Finland.
Real estate and construction	In terms of volume, the construction sector is the largest individual consumer of raw materials in Finland . A large share of steel, concrete, wood, and plastics flows through this area. Generating 16 million tonnes of waste per year, it is also the second largest producer of waste. Circular economy is an increasingly interesting opportunity including improving the utilisation rate of real estate, exploitation of materials in the end-of-life-phase (including use of recycled materials in construction), and smart building solutions to extend life-time and reduce resource consumption.
Sustainable food system (food and beverage sectors)	The food value chain includes two factors crucial to the circular economy, namely how well raw materials are utilised (whether for its primary purpose or as production side streams) and the way in which nutrients are reintroduced into the nutrient cycle. Circular opportunities identified include organic recycled nutrients, minimizing food waste, and supporting biogas and other renewable energy in agriculture. In Finland, the yearly food waste is estimated to be 400-500M kg, and food loss and waste is estimated to produce approximately 1 000 M CO_2-ekv kg yearly.

[181] Finnish Government, (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta
[182] Finnish Government (2021). New directions - The strategic programme to promote a circular economy, Publications of the Finnish Government 2021:1. https://ym.fi/documents/1410903/42733297/Uusi+suunta

Transport and logistics	Transport and logistics are a prerequisite for circular economy, enabling, for example, reverse resource flows. There is a need to lower emissions, develop efficient transport systems and logistics, and support innovative transport services. Circular opportunities include sharing transport resources and combining different transport possibilities, Mobility-as-a-Service (MaaS), the sharing economy, transport optimization, sustainable liquid biofuels and transport technologies. The potential for circular transport is noteworthy: it is estimated that new transport mechanisms can grow GDP by EUR 479M by 2030.
Textiles	Textiles are one of the interesting material flows in terms of reuse, recycling, and waste management opportunities as well as introduction of new renewable materials (including wood-based textiles). There is a strong expertise in wood-based value chains that provide future opportunities for textile production. New textile waste management options and value chains are emerging. In Finland, 70ot of textiles are purchased every year. Roughly the same amount is disposed yearly. Utilizing textile waste is minimal. In Fin-land, about a fifth end up in separate collection, and most of used textiles (80%) are burned for energy. Only 1,5 % of clothes are recycled.
Packaging	Packages are one of the interesting material flows in terms of reuse, recycling, and waste management opportunities as well as introduction of new renewable packaging materials. It links to many of the sectors described above. In Finland, the amount of packaging waste is approximately 8oot yearly. The total amount of packages is expected to grow 1,4 % a year in 2021-2030. The circular economy potential of plastic packaging in Finland is EUR 100-140M and the growth potential is EUR 60-80M.
Circular business models	Circular economy disrupts value chains and opening opportunities for new business models and value creation. Emerging business models include servitisation, sharing, and looping changing, for example, the ownership of materials and products. Sharing economy and platform economy are interesting opportunities.
Digitalisation	Digitalisation and data are key enablers and drivers of circular economy. They can help in narrowing, slowing, and closing material flows, for example, by extending product lifetimes. It can be useful in a variety of functions including circular design, supply chain management, material flow management, system optimisation etc. Data availability and quality are crucial, as well as efficient management and sharing of data in value networks and ecosystems. It is estimated that globally the digital sector has the potential to directly reduce fossil fuel emissions 15% by 203030 and indirectly support a further reduction of 35% through influence of consumer and business decisions and systems transformation.
Municipalities	Municipalities have a significant role in enabling, promoting, and designing infrastructure, platforms, and services for circular economy. Urban planning is one of the municipalities' key instruments to promote circular economy. Municipalities spend EUR 20B in public procurement every year. Such services and solutions can be in the fields of energy, water, nutrient circles, waste and side streams, mobility and ICT. Cooperation between private and public sector opens up further opportunities.

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Iceland

Preliminary identification of areas

The sources used in identification of areas are listed in Table A3, and the preliminary identified areas listed in Table B3.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Green Building Council Iceland (2019). Hringrásarhagkerfið og byggingariðnaðurinn. (The Circular Economy and the Construction Sector). https://cfb5f439-74b6-493e-a7fd-f5937638350 8.filesusr.com/ugd/54e708_c2be38b586b14a26a65551888bbaof5d.pdf.	NGO report	A report to introduce concepts and share information about opportunities and examples of tools and ideas to assist the building and construction sector on its road towards circular economy.
Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.	National strategy	A national waste prevention programme to fulfil the requirements of Article 29 of the EU Waste Framework Directive. The programme does not directly address circular economy, but it aims at the transition to that. The programme has six focus areas, i.e., food, plastics, textiles, EEE, buildings and paper. Each of these areas will be the primary focus area for two years at the time during the 12 years' validity period. In addition to this, three long-term focus areas are defined in the programme, i.e., by-products from the processing of meat and fish, single-use beverage packaging and energy intensive industries.
Miljöministeriet (2021). Í átt að hringrásarhagkerfi. Stefna umhverfis– og auðlindaráðherra í úrgangsmálum. (DRÖG). (Towards circular economy. Waste management plan for Iceland 2021-2032. DRAFT). https://samradsgatt.island.is/oll-mal/$Cases/Details/?id=2875.	National plan	A national waste management plan to fulfil the requirements of Article 28 of the EU Waste Framework Directive. (Draft still in the consultation phase).

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Building, construction and real estate	Green Building Council Iceland (2019). Hringrásarhagkerfið og byggingariðnaðurinn. (The Circular Economy and the Construction Sector). https://cfb5f439-74b6-	The building sector is the only sector in Iceland that has published some thoughts or considerations around circular economy. This sector is a big player in the national economy. Building and construction accounts for 9.66%

	493e-a7fd-f59376383508.filesusr.com/ugd/54e708_c2be38b586b14a26a65551888bbaof5d.pdf.	of GDP (2019) and real estate 8.57%. Furthermore, building and construction is responsible for some 47% of the total waste created (2019). These sectors, especially building and construction, hold a high potential for improvement from a sustainability point of view. Certification of buildings and reconstruction work is on its rise in Iceland, which reflects a growing interest in circular solutions within the sector.
Bioeconomy: Fisheries, aquaculture, agriculture	Roy, N., Árnason, R., & Schrank, W. E. (2009). The identification of economic base industries, with an application to the Newfoundland fishing. Land Economics 85 (4):675–691. DOI: 10.3368/le.85.4.675. Sjávarklasinn (2014). Þýðing sjávarklasans í íslensku efnahagslífi. Íslandsbanki. Economic Report. http://www.sjavarklasinn.is/wp-content/uploads/2014/11/%C3%9E%C3%BD%C3%Boing-sj%C3%A1varklasans-%C3%AD-%C3%ADslensku-atvinnul%C3%ADfi-Efnahagssk%C3%BDrsla-2010-m-%C3%8Dslandsbanka.pdf. Statistics Iceland (Hagstofa Íslands) (2021). Framleiðsluuppgjör. https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor.	Fisheries, aquaculture and agriculture are sectors of major importance (accounting for a total of 4.50% of GDP (2019)), with fisheries as the largest contributor (2.85% of GDP). These sectors should be seen in connection with the food processing sector. In Iceland, fisheries have been a base industry for centuries. A base industry is defined by Roy, Árnason and Schrank (2009) as an industry that in some sense is "autonomous or exogenous with respect to the rest of the economy in which it is embedded, and its impact on GDP through the base-industry multiplier [is] significantly greater than its direct contribution as measured by the national accounts. ... The base industry could be founded on a natural resource or a geographical feature discovered or rendered valuable by historical developments". In general, a base industry would be an export industry. This, however, is not always the case, as base industry could be "an activity that makes habitation in the area possible". (Roy, 2009, pg. 11). In Iceland, fishing industry is without a doubt a base industry in the above sense. Valuable fishing grounds are located within the economic zone and the utilization of these have had and do still have a significant multiplication effect, e.g. through employment in various service industries, such as food processing, transportation, maintenance, development of specific technical solutions, etc. In later years, byproducts from the fishing industries have been increasingly used as raw materials for valuable and innovative products, such as within pharmaceuticals, cosmetics, etc. Agriculture in Iceland has a similar historical background as fisheries and should also be seen as a base industry. Aquaculture is a more recent industry, but closely related.
Food processing	Statistics Iceland (Hagstofa Íslands) (2021). Framleiðsluuppgjör. https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland	Food processing is a sector of major importance (accounts for a total of 7.08% of GDP (2019)), with fish processing as the largest contributor (3.70% of GDP). This sector should be seen in connection with fisheries, aquaculture and agriculture, (see above). Food processing holds a high potential for circularity, such as by use of by-products. By-products from the processing of meat and fish is one of three long-term focus areas of the Icelandic national waste prevention programme.

	2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.	
Manufacturing and process industries / Energy and material intensive industries	Statistics Iceland (Hagstofa Íslands) (2021). Framleiðsluuppgjör. https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.	A handful of aluminum smelters and other heavy industries has been established in Iceland to harness the relatively accessible renewable energy. Some 5 companies in this sector are using >80% of all electricity produced in Iceland and emitting some 40% of the GHGs. So far, there are technical limitations to reduce the carbon intensity of this sector. Almost all the production is exported as raw material. This situation should entail some potential for increased use of by-products, increased recycling, use of wasted heat, etc. Waste reduction from energy intensive industries is one of three long-term focus areas of the Icelandic national waste prevention programme.
Transport and logistics	Statistics Iceland (Hagstofa Íslands) (2021). Framleiðsluuppgjör. https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor.	Transport and logistics are a big contributor to Icelandic economy and an important source of GHG emissions. At the same time, a well-functioning transport system is a requirement for circular economy. A huge potential might lie in smart and service-based transport systems, based on renewable energy. Iceland is among the leaders in electrifying personal transport, while transport of goods is lagging behind. There is a good supply of renewable energy, so the potential should be huge. Imports and combustion of fossil fuel is most likely the main obstacle in the way of circular economy in Iceland.
MATERIAL FLOWS		
Food	Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.	Food is one of the six focus areas of the national strategy for waste prevention. Food production (fisheries, aquaculture, agriculture) is of major importance for the national economy and employment. Soil erosion is a major problem in Iceland. Thus, efficient recycling of food nutrients as soil improvers is a crucial issue.
Plastics	Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.	Plastics is one of the six focus areas of the national strategy for waste prevention. In addition to that, reduction of single-use beverage packaging is one of three long-term focus areas of the strategy, including also packaging from glass and aluminium. There is no primary production of plastics taking place in Iceland, but the use- and end-of-use phases have been highly prioritised by the government for the last couple of years. Plastic waste from agriculture (hay emballage) was high on the agenda during the national stakeholder

		workshop in February 2021, as an emerging company in Iceland has set the goal to recycle all this waste, as well as plastic waste form other domestic sources.
Waste management	Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf. Miljöministeriet (2021). Í átt að hringrásarhagkerfi. Stefna umhverfis– og auðlindaráðherra í úrgangsmálum. (DRÖG). (Towards circular economy. Waste management plan for Iceland 2021-2032. DRAFT). https://samradsgatt.island.is/oll-mal/$Cases/Details/?id=2875.	Waste and recycling are central issues in governmental plans for circular economy. From an Icelandic perspective, the main focus should be on domestic supply chains, i.e., supply chains where the major parts of the live cycle are domestic. Food would be the number one material, as most of the production, distribution, consumption and reuse/recycling/regeneration/disposal takes place in Iceland. Food is also one of the focus areas of the national waste prevention program. The National Waste Association (FENÚR (Avfall Island)) is one of few organizations in Iceland promoting circular economy.
DRIVERS / ENABLERS		
Financial institutions	Suggested during the national workshop	Green funding is becoming a central issue at all the largest banks in Iceland, opening up an opportunity to impact the transition to circular economy in an efficient way.
Municipalities and regions	Suggested during the national workshop	Local authorities can contribute to CE through spatial planning, especially detail planning where certain rules on the choice of material can be employed, as well as some framework for urban agriculture and localisation of shops and service centres.
Public procurement	Suggested during the national workshop	Green public procurement (GPP) is an important enabler, especially when it comes to tender criteria. A revised national strategy on GPP will be published late winter or spring 2021.

Short list of areas and key figures

The areas seen to be the most feasible for further assessment and their reasoning are listed in Table C. Table D includes characteristics and key figures of the areas.

Table C. Short list of areas for in-depth assessment

Area	Reasoning
Bioeconomy	In Iceland, bioeconomy, with fisheries as the largest contributor, is a sector of major importance. Fisheries have been a base industry for centuries and the same applies to agriculture. Fisheries, aquaculture and agriculture together account for

	4.50% of GDP (2019)) and the food processing industry adds another 7.08%[183] According to this, the total share of the bioeconomy is close to 12% of GDP. The Icelandic bioeconomy has been a fertile ground for innovative solutions, including innovative use of by-products for pharmaceuticals, cosmetics, etc.[184]
Building and construction	The building sector is a big player in the national economy in Iceland, as building and construction accounts for 9.66% of GDP (2019) and Real estate for 8.57%.[185] Buildings is one of the six focus areas of the national strategy for waste prevention and construction waste is a significant part of the total waste created. These sectors hold a high potential for improvement from a sustainability point of view. Certification of buildings and reconstruction work is on its rise in Iceland,[186] which reflects a growing interest in circular solutions within the sector.
Energy intensive industries	A handful of aluminum smelters and other heavy industries has been established in Iceland to harness the relatively accessible renewable energy. Some 5 companies in this sector are using >80% of all electricity produced in Iceland and emitting some 40% of the GHGs.[187] So far, there are technical limitations to reduce the carbon intensity of this sector. Almost all the production is exported as raw material. This situation should entail some potential for increased use of by-products, increased recycling, use of wasted heat, etc.
Transport and logistics	Transport and logistics are a big contributor to Icelandic economy and an important source of GHG emissions. At the same time, a well-functioning transport system is a requirement for circular economy. A huge potential might lie in smart and service-based transport systems, based on renewable energy. Iceland is among the leaders in electrifying personal transport,[188] while transport of goods is lagging behind. There is a good supply of renewable energy, so the potential should be huge. Imports and combustion of fossil fuel is most likely the main obstacle in the way of circular economy in Iceland.
Waste and recycling	Waste and recycling are central issues in governmental plans for circular economy. From an Icelandic perspective, the main focus should be on domestic supply chains, i.e., supply chains where the major parts of the live cycle are domestic. Food would be the number one material, as the majority of production, distribution, consumption and re-use/recycling/regeneration/disposal takes place in Iceland. Food is one of the focus areas of the national waste prevention program and by-products from the processing of meat and fish are included in the program as one of three long-term focus areas.[189]
Public Procurement	Green public procurement is an important enabler, especially when it comes to tender criteria. A revised national strategy on GPP will be published late winter or spring 2021. Municipalities and local authorities can in addition to public procurement contribute to CE through spatial planning, especially detail planning where certain rules on the choice of material can be employed, as well as some framework for urban agriculture and localisation of shops and service centres.

[183] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Data for 2019.
[184] Iceland Ocean Cluster (Íslenski sjávarklasinn) (n.d.): *100% Fish*. http://www.sjavarklasinn.is/en/100-fish.
[185] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Data for 2019.
[186] HMS (Icelandic Housing and Construction Agency) (2021). *Svanurinn*, https://www.hms.is/byggingar/fraedsla/vistvaen-mannvirki/umhverfisvottanir/svanurinn.
[187] Environmental Protection Agency (Umhverfisstofnun) (2020). https://ust.is/loft/losun-grodurhusalofttegunda/losun-islands. Data for 2018.
[188] International Energy Agency (IEA) (2021): *Electric vehicles*. https://www.iea.org/reports/electric-vehicles.
[189] Miljöministeriet (2016). *Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027*. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.

Table D. Key figures of the areas

	Turnover (million EUR)[190]	Employment[191]	CO_2 emissions (million tonnes CO_2e)[192]	Waste amount (million tonnes) (waste treatments in the footnote)[193]	Categories in the statistical classification (TOL 2008)
Real estate and construction	6 350	16 600	0.11	0.61	F Construction, L Real Estate
Fisheries, aquaculture, agriculture	1 568	7 100	0.55	<0.01	A Agriculture, forestry and fishing
Food and beverage sectors	2 466	10 500	0.02	0.03	C10-11 Manufacture of food products and beverages
Transport and logistics	3 023	13 500	1.05		H Transportation and storage
Manufacturing and process industries / Energy and material intensive industries	1 491	1 900	1.87		C24 Manufacture of basic metals
Total economy	34 842	202 400	4.86	1.29	

Descriptions of the areas

Bioeconomy	
Description of the area	Includes fisheries, aquaculture, agriculture and food processing. In total, these sectors account for almost 12% of GDP.[194] The Icelandic bioeconomy has been a fertile ground for innovative solutions, including innovative use of by-products for pharmaceuticals, cosmetics, etc.[195] In Iceland, fisheries have been a base industry for centuries and the same applies to agriculture. Aquaculture is a more recent industry, but closely related. These three sectors differ in many ways, but a common characteristic is the use of living resources. Circular economy in these sectors means preventing waste, better recycling, and a more sustainable use of by-products.
Existing activities and initiatives	Iceland has for long taken an active approach in terms of ensuring sustainable use of the fishing resources and thereby creating both productivity and value from its fisheries. A huge emphasis is put on full use of raw materials in its processing industry.[196], [197]

[190] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Data for 2019.
[191] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/efnahagur/vinnumagn-og-framleidni/vinnumagn. Data for 2019.
[192] Environmental Protection Agency (Umhverfisstofnun) (2020). https://ust.is/loft/losun-grodurhusalofttegunda/losun-islands. Data for 2018.
[193] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/umhverfi/efnisflaedi/urgangur. Data for year 2019.
[194] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor. Data for 2019.
[195] Miljöministeriet (2017): *Lífhagkerfið. Endurnýjanlegar auðlindir til sjós og lands.* Miljöministeriet Reykjavík. https://rafhladan.is/bitstream/handle/10802/14463/2017_05_19_Lifhagkerfid_endurnyjanlegar_audlindir_LoRes.pdf.
[196] Stefán Gíslason and Hrafnhildur Bragadóttir (editors) (2017). *The Nordic Bioeconomy Initiative, NordBio. Final report*. TemaNord 2017:526. Copenhagen: Nordisk Ministerråd, 2017. DOI: 10.6027/TN2017-526.
[197] Sigrún Elsa Smáradóttir, et.al. (2015): Future Opportunities for Bioeconomy in the West Nordic Countries. TemaNord 2015:505. Copenhagen: Nordisk Ministerråd, 2015. https://www.norden.org/en/publication/future-opportunities-bioeconomy.

Potential opportunities and benefits	A lot has been done – and still more can be done. Fillets, that used to be the main output of the Icelandic demersal fishing industry, are becoming an ever-smaller part of the total value, while products from other parts of fish are climbing the list, including cosmetics and pharmaceuticals.
Enablers and challenges	Innovation funding is an important part of the way forward. There are already funds in place for that, such as Matvælasjóður (The Food Innovation Fund) administrated by The Ministry of Industries and Innovation.[198]
Preliminary assessment of the circular transition potential	The bioeconomy, with fisheries as the largest contributor, is a sector of major economic importance in Iceland. In later years, by-products from the fishing industries, and even from agriculture, have been increasingly used as raw materials for valuable and innovative products, such as within pharmaceuticals, cosmetics, etc. In addition to this, food is one of the focus areas of the national waste prevention program This is a growing area with a large potential in line with circular economy.

Building and construction

Description of the area	Includes building, alteration, and repair of buildings and constructions and infrastructures. Together with real estate this sector accounts for some 18% of GDP. Building and construction is responsible for some 47% of the total amount of waste (0.61 out of 1.61 tonnes in 2019), making these sectors by far the largest waste producer in Iceland.
Existing activities and initiatives	The building sector is the only sector in Iceland that has published some thoughts or considerations around circular economy. However, no known activities have been started to support circular economy within the sector. However, certification of buildings and reconstruction work is on its rise in Iceland, which reflects a growing interest in circular solutions.
Potential opportunities and benefits	Buildings is one of the six focus areas of the national strategy for waste prevention[199] and construction waste is a significant part of the total waste created.[200] This alone means that there is lot of circular economy potential in this area. Increased recycling of concrete would be high on the list of opportunities, as well as better sorting of other construction waste fractions, e.g., iron and wood, a lot of which is currently wasted at landfills.[201] Building and construction hold a high potential for improvement from a sustainability point of view. Because of the economic importance and the high amount of waste, circular economy activites within these sectors would be more beneficial than activities in most other sectors.
Enablers and challenges	Sorting of construction waste is already demanded by Icelandic law. However, a large portion still ends up as unsorted bulky waste. Improvements are simple by nature, but stricter implementation measures might be needed.[202] The main challenge is, though, most likely of a behavourial nature. This is basically a "just-do-it" task.
Preliminary assessment of the circular transition potential	The building and construction sector is a big player in the national economy in Iceland. Buildings is one of the six focus areas of the national strategy for waste prevention and construction waste is almost a half of the total waste created. These sectors hold a high potential for improvement from a sustainability point of view, especially when it comes to the choice of raw materials, reuse and recycling of waste. Certification of buildings and reconstruction work is on its rise in Iceland, which reflects a growing interest in circular solutions within the sector.

[198] Government of Iceland (2020): Matvælasjóður. https://www.stjornarradid.is/verkefni/atvinnuvegir/matvaeli-og-matvaelaoryggi/matvaelasjodur/.

[199] Miljöministeriet (2016). *Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027*. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.

[200] Statistics Iceland (Hagstofa Íslands) (2021). Úrgangstölfræði https://hagstofa.is/talnaefni/umhverfi/efnisflaedi/urgangur. Data for year 2019.

[201] Green Building Council Iceland (2019). *Hringrásarhagkerfið og byggingariðnaðurinn*. (The Circular Economy and the Construction Sector). https://cfb5f439-74b6-493e-a7fd-f59376383508.filesusr.com/ugd/54e708_c2be38b586b14a26a65551888bba0f5d.pdf.

[202] Green Building Council Iceland (2019). *Hringrásarhagkerfið og byggingariðnaðurinn*. (The Circular Economy and the Construction Sector). https://cfb5f439-74b6-493e-a7fd-f59376383508.filesusr.com/ugd/54e708_c2be38b586b14a26a65551888bba0f5d.pdf.

Energy intensive industries

Description of the area	This sector contains some 5 companies, enormous in size compared to the Icelandic economy. Three of those are aluminum smelters and two ferro-silica plants. These companies consume >80% of all electricity produced in Iceland and emit some 40% of the GHGs.
Existing activities and initiatives	The sector as a whole has not published any circular economy strategy nor has it introduced a goal to become carbon neutral. However, such goals have been introduced by individual companies. As an example, The Elkem ferro-silica plant at Grundartangi aims to be carbon-neutral in 2040.[203] The use of wasted heat is supposed to be the cornerstone of the company's plan to get there. Several initiatives are going on to find ways to de-carbonise the heavy industries in Iceland. Among these is the development of carbon-free anodes for the aluminium smelters. Some years will pass before this invention has been scaled up to commercial size. Some work has been undertaken to enhance recycling and to improve the use of by-products, with links to the idea of industrial symbiosis. Waste reduction from energy intensive industries is one of three long-term focus areas of the Icelandic national waste prevention programme.[204]
Potential opportunities and benefits	Almost all the production of the sector is exported as raw material. This situation should entail some potential for improvements. Any improvements that may lead to better resource use within this sector would be a significant contribution to circular economy as well as to the work on carbon neutrality in Iceland, bearing in mind the high share of this sector in the total national emissions.
Enablers and challenges	Funding of innovation is defined as an important enabler. The main challenge lies in technical limitations.
Preliminary assessment of the circular transition potential	A handful of aluminium smelters and other heavy industries has been established in Iceland to harness the relatively accessible renewable energy. These few companies use more than 80% of all electricity produced in Iceland and emit almost 40% of the GHGs. So far, there are technical limitations to reduce the carbon intensity of this sector, but improved use of by-products, increased recycling, harnessing of wasted heat, etc. hold a huge potential, especially bearing in mind the seize of this sector compared to the total economy of Iceland.

Transport and logistics

Description of the area	Includes the transport of people, material and products. Transport and logistics are a big contributor to Icelandic economy and an important source of GHG emissions. At the same time, a well-functioning transport system is a prerequisite for circular economy. Circular actions would include lowering emissions, developing smart and efficient transport systems and logistics, and supporting innovative transport services.
Existing activities and initiatives	Personal cars driven by gasoline or diesel will be banned from import and sale in Iceland from 2030, according to the national climate action plan.[205]

[203] Elkem Iceland (2019): *Umhverfisskýrsla 2018*. https://www.elkem.is/globalassets/iceland/umhverfi/2018-umhverfisskyrsla-elkem-island.pdf.
[204] Miljöministeriet (2016). *Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027*. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.
[205] Miljöministeriet (2020). *Aðgerðaáætlun í loftslagsmálum*. 2. útg. (National Climate Action Plan. 2nd ed.). Miljöministeriet Reykjavík. https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Adgerdaaetlun%20i%20loftslagsmalum%20onnur%20utgafa.pdf.

	The national government has provided funding for the installation of charging stations for electric cars, along the highway as well as in residential areas.[206] The passenger ferry between the "mainland of Iceland" and the Westman Islands shifted to electricity in 2020.[207] Initiatives are being taken to strengthen the electricity infrastructures in major harbours.
Potential opportunities and benefits	A huge potential might lie in smart and service-based transport systems, based on renewable energy. Iceland is among the leaders in electrifying personal transport, while transport of goods is lagging behind. There is a good supply of renewable energy, so the potential should be huge.
Enablers and challenges	The dependency on imports and combustion of fossil fuel is the biggest challenge is this respect, as well as the urgent need for major infrastructure changes.
Preliminary assessment of the circular transition potential	Iceland is among the leaders in electrifying personal transport, while transport of goods is lagging behind. There is a good supply of renewable energy, so the potential should be huge, such as in smart and service-based transport systems, based on renewable energy.

Waste and recycling

Description of the area	Waste and recycling are central issues in governmental plans for circular economy.[208] From an Icelandic perspective, the main focus should be on domestic supply chains, i.e., supply chains where the major parts of the live cycle are domestic. Food would be the number one material, as the majority of production, distribution, consumption and re-use/recycling/regeneration/disposal takes place in Iceland. Food is one of the focus areas of the national waste prevention program and by-products from the processing of meat and fish are included in the program as one of three long-term focus areas.[209]
Existing activities and initiatives	The Icelandic waste legislation is being revised to implement the CE-related EU waste directives from 2018. Circular economy has become a central issue in all waste related initiatives in Iceland.
Potential opportunities and benefits	The shortcomings of the current situation from a circular economy perspective are clearly reflected in the amount of wasted material.[210] Landfilling is still a major disposal means in Iceland, leading to a high degree of unnecessary waste of resources. Building and construction waste is a clear example of this.[211] In other words, landfilled waste may be seen as an indicator of non-circular economy activities. A substantial amount of organic waste is still sent to Icelandic landfills.[212] At the same time, soil erosion is a major problem in Iceland.[213] This situation reflects an important opportunity in line with circular economy.

[206] Government of Iceland (2020). *Aðgerðum í loftslagsmálum flýtt*. https://www.stjornarradid.is/efst-a-baugi/frettir/stok-frett/2020/05/05/Adgerdum-i-loftslagsmalum-flytt.

[207] Miljöministeriet (2020). *Aðgerðaáætlun í loftslagsmálum*. 2. útg. (National Climate Action Plan. 2nd ed.). Miljöministeriet Reykjavík. https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Adgerdaaetlun%20i%20loftslagsmalum%20onnur%20utgafa.pdf.

[208] Miljöministeriet (2016). *Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027*. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.

[209] Miljöministeriet (2016). *Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027*. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.

[210] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/umhverfi/efnisflaedi/urgangur. Data for year 2019.

[211] Green Building Council Iceland (2019). *Hringrásarhagkerfið og byggingariðnaðurinn*. (The Circular Economy and the Construction Sector). https://cfb5f439-74b6-493e-a7fd-f59376383508.filesusr.com/ugd/54e708_c2be38b586b14a26a65551888bba0f5d.pdf.

[212] Statistics Iceland (Hagstofa Íslands) (2021). https://hagstofa.is/talnaefni/umhverfi/efnisflaedi/urgangur. Data for year 2019.

[213] Government of Iceland (n.d.): Soil Conservation. https://www.government.is/topics/environment-climate-and-nature-protection/soil-conservation.

Enablers and challenges	When the Icelandic parliament has adopted the proposed act to fully implement the 2018 directives, the road forward should be clear without the need of any major support. However, enabling the use of waste related taxes and fees for investments in circular economy solutions within the waste sector would be a major driver for change. So far, no agreement has been reached on the use of these revenues.
Preliminary assessment of the circular transition potential	In Iceland, waste and recycling are central issues in governmental plans for circular economy. A substantial amount of organic waste is still sent to Icelandic landfills, at the same time as soil erosion is a major problem. These two facts, i.e, the governmental emphasis on the issue and the obvious potential for improvement, create an important opportunity in line with circular economy.

Public Procurement

Description of the area	Green public procurement is an important enabler, especially when it comes to tender criteria. A revised national strategy on GPP will be published late winter or spring 2021. Municipalities and local authorities can in addition to public procurement contribute to CE through spatial planning, especially detail planning where certain rules on the choice of material can be employed, as well as some framework for urban agriculture and localisation of shops and service centres.
Existing activities and initiatives	The national strategy on GPP is outdated, but a revised strategy will be published late winter or spring 2021. Individual local governments have developed their own strategies, but these are not available on a central hub. Environmental criteria have been included in public tenders to a growing degree during the last years.
Potential opportunities and benefits	-
Enablers and challenges	-
Preliminary assessment of the circular transition potential	Green public procurement is an important enabler, bearing in mind the high share of public spending in the total economy. Circular transition potential lies above other things in tender criteria, both on the national and local levels of government. A revised national strategy on GPP will be published late winter or spring 2021, paving the next steps forwards, i.e., steps towards circular economy.

Country-specific sum-up

Table F. Preliminary assessment of the circular transition potential

Area	Preliminary assessment of the circular transition potential
Bioeconomy	The bioeconomy, with fisheries as the largest contributor, is a sector of major economic importance in Iceland. In later years, by-products from the fishing industries, and even from agriculture, have been increasingly used as raw materials for valuable and innovative products, such as within pharmaceuticals, cosmetics, etc. In addition to this, food is one of the focus areas of the national waste prevention program This is a growing area with a large potential in line with circular economy.
Building and construction	The building and construction sector is a big player in the national economy in Iceland. Buildings is one of the six focus areas of the national strategy for waste prevention and construction waste is almost a half of the total waste created. These sectors hold a high potential for improvement from a sustainability point of view,

	especially when it comes to the choice of raw materials, reuse and recycling of waste. Certification of buildings and reconstruction work is on its rise in Iceland, which reflects a growing interest in circular solutions within the sector.
Energy intensive industries	A handful of aluminium smelters and other heavy industries has been established in Iceland to harness the relatively accessible renewable energy. These few companies use more than 80% of all electricity produced in Iceland and emit almost 40% of the GHGs. So far, there are technical limitations to reduce the carbon intensity of this sector, but improved use of by-products, increased recycling, harnessing of wasted heat, etc. hold a huge potential, especially bearing in mind the seize of this sector compared to the total economy of Iceland.
Transport and logistics	Iceland is among the leaders in electrifying personal transport, while transport of goods is lagging behind. There is a good supply of renewable energy, so the potential should be huge, such as in smart and service-based transport systems, based on renewable energy.
Waste and recycling	In Iceland, waste and recycling are central issues in governmental plans for circular economy. A substantial amount of organic waste is still sent to Icelandic landfills, at the same time as soil erosion is a major problem. These two facts, i.e, the governmental emphasis on the issue and the obvious potential for improvement, create an important opportunity in line with circular economy.
Public Procurement	Green public procurement is an important enabler, bearing in mind the high share of public spending in the total economy. Circular transition potential lies above other things in tender criteria, both on the national and local levels of government. A revised national strategy on GPP will be published late winter or spring 2021, paving the next steps forwards, i.e., steps towards circular economy.

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Miljöministeriet (2020). Aðgerðaáætlun í loftslagsmálum. 2. útg. (National Climate Action Plan. 2nd ed.). Miljöministeriet Reykjavík. https://www.stjornarradid.is/library/02-Rit--skyrslur-og-skrar/Adgerdaaetlun%20i%20loftslagsmalum%200nnur%20utgafa.pdf.

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Miljöministeriet (2016). Saman gegn sóun – Almenn stefna um úrgangsforvarnir 2016-2027. (Waste prevention strategy for Iceland 2016-2027). https://www.stjornarradid.is/media/umhverfisraduneyti-media/media/PDF_skrar/Saman-gegn-soun-2016_2027.pdf.

Roy, N., Árnason, R., & Schrank, W. E. (2009). The identification of economic base industries, with an application to the Newfoundland fishing. Land Economics 85 (4):675–691. DOI: 10.3368/le.85.4.675.

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Sigrún Elsa Smáradóttir, et.al. (2015): Future Opportunities for Bioeconomy in the West Nordic Countries. TemaNord 2015:505. Copenhagen: Nordisk Ministerråd, 2015.

Statistics Iceland (Hagstofa Íslands) (2021). Framleiðsluuppgjör. https://hagstofa.is/talnaefni/efnahagur/thjodhagsreikningar/framleidsluuppgjor.

Stefán Gíslason and Hrafnhildur Bragadóttir (editors) (2017). The Nordic Bioeconomy Initiative, NordBio. Final report. TemaNord 2017:526. Copenhagen: Nordisk Ministerråd, 2017. DOI: 10.6027/TN2017-526.

Norway

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fag-omraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society	National road map	The study has a strategic slant, with job creation and carbon emissions in focus. It is more concerned with overall strategic scenarios than with specific sectors – the interconnectedness of the latter are mapped using input-output data. Investigating the decoupling of resource use from employment opportunity and carbon emissions via understanding this interconnectedness is the main theme.
Norsk Industri (2018). Towards a European Circular Economy. https://www.norskindustri.no/siteassets/dokumenter/horinger-og-notater/sirkular-okonomi---industriens-hovedanbefalinger-en.pdf	National road map	Focuses on opportunities for Norwegian industries in developing new materials, products, and technologies. Key points relate to regulations, communication, stimulating demand, resources for research and development.
Prosess 21 (2021). Sirkulærøkonomi. https://www.prosess21.no/om-prosess-21/ekspertgrupper-og-workshops/sirkular-okonomi/	National expert group study	Builds on Norsk Industri work and maintains an overall strategic focus. Some reference made to specific process sectors.
Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Commissioned Study (Norwegian government)	Arguably the most detailed and focused recent study with a view on specific sectors across the Norwegian economy. The study investigated industries / areas with greatest increased circularity potential, barriers to realizing this potential and policy instruments to overcome barriers and facilitate progress. Slightly wider scope for assessment of different sectors than other reports (including materials and circularity thereof, waste volumes and recycling but also the size and scope of the sector in turnover and employment terms).
Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021	Report	Strategic focus, with arguably a somewhat narrow definition of circularity based on overall material flows of primary and secondary material. Like other reports above, the approach is focused on the economy as a whole using input-output approaches.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Building, construction, and real estate	Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Very high potential for increased circularity, because of the overall size of the sector and the ready availability of sustainable / circular construction materials.
Agriculture, forestry, aquaculture, and fishing	Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Relatively small but growing sector, widespread availability of key resources in the Norwegian resource base (forested and sea areas). Important for greenhouse gas emissions.
Manufacturing and process industry	Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Prosess 21 (2021). Sirkulærøkonomi. https://www.prosess21.no/om-prosess-21/ekspertgrupper-og-workshops/sirkular-okonomi/	Includes chemical / pharmaceutical, paper / wood, rubber, mineral product industries, metalworking, manufacturing of machinery. Very important both for turnover and for GHG emissions. High potential for circularity. Access to renewable energy is important. Potential for use of by-products and residual raw materials from other industries. Interconnectedness with other sectors is important alongside the opportunities in this sector itself.
Wholesale and retail trade	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021	Includes the retail sector generally, motor vehicle repair, accommodation services. Significant for turnover and employment, less so for GHG emissions. Limited resource use / circularity improvement potential.

Furniture	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Small sector but good potential, like the construction industry the availability of renewable raw materials (wood-based) may be key.
Food	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Moderately influential sector in terms of turnover and employment, but reasonable prospects of increased circularity through resource availability.
Transport	Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Moderately important for turnover and employment, but the single most important sector for GHGs and hence must be considered. Considerable circularity potential via use of alternative / renewable fuels.
Electricity / gas / district heating	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Relatively low circularity potential, but strong interconnectedness and the potential to influence other sectors.
Oil and gas	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021	Intrinsic potential for increased circularity may be moderate at best (industry largely predicated on linear, non-sustainable raw materials and products). However, must be considered because of its size and its particular significance for GHG emissions.
Health and social care	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021	Intrinsic circularity potential thought to be low to moderate, but the sector has economic and employment importance.
Other service industries	Avfall Norge (2016). The Circular Economy and Benefits for Society. https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society Deloitte (2020). Study for a National Strategy for Circular Economy.	Important for turnover and employment, but generally low resource use and GHG emissions, hence limited potential overall. Encompasses a broad range of sub-industries including information, finance, professional and business services.

	Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021	
DRIVERS / ENABLERS		
Clear national goals / indicators	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Norsk Industri (2018). Towards a European Circular Economy. https://www.norskindustri.no/siteassets/dokumenter/horinger-og-notater/sirkular-okonomi---industriens-hovedanbefalinger-en.pdf	Some targets and goals are specified in terms of broad aspiration rather than concrete targets, and possibly with a broad cross-sector scope such that lines of responsibility for driving progress towards targets is less clear than it could be. More specific, focused and quantified targets and metrics will be an important driver of circular innovation and practice.
Markets for circular commodities and products	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Norsk Industri (2018). Towards a European Circular Economy. https://www.norskindustri.no/siteassets/dokumenter/horinger-og-notater/sirkular-okonomi---industriens-hovedanbefalinger-en.pdf	The relevant marketplaces for goods and services must always be included in circularity considerations across any sector. Specific markets for secondary raw materials can be almost automatically identified in some cases, for example with reference to the EU's 27 materials defined as critical. Circularity improvements such as shifts in resource use, energy use or waste rarely if ever occur without specific reference to the relevant marketplaces. Practically, economic instruments for effectively manipulating markets (shifting tax burdens, increased taxation on certain activities and tax advantages for others) are considered very effective drivers of innovation and more circular behaviour from consumers and businesses alike.
Producer Responsibility	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Producer responsibility is reasonably effective at driving resource conservation and efficiency, but at present across a rather narrow range of sectors / products. Both revision of existing PR schemes and extension of these into other product areas are promising lines of development.
Waste management responsibilities	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	Wide variation in division of responsibility (municipalities, businesses, producers) and practice in waste collection, handling and treatment is commonplace: Greater harmonization both of formal requirements and of on-the-ground practice is possible and a strong potential driver of circularity.
Data / digitalisation	Deloitte (2020). Study for a National Strategy for Circular Economy.	Quality and availability of relevant data is patchy across many areas and severely inhibits

	Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html	circular procurement, resource use and consumption. Enhanced data could be a strong circularity driver.
Knowledge / competence development	Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3. https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html Norsk Industri (2018). Towards a European Circular Economy. https://www.norskindustri.no/siteassets/dokumenter/horinger-og-notater/sirkular-okonomi---industriens-hovedanbefalinger-en.pdf	Increasing knowledge and competence on the circular economy within business, the public sector, and consumers / the general public is vital if more circular consumption and production is to be achieved.

Short list of areas and key figures

The areas seen to be the most feasible for further assessment and their reasoning are listed in Table C. Tables D and E include the detailed analysis of the areas including characteristics and key figures of the area as well as assessing the preliminary circular transition potential.

Table C. Short list of areas for in-depth assessment

Area	Reasoning
Bioeconomy (agriculture, forestry etc.)	Relatively small GDP / output but significant contributor to GHG. Good circularity potential through natural / renewable resource use.
Food and beverages	Large sector, particularly in terms of GDP, with a high circularity potential most often related to reduction in waste and increased / more efficient use of natural and renewable resources.
Manufacturing and process industry	Very important for output, employment and GHG. High circularity potential from resource and energy use.
Mining, oil and gas	Limited circularity potential but very important because of the sector's size, particularly with respect to GDP and GHG. Marginal circularity improvements within this industry could result in significant outcomes overall.
Real estate and construction	There is consensus that this sector has a very high (increased) circularity potential. It is a very important sector for GDP and employment, less so in terms of GHG. Identified as a priority area in many previous studies.
Transport and logistics	Hugely important for GHG (by far the biggest discrete sector in this regard) with very significant opportunities for improved circularity.
Major parts of the economy not considered here are important in terms of GDP and/or employment but generally less so for resource use, waste, or CO_2 emissions. These include other service sectors, some of the administrative / public sector and health and social care. Combined, these constitute half or more of all GDP and well over half the total employment, but less than 10% of resource use / waste / CO_2. Some of the smaller sectors in the long list may be effectively subsumed in the sectors in the shortlist.	
DRIVERS / ENABLERS	
Clarified responsibilities for waste management	Wide variation in division of responsibility (municipalities, businesses, producers) and practice in waste collection, handling and treatment is commonplace: Greater harmonization both of formal requirements and of on-the-ground practice is possible and a strong potential driver of circularity.

Data and digitalization	Quality and availability of relevant data is patchy across many areas and severely inhibits circular procurement, resource use and consumption. Enhanced data could be a strong circularity driver.
Enhanced producer responsibility schemes	Producer responsibility is reasonably effective at driving resource conservation and efficiency, but at present across a rather narrow range of sectors / products. Both revision of existing PR schemes and extension of these into other product areas are promising lines of development.
Identifiable national goals and indicators	Some targets and goals are specified in terms of broad aspiration rather than concrete targets, and possibly with a broad cross-sector scope such that lines of responsibility for driving progress towards targets is less clear than it could be. More specific, focused and quantified targets and metrics will be an important driver of circular innovation and practice.
Knowledge and competence development	Increasing knowledge and competence on the circular economy within business, the public sector, and consumers / the general public is vital if more circular consumption and production is to be achieved.
Markets for circular products and commodities	The relevant marketplaces for goods and services must always be included in circularity considerations across any sector. Specific markets for secondary raw materials can be almost automatically identified in some cases, for example with reference to the EU's 27 materials defined as critical. Circularity improvements such as shifts in resource use, energy use or waste rarely if ever occur without specific reference to the relevant marketplaces. Practically, economic instruments for effectively manipulating markets (shifting tax burdens, increased taxation on certain activities and tax advantages for others) are considered very effective drivers of innovation and more circular behaviour from consumers and businesses alike.

Table D. Key figures of the areas[214] (percentages shown are of the whole economy)

	Turnover[215] (million EUR)	Employment[216]	CO_2 emissions[217] (million tonnes CO_2e[218])	Waste amount[219] (million tonnes)	Categories in the statistical classification (TOL 2008)
Food and Beverage	63 418	166 000	1.7	0.35	10-11, 56, 463, 472
Real estate and construction	74 916	337 000	2.1	2.81	41-43, 68, 81
Bioeconomy	11 553	58 000	5.3	0.45	1-3
Manufacturing and process industry	40 223	122 000	11.9	1.71	12-28
Mining, oil and gas	59 664	59 000	15.6	0.32	5-9

[214] Data from year 2018. Only for industrial sectors – enablers are by definition cross-sectoral and no specific data exists.
[215] Statistics Norway (2021). Business statistics https://www.ssb.no/en/statbank/table/12817
[216] Statistics Norway (2021). Business statistics https://www.ssb.no/en/statbank/table/12817
[217] Statistics Norway, Emissions to air https://www.ssb.no/en/statbank/table/09288 Classification different to table 12817; figures are estimates
[218] Includes CO2, CH4, N20, HFKs, PFKs and SF6
[219] Statistics Norway, estimated using various tables (08604, 07355 and others) – inconsistent classification of sectors

Transport and logistics	71 898	228 000	23.7	0.16	29-30, 3315-7, 45, 49-52
Total economy	**534 000**	**2 455 000**	**68.7**	**11.82**	

Descriptions of the areas

Table E.

Description of the area	Crop and animal production, farming and support activities, forestry, logging and support services, fishing and aquaculture.
Existing activities and initiatives	Strong research profile across the academic and research sectors. Recurring collaborative projects across agriculture and forestry.
Potential opportunities and benefits	Reduced material intensity (animal and plant husbandry, avoiding or limiting use of pesticides or antibiotics), data-driven precision agriculture, efficient land use, regenerative sources of feed, recycling of nutrients, use of more renewable energy, waste reduction, streamlining of value chains (more secondary production close to harvesting).
Enablers and challenges	Enablers: Policy goals for enhanced use of biomass and residual raw materials. Development of value chains for animal feed and enhanced production of certain intermediaries (seaweed, kelp). Development of markets for biofuels and biorefinery products. Enhanced recovery of waste from fishery. Better use of residual raw materials from forestry and wood processing. Challenges: economic aspects – plentiful and cheap primary material.
Preliminary assessment of the circular transition potential	Many opportunities for (more) circular resource production and use mean that even for a relatively small sector there is relatively high circularity potential. If downstream elements relating to this sector are also included (i.e., the broader food industry including consumption / waste) then the potential is extremely high.

Food and beverage	
Description of the area	Manufacture of food products (meat, fish, fruit and vegetables, animal oils and fats, dairy, grain and bakery products), manufacture of beverages, food and beverage services, wholesale and retail of food and beverages.
Existing activities and initiatives	Extensive and ongoing research in food waste and reduction thereof. Well-established and experienced research institutes with extensive food-related research programmes. A range of initiatives and agreements between different actors along the value chain (via Mattvett, sector-wide body for food waste reduction). Public campaigns including prominent television series on the subject. Guidelines and support for individuals and practitioners. A national action plan for sustainable food systems[220].
Potential opportunities and benefits	More efficient production with increased use of secondary materials. Changes in production practices (flexibility, seasonality, response to market conditions) and increased use of renewable energy in production. Increased focus and further improvements in reduction of food waste both from business sector and with consumers.

[220] Norwegian Ministries (2019). Food, People and the Environment: The Government's action plan on sustainable food systems in the context of Norwegian foreign and development policy. https://www.regjeringen.no/globalassets/departementene/ud/dokumenter/planer/sustainable-food_actionplan.pdf

Enablers and challenges	Enablers: continued setting of challenging targets for food waste reduction. Developments in technology and practice, identification of new secondary markets, public communication on food waste prevention. Challenges include tension between market efficiency and circularity (the most circular product or service may well not be the most economic).
Preliminary assessment of the circular transition potential	High potential in a large sector with numerous technical and non-technical (market, consumer-driven) avenues to increased circularity.

Manufacturing and process industry

Description of the area	Production of food, chemicals, pharmaceuticals, machinery, equipment, metallic and mineral products, many others.
Existing activities and initiatives	Mo Industrial Park: circular manufacturing through energy integration / recycling. Industrial Green Tech (sustainable business cluster). Industrial symbioses Øra, Fredrikstad with a large number of processes industries, municipal waste treatment plants and national sorting and treatment facilities for glass and metal packaging, batteries, scrapped vehicles, window frames etc. National expert group / forum on process industry and sustainability (Prosess 21). This has been followed up by a project commissioned by the Norwegian government and organized by the Eyde cluster in cooperation with SINTEF, NCCE and NORSUS to make a survey of secondary material flows from the Norwegian process industry.
Potential opportunities and benefits	Increased use of secondary raw materials, from by-products / waste, recycling. Increased use of renewable materials. Sales of by-products. Development of materials suitable for reuse and recycling. Sustainable fuels (aviation fuel, hydrogen). Developments in the battery value chain. Improved production of steel, plastic, cement, and other materials.
Enablers and challenges	Enablers: Specific goals for the battery value chain. Economic and regulatory drivers for stimulating the use of secondary raw materials, whilst maintaining quality. Review of producer responsibility schemes and extension into new product areas. Review existing data / statistics on material use and waste, identify shortcomings in data but also opportunities for improvement. Challenges: enhanced producer responsibility and/or waste reduction might be (seen to) compromise economic viability of certain sub-sectors.
Preliminary assessment of the circular transition potential	Very high across manufacturing and process industry as a whole. Large-scale sectors with very high potential for improved resource and energy circularity.

Oil and gas

Description of the area	Extraction of primary fossil fuels (but not downstream processing, this is manufacturing / process industry). Mining and quarrying activities.
Existing activities and initiatives	In a sector that struggles for circularity, there are relatively few examples of existing activities that serve to improve circularity. However, these have a very high potential impact as and when they become implemented at wider scale. Carbon capture and storage / utilisation is the clearest example of this.
Potential opportunities and benefits	Increased use of renewable energy, energy streamlining / integration, carbon reduction through capture and storage. Enhanced use of recycled materials in construction and infrastructure.

Enablers and challenges	Goals for reduction in overall fossil fuel use and hence reduction of market demand for non-circular materials and fuels. Strengthening of economic instruments such as carbon pricing, emissions trading. Transition away completely from fossil fuels in certain markets (notably domestic energy). Enhancing markets for alternative materials and fuels, perhaps through further economic interventions. Many possible initiatives are highly challenging in terms of economic costs.
Preliminary assessment of the circular transition potential	There is potential intrinsic to the sector, however the primary circular transition potential relating to oil and gas involves shifts away from the sector completely, in favour of other sectors (renewable energy, alternative circular / renewable resource stocks).

Real estate and construction

Description of the area	Construction of residential and non-residential buildings, civil engineering projects for roads, railways, utility projects and other infrastructure, specialised construction activity including demolition, installation (electrics, plumbing), real estate activities, building services (facilities, landscaping).
Existing activities and initiatives	Large collaborative sustainable construction projects (examples: FutureBuilt, PowerHouse). A well-established and strong research sector involving academic faculties, research institutions and private actors. Reviews of building regulations, collaborative projects on circular business models in the industry. Developments to reduce / eliminate fossil emissions from construction sites.
Potential opportunities and benefits	Better maintenance and rehabilitation of existing building stocks. Building design for the future, for reuse and for recycling. Increased use of repairable / reusable / recyclable materials. Increased use of efficient industrialised production techniques (e.g. prefabrication). Better / more flexible multi-use and shared solutions for efficient land use.
Enablers and challenges	Enablers: reviewed / revised building regulations. Incentivise rehabilitation of existing building stock over demolition and rebuild. Specifying requirements for location, functionality and quality of buildings. Setting and meeting requirements for circular materials, reduced waste and energy efficiency in new and rehabilitated buildings. Digital technology (building information management systems, material passports, stock analyses). Developments in the construction process itself (on-site operations, emissions reduction, efficiency increase). Challenges: cheap materials provide little incentive for prudent specification and purchasing
Preliminary assessment of the circular transition potential	Massive potential, partly because the resource consumption and waste volumes remain large in the existing, largely linear, economy – but also because there is huge scope.

Transport and logistics

Description of the area	Passenger transport, commercial transport and logistics, shipping, aviation.
Existing activities and initiatives	Recycling of EOL vehicles and batteries, infrastructure (recycling of material such as asphalt from roads – earthresQUE), transition to more sustainable fuels.
Potential opportunities and benefits	Reductions in raw materials use and particularly emissions associated with fuel consumption.

Enablers and challenges	The largest challenges are the transformation of passenger transport markets (away from privately-owned vehicles towards sharing / rental / mass transit), the enhanced reuse and repair of vehicles and components and widespread electrification of the vehicle fleet. Enablers could include economic / regulatory instruments to promote market developments. Enhancements in commercial road transport (smart logistics, developments in vehicle design and operation). Electrification, battery technology developments in shipping.
Preliminary assessment of the circular transition potential	Enormous, owing to the massive importance of transport for the existing economy (particularly with respect to GHG) and myriad possibilities for transformation of transport demands, more sustainable / renewable fuels, lighter and more efficient vehicles, and other network / logistical efficiency improvements.

Digitalization

Description of the area	Collection, monitoring and analysis of data, in real-time where possible, of important quantities, qualities and prices of material and waste flows and other circular resources. Establishment and maintenance of infrastructure that supports these activities.
Existing activities and initiatives	Most existing studies have focused on the relative lack of activity in this area and the shortcomings in collecting and monitoring of relevant data. WasteIQ is an example of a developing platform for enhanced utilisation of data on waste resources. Several specific sectors, for example consumer electronics, are developing digital platforms for the monitoring, analysis and documentation of circularity activities such as product reuse and brokerage thereof.
Potential opportunities and benefits	Increased digitalisation promises vast improvements in material flow through better-informed procurement and sales, with a clearer connection between supply and demand. Examples of specific opportunities can be identified for all business sectors, the broadening and strengthening of existing digital infrastructures (example: BIM – building information management systems in the building industry) offer obvious immediate opportunities.
Enablers and challenges	Studies to date have identified cooperation and coordination of digitalisation activities, with high-level political involvement being essential, as crucial for ongoing developments in digitalisation. Concerns include the need for appropriate standards and regulations for data gathering, reporting, sharing and storage, with the need to ensure appropriate ownership and usage rights for data. A balance must be struck that takes commercial interests into account but also enables the use of data for broader societal benefit.
Preliminary assessment of the circular transition potential	Enhanced digitalisation is a key driver for improved circularity right across the economy, with potential applications in each and every business sector.

Markets for circular products and services

Description of the area	Circular products and services are often at a disadvantage under existing economic frameworks which are fundamentally based on a linear economy and often unduly favour linear products. For example, externalities such as environmental effects and other societal costs may not be fully (or at all) priced in. This area concerns developing and strengthening markets for circular products and services, so that society's general demand for such products and services is reflected in economic factors.
Existing activities and initiatives	Studies have identified a wide range of existing and potential ongoing activities, mostly in the form of political interventions: economic initiatives such as taxation

	frameworks (reducing tax burdens on circular materials / services and increasing taxes on linear ones), regulatory requirements for use of secondary raw materials, developing public procurement rules to compel (more) circular products and services, incentivising and funding the development of circular products, technologies and services.
Potential opportunities and benefits	There is huge potential for increasingly circular materials in many parts of the economy, and some examples where the barriers to these are wholly or mostly economic (for example low oil prices and consequent offering of cheap virgin plastic on the market greatly impinges the recycling and reuse of plastics). Establishing more equitable markets could be hugely transformative.
Enablers and challenges	Economic and regulatory instruments almost by definition ensure that some actors will lose out compared to the present situation. Strong political pressure from vested interests in the linear economy presents a serious challenge which is not straightforwardly overcome. However, change is enabled through strong popular support which seems reasonably secure.
Preliminary assessment of the circular transition potential	Almost every industrial and commercial sector has the possibility of being influenced by more and stronger markets for circular products and services. The overall potential is very high and very wide.

Country-specific sum-up

Table F. Preliminary assessment of the circular transition potential

Area	Preliminary assessment of the circular transition potential
Bioeconomy	Many opportunities for (more) circular resource production and use mean that even for a relatively small sector there is relatively high circularity potential. If downstream elements relating to this sector are also included (i.e., the broader food industry including consumption / waste) then the potential is extremely high.
Real estate and construction	Massive potential, partly because the resource consumption and waste volumes remain large in the existing, largely linear, economy – but also because there is huge scope.
Manufacturing and process industry	Very high across manufacturing and process industry as a whole. Large-scale sectors with very high potential for improved resource and energy circularity.
Oil and Gas	There is potential intrinsic to the sector, however the primary circular transition potential relating to oil and gas involves shifts away from the sector completely, in favour of other sectors (renewable energy, alternative circular / renewable resource stocks)
Transport and logistics	Enormous, owing to the massive importance of transport for the existing economy (particularly with respect to GHG) and myriad possibilities for transformation of transport demands, more sustainable / renewable fuels, lighter and more efficient vehicles, and other network / logistical efficiency improvements.
Digitalization	Enhanced digitalisation is a key driver for improved circularity right across the economy, with potential applications in each and every business sector.
Markets for circular products and services	Almost every industrial and commercial sector has the possibility of being influenced by more and stronger markets for circular products and services. The overall potential is very high and very wide.

Sources

Avfall Norge (2016). The Circular Economy and Benefits for Society.

https://www.avfallnorge.no/fagomraader-og-faggrupper/rapporter/the-circular-economy-and-benefits-for-society

Circular Norway (2020,). The Circularity Gap Report. https://www.circularity-gap.world/2021

Deloitte (2020). Study for a National Strategy for Circular Economy. Parts 1-3.

https://www2.deloitte.com/no/no/pages/risk/articles/sirkulaer-okonomi.html

Norsk Industri (2018). Towards a European Circular Economy. https://www.norskindustri.no/siteassets/dokumenter/horinger-og-notater/sirkular-okonomi---industriens-hovedanbefalinger-en.pdf

Norwegian Ministries (2019). Food, People and the Environment: The Government's action plan on sustainable food systems in the context of Norwegian foreign and development policy. https://www.regjeringen.no/globalassets/departementene/ud/dokumenter/planer/sustainable-food_actionplan.pdf

Prosess 21 (2021). Sirkulærøkonomi. https://www.prosess21.no/om-prosess-21/ekspertgrupper-og-workshops/sirkular-okonomi/

Statistics Norway (2021). Business statistics https://www.ssb.no/en/statbank/table/12817

Statistics Norway, Emissions to air https://www.ssb.no/en/statbank/table/09288

Sweden

Preliminary identification of areas

The sources used in identification of the Swedish areas are listed in Table A, and the preliminary identified areas are listed in Table B. Additional reports were also consulted during analysis of each area. These are referenced via footnotes in Section 3.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige. https://www.regeringen.se/informationsmaterial/2020/07/cirkular-ekonomi---strategi-for-omstallningen-i-sverige/	National strategy document	National Circular Economy strategy developed by the Swedish government. Outlies broad policy focus areas and strategies for achieving circularity.
Svenskt Näringsliv (2019). Circular economy for a competitive and sustainable business community in Sweden. https://www.svensktnaringsliv.se/sakomraden/hallbarhet-miljo-och-energi/circular-economy-for-a-competitive-and-sustainable-business-commu_1139506.html	Industry report	Sector-specific report identifying challenges and opportunities for individual sectors in a circular economy.
Material Ekonomics (2017). Ett värdestabilt svenskt materialsystem. https://materialeconomics.com/new-publications/ett-varde-bestandigt-svenskt-materialsystem	Industry report	Investigation into current material flows in the Swedish society and economic opportunities for the future.
Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf	Research report	Industry report that identifies 5 areas each of the sub-project areas for resource efficiency and circular economy in Sweden: food, finance, mobility, plastics and textiles.
Jönbrink, A.K., Flink, T., Togård, C.; Hakkarainen, V. (2020). Förutsättningar för ökat helhets- och materialperspektiv i cirkulär ekonomi. https://www.oneplanetnetwork.org/sites/default/files/slutrapport_etz_6530-08_okat_helhetsperspektiv_afry.docx_.pdf	Research report	Report identifying prerequisites for a resource efficient circular economy in Sweden.
Linder, Marcus, Karin André, Raul Carlsson, Johan Järvung, Anna Körner, Ida Langborg, Johanna Ljunggren, Ann-Charlotte Mellquist, Joakim Thorneus, Louise Sörme. Delegationen för Cirkulär Ekonomi (2020). Slutrapport Expertgrupp mätning. https://www.delegationcirkularekonomi.se/download/18.544231a17619ca0781733f/1606999384313/Expert-grupp%20ma%CC%88tnings%20slutrap-	Research report	A report from a panel of circularity experts offering recommendations circularity measurement standards to the Delegation for Circular Economy.

port%20till%20Delegationen%20fo%CC%88r%20cirkula%CC%88r%20ekonomi%202020.pdf		
Mont, O., Plepys, A., Whalen, K., & Nußholz, J. (2017). Business model innovation for a Circular Economy: Drivers and barriers for the Swedish industry – the voice of REES companies. http://lup.lub.lu.se/search/ws/files/33914256/MISTRA_REES_Drivers_and_Barriers_Lund.pdf	Research report	Report from the MISTRA-funded project 'Resource Efficient and Effective Solutions' (REES) that identified opportunities and challenges for Swedish companies related to circular business models.
RISE Research Institutes of Sweden (2020). Upphandling Och Circukär Ekonomi. https://docplayer.se/188711055-Upphandling-och-cirkular-ekonomi.html	Industry report	A RISE Research Institutes of Sweden AB report on circular procurement in the public sector.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Renewable and biobased materials (including paper products, biomass)	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 26). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf Svenskt Näringsliv. (2019). Circular economy for a competitive and sustainable business community in Sweden. https://www.svensktnaringsliv.se/sakomraden/hallbarhet-miljo-och-energi/circular-economy-for-a-competitive-and-sustainable-business-commu_1139506.html	Sweden is rich in natural resources and skilled in refinement/recycling of raw materials. Where possible, we should replace plastic and metal with renewable and biobased materials and that even these are reused.
Food & Beverage	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 27). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf	Most emissions (75%) related to food production in Sweden originate internationally. Increasing domestic food production can lower emissions. Reducing food waste can also have an impact on emissions; significant losses occur prior to consumption; data and measure have a role to play in facilitation of this reduction.
Building & Construction	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 28). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf	Building and real estate account for 20 percent of consumption-based CO_2 emissions. There are a number of opportunities identified for increasing reuse of building material and construction waste.

	Material Ekonomics (2017). Ett värdestabilt svenskt materialsystem. https://materialeconomics.com/new-publications/ett-varde-bestandigt-svenskt-materialsystem	
Mobility/Transport & Logistics	Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf RISE Research Institutes of Sweden (2020). Upphandling Och Circukär Ekonomi. https://docplayer.se/188711055-Upphandling-och-cirkular-ekonomi.html	Emissions from transport are significant and one of transport sector's biggest challenges.
Manufacturing & Process Industries	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 26). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf Svenskt Näringsliv. (2019). Circular economy for a competitive and sustainable business community in Sweden. https://www.svensktnaringsliv.se/sakomraden/hallbarhet-miljo-och-energi/circular-economy-for-a-competitive-and-sustainable-business-commu_1139506.html	Significant opportunities for increasing circularity in production. Interconnected with many of the identified material flows. Includes chemical, paper / wood, mineral product industries, metalworking, machinery manufacturing.
Vehicles	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	One of three value chains that account for where the three materials (Steel, Aluminum, and Plastic) 'fall out of use' most in Sweden.
Furniture	RISE Research Institutes of Sweden (2020). Upphandling Och Circukär Ekonomi. https://docplayer.se/188711055-Upphandling-och-cirkular-ekonomi.html	Several examples of circular public procurement of furniture including repair and redesign services, requirements that furniture suppliers have 5 years of spare parts in stock, standards for procuring material with threshold levels of recycled content, procuring reused furniture.
Electronics	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	Part of 'consumer products', which is one of the three value chains that account for where the three materials (Steel. Aluminum, and Plastic) 'fall out of use' most in Sweden.
Packaging	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv.	Part of 'consumer products', which is one of the three value chains that account for where the three materials (Steel. Aluminum, and Plastic) 'fall out of use' most in Sweden.

	https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	
MATERIAL FLOWS		
Plastics	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 26). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	An estimated 10 billion SEK of plastic reaches end of use annually in Sweden and 16% of plastic is recycled into new material.
Textiles	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 26). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf	Emissions from textile production are substantive. Textile production involves a lot of water consumption, energy, and chemicals; therefore there is a need to optimize the use and reuse of textiles from an environmental perspective.
Innovation-critical metals and minerals	Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige (pg. 28). https://www.regeringen.se/4a3baa/contentassets/619d1bb3588446deb6dac198f2fe4120/200814_ce_webb.pdf	Rare earth metals are used in very small quantities but are nevertheless necessary for wind energy, electric vehicles, and other products that will increase when the world transitions away from fossil fuels.
Aluminum	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	It is estimated that 3.1 billion SEK worth of aluminum reaches end of use annually in Sweden; of this, 1.2 billion SEK worth of value is retained.
Steel	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	Classified as the most valuable material flow in Sweden, 29 billion SEK worth of end-of-use steel becoming available each year.

Cement	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	There are high emissions from cement production in Sweden, but this material is classified as having considerably less economic value than steel and aluminum.
Paper	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	Sweden has currently high recycling rate for paper but large loss of value because of technical limitations in recycling paper (i.e. quality after recycling).
DRIVERS / ENABLERS		
Sharing unused assets	Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär ekonomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf	Increase the utilization of assets, especially in the built environment.
Digitialization	Teknikföretagen (2020). Digitaliserade affärsmodeller för cirkulära materialflöden. https://www.teknikforetagen.se/globalassets/rapporter/miljo-energi-och-klimat/digitaliserade-affarsmodeller-for-cirkulara-materialfloden.pdf Svenskt Näringsliv. (2019). Circular economy for a competitive and sustainable business community in Sweden. https://www.svensktnaringsliv.se/sakomraden/hallbarhet-miljo-och-energi/circular-economy-for-a-competitive-and-sustainable-business-commu_1139506.html Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	Sharing information, digital labelling systems and information exchange can be a powerful tool to support CE and facilitate industrial symbiosis, monitoring, maintenance and updating. Opportunities for track and trace, monitoring materials and products in use can help contribute to maintenance and collection of materials for a circular economy.
Innovation programs	Material Economics (2017). Ett värdebeständigt svenskt materialsystem. En rapport om materialanvändning ur ett värdeperspektiv. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem	Initiatives to test and demo projects as well as financing and R&D support is needed, especially in regard to circular materials. Most companies in Sweden as SMEs who could use such support.
Finance	Kungl. Ingenjörs Vetenskaps Akademien (2020). Resurseffektivitet och cirkulär eko-	Crucial in providing funding for new business models and enabling circular solutions to be adopted.

	nomi. Syntesrapport. https://www.iva.se/globalassets/rapporter/resurseffektivitet-och-cirkular-ekonomi/200401-rece-syntes-publ.pdf	
Public procurement	RISE Research Institutes of Sweden (2020). Upphandling Och Circukär Ekonomi. https://docplayer.se/188711055-Upphandling-och-cirkular-ekonomi.html Linder, Marcus, Karin André, Raul Carlsson, Johan Järvung, Anna Körner, Ida Langborg, Johanna Ljunggren, Ann-Charlotte Mellquist, Joakim Thorneus, Louise Sörme. Delegationen för Cirkulär Ekonomi (2020). Slutrapport Expertgrupp mätning. https://www.delegationcirkularekonomi.se/download/18.544231a17619ca0781733f/1606999384313/Expertgrupp%20ma%CC%88tnings%20slutrapport%20till%20Delegationen%20fo%CC%88r%20cirkula%CC%88r%20ekonomi%202020.pdf	Public procurement represents around 700 billion in spending, or about 1/6 of Swedish GDP. Standards for public procurement can encourage circular products while discouraging linear products. Public procurement also unites many public and private-sector actors.

Short list of areas and key figures

The areas seen to be the most feasible for further assessment and their reasoning are listed in Table C. Tables D includes characteristics and key figures of the areas.

Table C. Short list of areas for in-depth assessment

Area	Reasoning
Bioeconomy	Sweden is rich in natural resource products, refinement and recycling, including for biomass. The Swedish circular economy strategy points specifically to paper products. One goal is to replace plastic and metals with renewable and bio-based materials where possible.
Building & Construction	Specifically identified by the Swedish government in the circular economy strategy based on reducing emissions from building use and opportunities for reusing building materials. IVA report also specifically mentions opportunities in the built environmental related to increasing the utilization of assets (i.e. sharing).
Food & Beverage	Currently a priority area for the Swedish government, including one specific focus to increase domestic food production and lower emissions.
Manufacturing & Process Industries	Circular production interconnects with many of the identified material flows and presents significant opportunities for reducing resource and energy use.
Mobility/ Transport & Logistics	Transportation, including reverse logistics, is required for a circular economy. Moreover, transport is a significant part of Sweden's CO_2 emissions. To meet Swedish emission goals, mobility has been identified as an area to become more resource efficient and circular. It is also a focus area for public procurement in Sweden.
Textiles	Opportunities exist for both the production and consumption of textiles. This includes reducing emissions from textile production, reducing consumption by encouraging longer lifetimes, and prioritizing collection for their reuse and recycling.

Plastics	Reduce and prevent plastic waste for economic and environmental impact reduction. Overcoming challenges related to recycling of plastics is one specific focus. Plastic is often linked to packaging.
Minerals & Metals	Increased circular material flows for minerals and metals. In Sweden, including steel and aluminum are shown to have significant economic and environmental benefits. The Swedish circular economy strategy specifically prioritizes circular solutions for critical materials and minerals because of their role in the transition to renewable energy solutions.

Digitalization	Digitalization can facilitate the adoption of circular business models and support the transition to a circular economy. Information sharing that monitors products and digital labeling systems that allow information exchange are two important enablers.
Finance	This is seen as crucial in providing funding to support the transition and enabling new circular business models.
Public Procurement	Municipalities, regions, and other public sector actors not only have a role to play in planning for a circular transition; they also have purchasing power to help stimulate market for circular products and business models.

Table D. Key figures of the areas[221]

	Turnover[222] (million SEK)	Employment[223]	GHG emissions[224] (kt CO_2e[225])	Waste amount[226] (million tonnes) (waste treatments in the footnote)	Categories in the statistical classification (SNI 2007)
Real estate and construction	1 212 064	400 447	---	12.383 (only F)	L Real estate, F Construction
Food and Beverage	291 565	76 294	327.5 (only C10)	0.702 (only C10-12)	A01 Agriculture; 03 Hunting & Fishing, C10-12 Food; Beverage preparation; Manufacture of tobacco

[221] Data from year 2018
[222] Statistics Sweden (2021) Företagsenhet - Basfakta företag enligt Företagens ekonomi efter näringsgren SNI 2007. År 2000 - 2018 https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__NV__NV0109__NV0109L/BasfaktaFEngs07/, accessed 12.1-2021
[223] Statistics Sweden (2021) Företagsenhet - Basfakta företag enligt Företagens ekonomi efter näringsgren SNI 2007. År 2000 - 2018 https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__NV__NV0109__NV0109L/BasfaktaFEngs07/, accessed 12.1-2021
[224] Statistics Sweden (2021) Utsläpp av växthusgaser från industrin efter växthusgas, bransch och år. https://www.statistikdatabasen.scb.se/sq/99465, accessed 12.1.2021
[225] Including CO2-fos, CH4, N2O, HFC, PFC, SF6.
[226] Statistics Sweden (2021). Uppkommet avfall (ton) efter egenskap, näringsgren enligt SNI 2007, avfallsslag enligt EWC-Stat och vartannat år. https://www.statistikdatabasen.scb.se/sq/99463, accessed 13.1.2021

Bio-based Solutions	335 211	71 908	967.5 (only C16-18)	1.762 (only C16-18)	A02 Forest management and harvesting; C16-17 Pulp, paper, and stationery industries
Manufacturing and process industry	1 534 070	399 179	---	2.692	C19-33 Manufacturing
Transport and logistics	493 798	216 145	16 799[227] (domestic transport)	---	H Transportation and storage
Total economy	**9 111 437**	**5 097 400**[228]	**63 760**[229]	**138 666**[230]	

Descriptions of the areas

Bioeconomy	
Description of the area	Related to the production or processing of biological resources. Includes production and recycling of bio-based products such as paper and wood-products as well as refinement of biomass to produce biofuels. Amounts to an economic value of around 7% Sweden's GDP; forestry accounts for about two-thirds of the Swedish bioeconomy.[231]
Existing activities and initiatives	Government programme includes an objective to replace fossil raw materials with renewable and bio-based raw materials. Both in products and production processes. This aligns with Sweden's goal to become the first fossil-free welfare state by 2045.[232] Paper and cardboard are already used in many applications as alternatives for fossil-based plastics.
Potential opportunities and benefits	Bio-based products and bioenergy can replace fossil fuel options in many applications including plastics, textiles, and building materials. Ensure nutrients and other important substances in soil are replenished, recirculated, and maintained. Reuse of by-products and waste products into new raw materials.

[227] Statistics Sweden (2021) Totala utsläpp av växthusgaser efter växthusgas, sektor och år https://www.statistikdatabasen.scb.se/sq/99464, accessed 12.1.2021

[228] Statistics Sweden (2021) Population aged 15-74 (LFS) by sex, age and labour status. Year 1970 – 2020. https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__AM__AM0401__AM0401A/NAKUBefolkning2Ar/

[229] Statistics Sweden (2021) Greenhouse gas emissions by the Swedish economy unchanged in 2018. https://www.scb.se/en/finding-statistics/statistics-by-subject-area/environment/environmental-accounts-and-sustainable-development/system-of-environmental-and-economic-accounts/pong/statistical-news/environmental-accounts--emissions-to-air-fourth-quarter-of-2018.

[230] Statistics Sweden (2021) Uppkommet avfall (ton) efter egenskap, näringsgren enligt SNI 2007, avfallsslag enligt EWC-Stat och vartannat år. https://www.statistikdatabasen.scb.se/sq/99479

[231] Stockholm Environment Institute (2020). Realizing the vision of a circular food system: A policy dialogue on a sustainable bioeconomy in the Öresund region. https://www.sei.org/wp-content/uploads/2020/08/sei-report-oresund-circular-food-olsson-aug-2020.pdf

[232] SDG Partners Platform (2017). Sweden's goal – becoming the world's first fossil-free welfare state. https://sustainabledevelopment.un.org/partnership/?p=33918#:~:text=In%20the%20Action%20Plan%20the,by%202045%20at%20the%20latest.&text=Sweden's%20goal%20of%20becoming%20the,responds%20directly%20to%20SDG%2013.

Enablers and challenges	*Enablers:* Sweden's access to renewable resources; Collaboration between the state, universities and business community to find scalable business models and technical solutions; Regulations that promote the replacement of fossil fuels with bio-based alternatives *Challenges:* Ensuring that bio-based materials are recyclable and recycled; Limitations to recycling – for example, Sweden has currently high recycling rate for paper but large loss of value (i.e. quality after recycling) because of technical limitations in recycling paper. Fibres wear out during use/recycling and must be replaced with new fibres over time; Need to ensure biodiversity and other ecosystem services are not negatively impacted (i.e. making sure there are limited consequences for carbon sinks)
Preliminary assessment of the circular transition potential	Sweden is rich in natural resources and skilled in refinement/recycling of raw materials. Moving towards a circular, bio-economy presents Sweden with 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 phase for bio-based materials (including increased recycling of bio-based solutions). The largest market for bio-based solutions in Sweden is the use of biomass within transport and energy and replacing raw materials in the chemical and petrochemical sectors with bio-based products.[233]

Manufacturing & Process Industries

Description of the area	Production of metallic and mineral products, textiles, food, chemicals, machinery, equipment, and many others. Interconnected to many of the identified material flows.
Existing activities and initiatives	The national goal for 100% renewable energy by 2040 is encouraging Swedish manufacturing companies to already start investing in the usage of renewable energy technologies for production processes (e.g. fossil free steel production, hybrid). Digitalisation is an important driver for circular business models in terms of selling functionality. Targets and demands on suppliers from large companies are being developed which is an important driver for change. Collaboration between large companies and innovative startups is helping to drive development. Initiatives such as Science Based Targets and Exponential Roadmap are attracting large companies. SNIUS is driving industrial and urban symbiosis initiatives and on ongoing process industry project is "Climate leading process industry" funded by Vinnova
Potential opportunities and benefits	New opportunities for Sweden's production industries, such as developing products and materials for increased reuse and playing a role in better end-of-life product and material handling. Increased circular material flows for minerals and met-

[233] Lund University Research Magazine (2017). Why have a circular bio-based economy?. Column. https://www.researchmagazine.lu.se/2017/01/11/why-have-a-circular-bio-based-economy/

	als in Sweden, including steel and aluminum, are shown to have significant economic and environmental benefits. Each year, around 29 billion SEK of steel and 3.1 billion SEK of aluminum reach end of use.[234] Increased use of secondary materials in production including from by-products/waste/recycling. There are also opportunities for renewable energy. New market opportunities such as from selling by-products and remanufacturing existing products. Also, digitalisation in terms of easier and more profitable to sell functionality helps the development of circular business models.
Enablers and challenges	*Enablers:* designing products for circular production methods; economic and regulatory drivers stimulating secondary raw material usage; Sweden's 2040 goal; digitalisation; Changing consumer behaviours, drive for competitiveness, local production, good and inspiring examples/frontrunners e.g. IKEA *Challenges:* recycling rates for these materials; extraction from mix-waste streams; quality losses in recycling; changing business models is challenging for many companies and takes time; linear business logic.
Preliminary assessment of the circular transition potential	Large scale sector with significant opportunities for increasing circularity. Interconnected with many of the identified material flows and high potential for improved resource and energy use.

Buildings & Construction

Description of the area	Includes buying, selling, and renting land, buildings, and housing as well building, alteration, repair of buildings and demolition.
Existing activities and initiatives	Buildings and real estate account for 20% of consumption-based CO_2 emissions in Sweden. Efforts to increase material recycling and reduce non-hazardous construction and demolition waste by at least 70% by weight have likely been achieved.[235] Existing voluntary private sector agreements include BASTA, Byggvarubedömningen, and Sunda Hus as well as certification schemes including Miljöbyggnad, BREEAM and LEED.[236]
Potential opportunities and benefits	Building and construction waste contains large quantities of mixed waste that could be reused and recycled. Recovery and reuse of these materials such as cement can help extend material lifetimes and reduce consumption as well as carbon emissions. To help increase material reuse, building material and waste should be designed to enable more efficient separation and toxic materials should be minimized. Information on what material and building products are included in building should also be made available. One potential for this is through material passports which contain knowledge on the materials contained in buildings. Opportunities exist for sharing business models to increase the utilization of unused assets and

[234] Material Economics. Ett värdebeständigt svenskt materialsystem. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem
[235] Naturvårdsverket (2021) Etappmål. http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Sveriges-miljomal/Etappmal/
[236] Høibye, Linda and Sand, Henrik (2018). Circular economy in the Nordic construction sector. https://www.diva-portal.org/smash/get/diva2:1188884/FULLTEXT01.pdf

	maximize the value of existing buildings. There are also potential opportunities to achieve environmental benefits by reducing emissions from building use. Repurposing existing buildings can also help extend their lifetimes and reduce the need for new construction. For more Swedish-specific, suggested policy recommendations, see 'Circular Economy in the Nordic Construction Sector'. [237]
Enablers and challenges	*Enablers:* Material passports which make material construction product information available; circular design techniques and designing for deconstruction so it is possible to separate and sort materials; Reduction in amount of hazardous materials; mandatory quotas for reused/recycled materials in building construction; policies that increase contractors' responsibility to sort and separate reusable and recycled materials during construction and after demolition *Challenges:* Design and building phases impact the ability to separate and reuse materials after use; Long lifetimes of buildings means building materials are tied up in use for a long time; Significant amounts of hazardous waste generated; ability of reused material to meet safety requirements; lack of quality assurance from reused building materials; statistical data on material flows is low quality
Preliminary assessment of the circular transition potential	A large number of different material flows are used in the building & construction sector, and there are numerous opportunities throughout the entire lifecycle of a building to reduce the need for virgin resources and increase resource efficiency through implementation of circular economy strategies.

Food & Beverage

Description of the area	Includes the production and sale of food and beverages. Most food consumed in Sweden is produced abroad, with 75% of emissions related to food production originating internationally. [238]
Existing activities and initiatives	Government aims to increase domestic food production to help lower emissions related to food and beverage. The Swedish EPA has set a target to reduce food waste by at least 20% by weight per capita from 2020 to 2025. [239] Food waste amounts to an average of 133 kilos per person of food waste is generated per year in Sweden. [240] The government has also created a national Food Strategy for Sweden to reduce vulnerability in the supply chain.
Potential opportunities and benefits	Reduce food waste and other loses in the value chain (both prior to and after consumption) through increased use of data and measurements. New business models to reuse and recycle food waste. Replace imported food with domestic production (in situations related to high climate impact). Increased resource efficient food pro-

[237] Høibye, Linda and Sand, Henrik (2018). Circular economy in the Nordic construction sector. https://www.diva-portal.org/smash/get/diva2:1188884/FULLTEXT01.pdf
[238] Regeringskansliet (2020). Cirkulär ekonomi - strategi för omställningen i Sverige. https://www.regeringen.se/informationsmaterial/2020/07/cirkular-ekonomi---strateg
[239] Naturvårdsverket (2021) Etappmål. http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Sveriges-miljomal/Etappmal/
[240] Naturvårdsverket (2018) Matavfall i Sverige. https://www.naturvardsverket.se/Documents/publ-filer/8800/978-91-620-8861-3.pdf?pid=26710

	duction. Current food and beverage production is often resource intensive; for example, the sector is one of the most water intensive sectors. Reduced water usage, eutrophication, and other environmental benefits such as nutrient reuse could be achieved through increased reuse and recycling of resources in the sector.
Enablers and challenges	*Enablers:* Collaboration between government and companies in the food chain; National framework for how companies should measure and report food waste; Digital solutions that can help to measure and reduce food waste *Challenges:* Gaps in data and uncertain statistics due to production and waste originating outside the country's borders
Preliminary assessment of the circular transition potential	Although most food waste is generated during the consumption phase in households[241], opportunities for circular solutions are present throughout the entire food chain. Focus should be on reducing and reusing 1) 'inevitable food waste' (i.e. things that cannot be reused by humans) and 2) 'unnecessary' food waste (i.e. food that could have been used by humans but is left unused.

Mobility/Transport & Logistics

Description of the area	Includes production, buying, selling, operation, and end-of-life for of all forms of transportation. Domestic transport accounts for Sweden's second-largest source of carbon emissions.[242]
Existing activities and initiatives	Transport is a significant part of Sweden's CO_2 emissions, therefore it is a focal point in the Swedish Circular Economy Strategy. To meet Swedish emission goals, mobility has been identified by the government as an area to become more resource efficient and circular. It is also a focus area for public procurement in Sweden.
Potential opportunities and benefits	If Sweden can contribute to shape the future of mobility as resource-efficient, it is expected the household and societal cost of transportation will decrease, the environmental impact of transportation will decline, and the competitiveness of Swedish mobility solutions will increase. Opportunity areas include transitioning from selling vessels/vehicles to Mobility as a Service (MaaS) and Logistics as a Service (LaaS). One area of focus for LaaS is the 'last mile', or between shops and homes, as it is the most expensive and least environmentally efficient leg of the logistics journey (most trips are still done by vehicle). As returns from e-commerce grow, better return logistic solutions are also needed; on average, 22 percent of all clothes purchased online in Sweden are returned by the customer.[243]

[241]IVA (2020) Resurseffektiv livsmedelssektor i Sverige – Mätning av matsvinn och övrigt matavfall. https://www.iva.se/globalassets/bilder/projekt/resurseffektivitet-och-cirkular-ekonomi/201912-iva-rece-branschrapport-livsmedel-i.pdf

[242] Statistics Sweden (2019) Greenhouse gas emissions by the Swedish economy unchanged in 2018. https://www.scb.se/en/finding-statistics/statistics-by-subject-area/environment/environmental-accounts-and-sustainable-development/system-of-environmental-and-economic-accounts/pong/statistical-news/environmental-accounts--emissions-to-air-fourth-quarter-of-2018/

[243] Cullinane, S., Browne, M., Karlsson, E. (2017). An examination of the reverse logistics of clothing (r)e-tailers in Sweden, University of Gothenburg

Enablers and challenges	*Enablers:* Data to enable connection between different modes of transportation; open data and regulated usage of data; function-based procurement strategies that expresses needs to be met rather than expressing how something should be achieved[244]; increased cooperation between transport buyers and providers, emerging business models that shift incentives away from individual vehicle ownership; the growth of electric mobility infrastructure like charging stations; Sweden is a digitally well-connected country. *Challenges:* Expansion of 5G network is slow; data sharing brings privacy and legal concerns; limited public-private partnerships to support infrastructure development (unlike many other European countries); fears of business cannibalization as a result of cooperation among different transportation service providers; the impact of COVID-19 on shared transportation modes
Preliminary assessment of the circular transition potential	As domestic transport must reduce emissions by 70% by 2030[245], there is significant potential for a circular mobility transition. Numerous opportunities for circular mobility solutions exist: 1) in usage, such as through service-based solutions that increase product utilization, help extend product lifetimes, and decrease carbon emissions, and 2) at end-life, such as through increased recovery and reuse of materials. In fact, one particular opportunity lies in increasing recovery of steel, aluminum and plastic from end-of-life vehicles, as this is one of the value chains where materials 'fall' most out of use in Sweden[246]. Reverse logistic transport solutions are also needed in a circular economy to help extend the lifetimes of products and materials.

Metals & Minerals

Description of the area	Relating to the use of minerals and metals such as steel and aluminium as well as critical raw materials in the Swedish economy.
Existing activities and initiatives	The Swedish Circular Economy Strategy focuses on 'critical' raw materials that are crucial for innovation, especially in the transition to sustainable energy technologies. For example, electrification of society means an increased use of lithium-ion batteries and reliance on critical materials like lithium. Another example is rare earth metals wind energy and electric vehicles applications. Although such critical materials are often used in small quantities, a number of concerns make circular solutions for these materials necessary: 1) global demand is increasing for these materials, 2) concentration of mining outside of Sweden poses supply chain vulnerabilities and 3) relatively low recycling rates for these materials.
Potential opportunities and benefits	New opportunities for Sweden's mining and raw material production industries, such as playing a role in new material production and end-of-life material handling. Increased circular material flows for minerals and metals in Sweden, including steel

[244] IVA (2020) Resource Effectiveness – Circular Economy Subproject: Mobility. https://www.iva.se/globalassets/bilder/projekt/resurseffektivitet-och-cirkular-ekonomi/202002-iva-rece-branschrapport-mobilitet-english-b.pdf
[245] Ministry of Foreign Affairs (2017) The Swedish Government's climate initiatives – three years into the electoral period. https://www.government.se/articles/2017/10/the-swedish-governments-climate-initiatives--three-years-into-the-electoral-period
[246] Material Economics. Ett värdebeständigt svenskt materialsystem. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem

	and aluminum, are shown to have significant economic and environmental benefits. Each year, around 29 billion SEK of steel and 3.1 billion SEK of aluminum reach end of use.[247] In terms of critical materials, batteries and electrical products are two streams that are of particular interest for increased use and recycling. The government is considering a deposit system for small electronics to increase the collection and recycling of electrical waste. Extracting materials from existing mining waste has been suggested as one potential source for critical metals and minerals in Sweden.
Enablers and challenges	*Enablers:* designing products for easier material recycling, especially in terms of critical raw materials *Challenges:* recycling rates for these materials; extraction from mix-waste streams; quality losses in recycling
Preliminary assessment of the circular transition potential	Sweden is in relatively good position - the collection of electrical waste in Sweden is at a relatively high level, and even though the trend is downward there is potential to further increase the collection, especially of small electronics. Recovery of critical materials is a priority.

Textiles

Description of the area	Includes the production, purchasing, and end-of-life for material (i.e. fibre, textiles) and finished goods (i.e. clothing).
Existing activities and initiatives	The EPA has a 2025 target to decrease textiles in household waste by 60% from 2015. Each year in Sweden, around 15 kg of textiles are consumed per person. According to the Swedish Circular Economy Strategy, most of these textiles are incinerated (around 8%). However, it is estimated that much of these textiles are in good condition and could be further used. [248] Introducing producer responsibility measures to make it easier for households to recycle or reuse textiles was suggested in Swedish Circular Economy Strategy and new legislation will be enacted starting in 2022.
Potential opportunities and benefits	Increasing garment lifetimes is most likely the most effective intervention to reduce climate impact. Opportunities include encouraging new consumption models and extending the lifetime of textiles through new business models that encourage reuse, rental, and subscription models. Technical innovation such as digital labelling to assist with material sorting and textile traceability. [249] Scale-up of chemical recycling as an alternative to mechanical recycling. National framework for handling different materials and products.

[247] Material Economics. Ett värdebeständigt svenskt materialsystem. https://materialeconomics.com/new-publications/ett-vardebestandigt-svenskt-materialsystem

[248] IVA (2019) Rapport: En resurssmartare textilsektor. https://issuu.com/iva-publikationer/docs/201911-iva-rece-branschrapport-textil-j

[249] IVA (2019) Rapport: En resurssmartare textilsektor. https://issuu.com/iva-publikationer/docs/201911-iva-rece-branschrapport-textil-j

Enablers and challenges	*Enablers:* Numerous projects and platforms conducted including, MISTRA Future Fashion (focused on sharing, reusing and prolonging garment lifetimes) and Textile & Fashion 2030 provide cross-sector collaboration and arenas for knowledge development; fibre technology that decreases fossil-fuel reliance and increases recyclability; on-demand production and local manufacturing techniques could reduce over production; multiple end-of-life solutions and processes to address the variety of material types *Challenges:* inefficient sorting and recycling solutions; Lack of data about fibre content makes end-of-life handling challenging; lack of alternatives for fossil-fuel based fibres; need for more data about newly innovated material fibres; increasing availability of alternative fibres; currently a lack of scalable recycling solutions for polyester materials; short sale cycles for garments are established practice in industry
Preliminary assessment of the circular transition potential	Opportunities exist for both the production and consumption of textiles. The Swedish Circular Economy Strategy emphasizes focusing on 1) Designing textiles for reuse and material recycling 2) New business models that encourage optimized usage and reusage of textiles and 3) Increased and cost-effective methods for textile recycling

Plastics

Description of the area	Variety of materials (mainly oil-based) used in a number applications including packaging, building materials, vehicles, and electronics.
Existing activities and initiatives	Sweden leads a global agreement effort to reduce plastic waste and microplastic in oceans, including a tax on single use plastic bags. It is estimated only 16% of plastic waste is recycled in Sweden, with 84 % of plastic waste burned or landfilled. The Sweden Circular Economy Strategy emphasizes overcoming challenges related to recycling of plastics as one specific focus as well as reducing and preventing plastic waste for economic and environmental impact reduction. Systems for returning plastic products exist, including the 'Pant' system, where consumers receive money back in return for plastic products.
Potential opportunities and benefits	Economic benefits by retaining value. Currently, it is estimated plastic worth 10 billion SEK reaches end of use each year. The Material Economics report states: "All in all, a mere 1.3 billion of the original 10 billion is captured. This is in sharp contrast to public statistics on plastics, which states that 53% of 'plastic waste' is recycled." It is estimated only 10-20% of all the plastic put on the Swedish market is recycled into new raw material. [250] Increased reuse and recycling would also have environmental benefits including reduced emissions from plastic incineration and reduced plastic littering, including in water. New packaging solutions focused on refill or reuse (i.e. Swedish start-up loop-it) could also help extend the lifetime of plastic packaging.

[250] IVA (2020) Resource-effective and circular plastics flows – The role of Plastic in a circular society. https://www.iva.se/globalassets/bilder/projekt/resurseffektivitet-och-cirkular-ekonomi/202002-iva-rece-branschrapport-plast-english-b.pdf

Enablers and challenges	*Enablers:* Better data and statistics of the various flows; digital traceability systems; developing markets and business models for recycled plastics, including increased capacity of system and collection and recycling efficiency; digital marketplaces for recycling raw materials; Chemical recycling is a promising direction; designing products so it is possible to recycle plastics; New source sorting to improve quality of plastic material *Challenges:* Current recycling technology is limited; quality deterioration in existing recycling techniques plastic lead to loss of value; demand for recycled plastics; lack of cooperation or coordination between Swedish industries involved in plastic flows[251]
Preliminary assessment of the circular transition potential	Opportunities to reduce, prevent, and recycle plastic waste and packaging for economic and environmental impact reduction. Current figures estimate only 10-20% of all the plastic put on the Swedish market is recycled into new raw material. Overcoming the many challenges related to recycling of plastics is one specific focus going forward.

Digitalization

Description of the area	Related to information technology and infrastructure, digital software and data sharing. This includes parts: measuring and collecting data; connecting and transferring data between devices; storing data; and processing/interpretating the data.
Existing activities and initiatives	Digital platforms contribute to product sharing opportunities (i.e. Off2Off).
Potential opportunities and benefits	Sharing of information, digital labelling systems and information exchange can be a powerful tool to support CE and facilitate industrial symbiosis, monitoring, maintenance and updating. Opportunities include 1) digital traceability solutions to facilitate circular business models 2) Digital alternatives for physical products to reduce resource consumption. Because sharing of information between companies and across the value chain is crucial in a circular economy, and Teknikföretagen's 2020 report emphasizes cybersecurity legislation to facilitate this collaboration[252]. Other opportunities include digital solutions to collect, sort, and present data on circularity metrics. Track and trace and digital monitoring of materials and products in use can help contribute to maintenance and collection of materials for a circular economy. Digital material 'passports' can contain valuable product information including material content, origin, environmental impact, and end of life solutions. This can be used to inform companies and other members of the value chain about products and help them make informed choices that contribute to increased product and resource life. The Teknikföretagen report highlights harmonizing and developing standards for such passports.

[251] IVA (2020) Resource-effective and circular plastics flows – The role of Plastic in a circular society. https://www.iva.se/globalassets/bilder/projekt/resurseffektivitet-och-cirkular-ekonomi/202002-iva-rece-branschrapport-plast-english-b.pdf

[252] Teknikföretagen (2020). Digitaliserade affärsmodeller för cirkulära materialflöden. https://www.teknikforetagen.se/globalassets/rapporter/miljo-energi-och-klimat/digitaliserade-affarsmodeller-for-cirkulara-materialfloden.pdf

Enablers and challenges	*Enablers:* Blockchain, 5G and other technologies, machine learning, open standards in digital environments *Challenges:* Information security; Privacy and IP concerns; misuse of data; technological obsolescence
Preliminary assessment of the circular transition potential	Digitalization is a powerful enabler that can help make circular material flows and business models possible. High potential in the circular transition because it allows the optimization and sharing of knowledge across the value chain.

Finance

Description of the area	The projects and ventures that need to take place in industry and business to transition to a circular economy need financing. Everything from large transitional infrastructure and new technology projects to development and change of business models and scaling of start-up circular business venture need both long-term (equity) and sort-term (loan) capital. The circular transition of the economy will not happen without active financing decisions from the financial actors. The financial sector constitutes 3,8% of the Swedish GDP (in 2019).[253]
Existing activities and initiatives	A number of Swedish banks have shown interest in different types of circular ventures, both research projects and training programs. Danske Bank is running a Nordic start-up accelerator, where – for the third consecutive year – only circular businesses get coached. Financing has been nominated to one of the work groups of the Swedish governmental collaboration groups "Climate transition of Swedish industry". Here circular economy and financing of circular business models are brought up as one of the key themes.
Potential opportunities and benefits	For the financial sector, there is an opportunity for new business. When society and business transition to circular models, the financing actors who understand this and take lead will be those that benefit the most. The transition will need updated risk/return frameworks, which means an opportunity to also better understand the risk of 'business as usual' and current projects, for example linked to resource scarcity and changing demand.
Enablers and challenges	*Enablers:* Banking and financial markets are international. Many of the larger banks in Sweden operate internationally, specifically in the Nordic and Baltic regions. There is an opportunity to collaborate between banks and other financial actors at a Nordic level, to enable a broader and faster transition. *Challenges:* Banking is a very traditional industry, risk averse and with inbuilt rigidity. As new business models develop in industry, risk assessments need to change, including how to assess collateral, payback periods and assets in new business ecosystems. These changes are demanding and challenging but could potentially unlock new and more profitable business opportunities.
Preliminary assessment of the circular transition potential	All circular transition projects and ventures – in industry as well as in the public sector – will need financing and capital. Therefore, the circular potential of this area is high.

[253] Swedish Bankers' Association (2021) Den svenska finansmarknaden. https://www.swedishbankers.se/fakta-och-rapporter/svensk-bankmarknad/den-svenska-finansmarknaden/

Procurement

Description of the area	Concerns the purchasing and supply of goods and services by state-owned enterprises.
Existing activities and initiatives	The Swedish Circular Economy Strategy highlights great potential to reduce emissions through public action and promote the supply and demand for innovative, circular and climate-smart solutions. Public procurement accounts for around 700 billion SEK in spending, or about 1/6 of Swedish GDP. One example of an industry where circular procurement initiatives are ongoing is furniture. Several examples of circular public procurement of furniture exist including repair and redesign services, requirements that furniture suppliers have 5 years of spare parts in stock, standards for procuring material with threshold levels of recycled content, procuring reused furniture. A number of different ongoing initiatives are trying to support municipalities hands on in circular public procurement. Eg. UHM (Upphandlingsmyndigheten) is launching an arena for innovation procurement, and on assignment from the government has also recently launched a special guide for circular public procurement. ReSource (financed by Energimyndigheten) also runs several initiatives on the same theme and Fossilfritt Sverige is gathering 6 frontrunner municipalities to support and develop best practice. Government run "Samverkansprogram" for public procurement as a driver for climate change, round table discussions in between authorities, research organisations and companies.
Potential opportunities and benefits	Use this purchasing power to encourage circular offerings and discourage linear offerings. Create conditions for a greater supply and demand for services for reuse, repair and sharing services.
Enablers and challenges	*Enablers:* Unites public-private actors, local politicians setting targets, and demand on government authorities to take lead (a possible enabler identified and suggested but not decided) *Challenges:* Slow progress due to procurers often not having circular economy competence and time, lack of targets from politicians, lack of acceptance within organisations/users for circular solutions; Organisational/structures not set up for circular business models
Preliminary assessment of the circular transition potential	As public procurement is comprised of a significant portion of Swedish GDP, there is great potential to stimulate circular economy solutions and contribute to resource efficiency, recycling and circular business models through public procurement. In terms of reducing carbon emissions, five agencies contribute to almost half of the emissions: Swedish Property Agency, the Swedish Civil Aviation Administration, the Swedish Maritime Administration, Svenska kraftnät and the Swedish Transport Administration.[254]

[254] Upphandlingsmyndigheten (2021) Statens miljöpåverkan. https://www.upphandlingsmyndigheten.se/om-hallbar-upphandling/miljomassigt-hallbar-upphandling/analysera-inkopen-med-miljospendanalys/statens-miljopaverkan/

	The state's GHG equivalent of purchases (4.3 million CO_2-eq) was just under 1/5 of total public sector purchases. Land and buildings are generally the top in terms of highest contribution to greenhouse gases, followed by equipment and materials. However, what is procured varies depending on the level of government so this must also be considered.

Country-specific sum-up

Table F. Preliminary assessment of the circular transition potential

Area	Preliminary assessment of the circular transition potential
Building & Construction	A large number of different material flows are used in the building & construction sector, and there are numerous opportunities throughout the entire lifecycle of a building to reduce the need for virgin resources and increase resource efficiency through implementation of circular economy strategies.
Food & Beverage	Although most food waste is generated during the consumption phase in households, opportunities for circular solutions are present throughout the entire food chain. Focus should be on reducing and reusing 1) 'inevitable food waste' (i.e. things that cannot be reused by humans) and 2) 'unnecessary' food waste (i.e. food that could have been used by humans but is left unused.
Bioeconomy	Sweden is rich in natural resources and skilled in refinement/recycling of raw materials. Moving towards a circular, bio-economy presents Sweden with 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 phase for bio-based materials (including increased recycling of bio-based solutions). The largest market for bio-based solutions in Sweden is the use of biomass within transport and energy and replacing raw materials in the chemical and petrochemical sectors with bio-based products.
Manufacturing & Process Industries	Large scale sector with significant opportunities for increasing circularity. Interconnected with many of the identified material flows and high potential for improved resource and energy use. Opportunities for product remanufacturing and increased use of secondary materials in production including from byproducts/waste/recycling.
Mobility/Transport & Logistics	As domestic transport must reduce emissions by 70% by 2030, there is significant potential for a circular mobility transition. Numerous opportunities for circular mobility solutions exist: 1) in usage, such as through service-based solutions that increase product utilization, help extend product lifetimes, and decrease carbon emissions, and 2) at end-life, such as through increased recovery and reuse of materials. One particular opportunity lies in increasing recovery of steel, aluminum and plastic from end-of-life vehicles.
Metals & Minerals	Sweden is in relatively good position - the collection of electrical waste in Sweden is at a relatively high level, and even though the trend is downward there is potential to further increase the collection, especially of small electronics. Recovery of critical materials is a priority.
Textiles	Opportunities exist for both the production and consumption of textiles. The Swedish Circular Economy Strategy emphasizes focusing on 1) Designing textiles for

	reuse and material recycling 2) New business models that encourage optimized usage and reusage of textiles and 3) Increased and cost-effective methods for textile recycling
Plastics	Opportunities to reduce, prevent, and recycle plastic waste and packaging for economic and environmental impact reduction. Current figures estimate only 10-20% of all the plastic put on the Swedish market is recycled into new raw material. Overcoming the many challenges related to recycling of plastics is one specific focus going forward.
Digitalisation	Digitalization is a powerful enabler that can help make circular material flows and business models possible. High potential in the circular transition because it allows the optimization and sharing of knowledge across the value chain.
Public Procurement	As public procurement is comprised of a significant portion of Swedish GDP and GHG emissions, there is great potential to stimulate circular economy solutions and contribute to resource efficiency, recycling and circular business models through public procurement. Land and buildings are generally the top in terms of highest contribution to greenhouse gases, followed by equipment and materials. However, what is procured varies depending on the level of government so this must also be considered.
Finance	All circular transition projects and ventures – in industry as well as in the public sector – will need financing and capital. Therefore, the circular potential of this area is high.

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The Faroe Islands

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Faroeislands.fo, The Government of the Faroe Islands, 2021. https://www.faroeislands.fo/	Official website	Presents an overview of sustainability policies and documents on the environmental and nature area.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Renewable energy	The Government of the Faroe Islands (2019). Natural Resources. https://www.faroeislands.fo/nature-environment/natural-resources/	The energy production in the Faroe Islands already has a renewable share of 45%, and in the energy production from wind turbines is expected to increase in the future. There are also experiments with tidal turbines, indicating that technological development may be an enabler of a circular transition in this field[255].
Bio-based industries/ Agriculture, fishery	The Government of the Faroe Islands (2019). Natural Resources. https://www.faroeislands.fo/nature-environment/natural-resources/	Like in Greenland, the fishery industry makes up around 90% of the export in the Faroe Islands. Aquaculture is also a substantial part of the bio-based industries. On-land agriculture is also important, and 60% of the meat consumption comes from locally produced sources. There is interest in higher self-sufficiency in the islands, which could be supported by technological development of the agricultural sector[256].
MATERIAL FLOWS		
Waste streams and recycling	IRF (2021). IRF ment føroyska burturkasttrappu. https://irf.fo/irf-ment-foroyska-burturkasttrappu/	The waste handling system in the Faroe islands can be refined further to avoid loss of energy and materials. Recycling has recently become available for more waste fractions, and a project has been run where citizens were given the material to compost bio-waste at home to address the loss of bio-waste[257].
DRIVERS / ENABLERS		
Circular businesses	The Government of the Faroe Islands (2019). Faroese businesses join forces to prioritise sustainability.	A business network has been established to set up a common sustainability strategy. The tourism sector is a growing industry in the Faroe Island, and in this sector, there is

[255] The Government of the Faroe Islands (2019). Natural Resources https://www.faroeislands.fo/nature-environment/natural-resources/
[256] The Government of the Faroe Islands (2019). Natural Resources https://www.faroeislands.fo/nature-environment/natural-resources/
[257] IRF (2021). IRF ment føroyska burturkasttrappu. https://irf.fo/irf-ment-foroyska-burturkasttrappu/

	https://www.faroeislands.fo/the-big-picture/news/faroese-businesses-join-forces-to-prioritise-sustainability/	also increasing focus on sustainable practices to minimize the pressure on the climate and natural resources[258].

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Faroeislands.fo, The Government of the Faroe Islands, 2021. https://www.faroeislands.fo/

IRF (2021). IRF ment føroyska burturkasttrappu. https://irf.fo/irf-ment-foroyska-burturkasttrappu/

The Government of the Faroe Islands (2019). Faroese businesses join forces to prioritise sustainability. https://www.faroeislands.fo/the-big-picture/news/faroese-businesses-join-forces-to-prioritise-sustainability/

The Government of the Faroe Islands (2019). Natural Resources. https://www.faroeislands.fo/nature-environment/natural-resources/

[258] The Government of the Faroe Islands (2019). Faroese businesses join forces to prioritise sustainability. https://www.faroeislands.fo/the-big-picture/news/faroese-businesses-join-forces-to-prioritise-sustainability/

Greenland

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Departmentet for forskning og miljø (2020). Waste Action Plan, Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf	Government plan	The action plan draws up objectives and actions necessary to improve waste handling from local to national level in Greenland. It includes specific goals for waste prevention and circular economy.
Departementet for fiskeri, Fangst og Landbrug (2020). Agricultural Strategy 2021-2030, Strategi for landbrug 2021-2030. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Fangst%20og%20fiskeri/DK/Final%20Strategi%20for%20Landbrug%202021-2030%20DK.pdf	Government strategy report	In the agricultural strategy issued by Greenland's Government focus lies on creating the framework for increased production and sales of local products. Improving resource efficiency in the production is a consistent theme throughout the strategy.
Anguniakkavu (2020). Sustainable Development Goals Greenland. https://www.anguniakkavut.gl/	National overview	The national website for SDGs provides an overview of the actions directed towards fulfilling the SDGs in Greenland.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Renewable energy	Naalakkersuisut (2020). Vedvarende energi som eksempel på succesfuld importsubstitution og som eksportpotentiale - hvad skal der til i praksis?	Greenland has high potential for renewable energy, and 70% of the public energy supply is already made up by energy from renewable sources. A defined goal is that public energy supply be renewable as far as possible in 2030, and with the establishment of new hydropower plants they expect the share to be at 90% in 2030[259]. Renewable energy is also seen as a potential export product in Greenland,

[259] Naalakkersuisut, (2020). Vedvarende energi som eksempel på succesfuld importsubstitution og som eksportpotentiale - hvad skal der til i praksis? https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/Oekonomisk%20raad/Seminar%202020/DK%202%20Energi%20pr%C3%A6sentation%20til%20JSN%20DK.pdf

	https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/Oekonomisk%20orad/Seminar%202020/DK%202%20Energi%20pr%C3%A6sentation%20til%20JSN%20DK.pdf	as it can support Power-to-X or be used for in data centers that require high amounts of energy[260].
Waste and recycling	Departmentet for forskning og miljø (2020). Waste Action Plan, Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf	In Greenland's Waste Treatment Strategy, goal number 3 is related to circular economy and waste prevention. Specifically, the goal aims to reduce the amounts of waste produced, with special focus on waste from the public and industrial sectors, and increasing reuse and recycling. A number of initiatives will be implemented to support the goal, including increased waste sorting, activities for direct reuse, dialogue with relevant stakeholders considering packaging and development of public green procurement methods[261].
Bio-based industries / Agriculture, fishery	Departementet for fiskeri, Fangst og Landbrug (2020). Agricultural Strategy 2021-2030, Strategi for landbrug 2021-2030. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Fangst%20og%20fiskeri/DK/Final%20Strategi%20for%20Landbrug%202021-2030%20DK.pdf	The fishery sector has a big economic importance in Greenland, it accounts for the majority of the export and a large share of the employment. There are initiatives to support energy efficiency in the fisheries, protect the fish stocks and make use of by-products for other types of agricultural production. Agriculture is another relevant sector, especially with regards to animal production, primarily sheep. Efforts are being made to increase the local production of fodder, to increase substitution of imported fodder[262].
MATERIAL FLOWS		
Packaging	Departmentet for forskning og miljø (2020). Waste Action Plan, Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf	Packaging is one of the focus flows in the Waste Action Plan[263].

[260] Naalakkersuisut, (2020). Formandskab 2020. https://naalakkersuisut.gl/da/Naalakkersuisut/Departementer/Udenrigsanliggende/Nordisk-Samarbejde/Formandskab-2020

[261] Departmentet for forskning og miljø, (2020). Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf

[262] Departementet for fiskeri, Fangst og Landbrug, 2020. Strategi for landbrug 2021-2030. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Fangst%20og%20fiskeri/DK/Final%20Strategi%20for%20Landbrug%202021-2030%20DK.pdf

[263] Departmentet for forskning og miljø, 2020. Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf

Biodegradable waste	Departmentet for forskning og miljø (2020). Waste Action Plan, Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf	The main flow of biodegradable waste comes from fisheries[264]. Circular opportunities, such as reducing by-catch and thereby reducing the amount of discarded fish, or higher quality utilisiation of the nutrients in the biomass, lies in this waste flow.
DRIVERS / ENABLERS		
Sustainable procurement	Anguniakkavu (2020). Sustainable Development Goals Greenland. https://www.anguniakkavut.gl/	The dependence on imported products, the need for long transport of these products and a small population distributed over a large land area constitute challenges for sustainable procurement in Greenland. Cooperation and agreements that support local procurement, resource efficient transport and procurement of sustainable products could support a circular transition on this sector[265].
Circular innovation	Naalakkersuisut (2020). Vedvarende energi som eksempel på succesfuld importsubstitution og som eksportpotentiale - hvad skal der til i praksis? https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/Oekonomisk%20raad/Seminar%202020/DK%202%20Energi%20pr%C3%A6sentation%20til%20JSN%20DK.pdf	Innovation and establishment of new technology is an enabler for the circular transition in Greenland. This relates to the renewable energy sector, where new technologies can allow more efficient energy storage, the waste sector, where innovations can promote usage of waste material, and the agricultural sector, where technological innovations can contribute to increased productivity and nutrient cycling[266].

Sources

Anguniakkavut, (2020). Ansvarligt forbrug og produktion. https://www.anguniakkavut.gl/12-ansvarligt-forbrug-og-produktion
Anguniakkavu (2020). Sustainable Development Goals Greenland. https://www.anguniakkavut.gl/

Departmentet for forskning og miljø (2020). Waste Action Plan, Affaldshandlingsplan. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Natur/Affaldshandlingsplan%202020-2031.pdf

Departementet for fiskeri, Fangst og Landbrug (2020). Agricultural Strategy 2021-2030, Strategi for landbrug 2021-2030. https://naalakkersuisut.gl/~/media/Nanoq/Files/Publications/Fangst%20og%20fiskeri/DK/Final%20Strategi%20for%20Landbrug%202021-2030%20DK.pdf

[264] Environment Agency of Iceland, 2020. Biodegradable waste as a Resource for Innovation. https://ust.is/library/Skrar/Einstaklingar/urangur/NordBio%20final%20report.pdf

[265] Anguniakkavut, (2020). Ansvarligt forbrug og produktion. https://www.anguniakkavut.gl/12-ansvarligt-forbrug-og-produktion

[266] Naalakkersuisut (2020). Vedvarende energi som eksempel på succesfuld importsubstitution og som eksportpotentiale - hvad skal der til i praksis? https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/Oekonomisk%20raad/Seminar%202020/DK%202%20Energi%20pr%C3%A6sentation%20til%20JSN%20DK.pdf

Environment Agency of Iceland, 2020. Biodegradable waste as a Resource for Innovation. https://ust.is/library/Skrar/Einstaklingar/urgangur/Nord-Bio%20final%20report.pdf

Naalakkersuisut, (2020). Formandskab 2020. https://naalakkersuisut.gl/da/Naalakkersuisut/Departementer/Udenrigsanliggende/Nordisk-Samarbejde/Formandskab-2020

Naalakkersuisut (2020). Vedvarende energi som eksempel på succesfuld importsubstitution og som eksportpotentiale - hvad skal der til i praksis? https://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Finans/DK/Oekonomisk%20raad/Seminar%202020/DK%202%20Energi%20pr%C3%A6sentation%20til%20JSN%20DK.pdf

Åland

Preliminary identification of areas

The sources used in identification of areas are listed in Table A, and the preliminary identified areas listed in Table B.

Table A. Sources used in the identification of areas

Source	Status of the source	Short content
Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	National strategy	The agenda consists of a vision and seven strategic development goals for 2030. For each development goal, there is a roadmap with targets and indicators. Goal 7, sustainable and mindful patterns of consumption and production includes several action plans of relevance for the circular economy. The action plan for the industry[267] includes actions for the supply chain, waste, production, transport and logistics, and material. It also suggests that a separate action plan for the construction sector will be developed (work in progress). The action plan for wholesales and grocery stores[268] focuses on the food chain, packages and waste. It identifies the need for further action plans for circular innovations. In 2021, such action plans are in development for the sustainable food chain, for circular services, and for the sharing economy.

Table B. Preliminary identification of areas

Area	Source	Reasoning
INDUSTRIES / SECTORS		
Sustainable food system	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	A major share of the industrial production in Åland is connected to primary industries and food production, specifically agriculture and fisheries. Some circular solutions have been piloted in the area. The major challenges for an island society like Åland lie in the small scale that does not encourage producers to make the big investments needed for developing sustainable circular solutions. An action plan for the sustainable food system is under development (2021).

[267] Bärkraft, (2019). Den hållbara industrin på Åland. Åtgärdsplan 2020-2030, https://www.barkraft.ax/sites/default/files/attachments/timeline/den_hallbara_industrin_pa_aland_atgardsplan.pdf
[268] Bärkraft, (2020). Hållbar dagligvaruhandel och grossist Färdplan, ansvarsfördelning och tidsplan - Version 1, 7.2.2020

Bio-economy / Agriculture, fishery (and forestry)	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	A major share of the industrial production in Åland is connected to primary industries - specifically agriculture and fisheries. The area is linked to the strategic development goals 7 (sustainable and mindful patterns of consumption and production), 3 (water) and 6 (energy). Under goal 3, actions are in development for reducing the stress on the natural resources and increasing the circularity in agriculture and animal husbandry, e.g. connected to nutrients and reuse of water.
Real estate and construction / Building sector	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	The construction sector has been identified as the biggest industrial waste producer. In the development and sustainability agenda, the action plan for industry includes the following actions for the construction industry: wood construction, waste minimization, energy efficiency. The need for a specific action plan for sustainable construction industry has also been identified.
Transport and logistics	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	The transport and logistics sector is of great importance for Åland and it brings great challenges linked to emissions but also huge new opportunities brought by biobased fuels, electric vehicles and increased resource efficiency through e.g. digitalized solutions. The need for a specific action plan for the shipping industry has been identified. The possibility of marketing Åland as a test zone for e.g. digitalized transport solutions has also been discussed. The development of the public traffic system includes actions for e.g. digital services for circular and sharing economy solutions.
MATERIAL FLOWS		
Packages	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	Packages, specifically plastic, are among the indicators of the strategic development goal for sustainable consumption and production patterns.
Waste to resources	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	One of the targets of the strategic development goal 7 is waste to resources and several actions are underway.
Plastics	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	Åland hosts a (to its economy) significant plastics industry that motivates the emphasis on plastics in the circular economy. As an island society, the challenges with plastic waste and the sea are also

		high on the agenda. Åland's strategy for preventing plastic waste and microplastics into the sea[269] links to the strategic development goals 7 of sustainable consumption and production but also goal 3 on the good quality of all water. It includes actions for reducing and replacing plastics with other materials, connected to the circular economy.
Textiles	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	The material flow of textiles is emphasized in the waste reduction actions and the actions for prolonging life time, reuse and recirculation.
DRIVERS / ENABLERS		
Digitalisation	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	Digitalisation and open data is prioritized in several action plans of the sustainability agenda linked to e.g. transport and logistics. Digitalization can be used to minimise the transport needs. There have also been discussion on e.g. digital platforms for sharing resources linked to material flows and industrial symbiosis.
Public procurement	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	Actions for developing sustainable public procurement, including circularity aspects are emphasized in the sustainability agenda. The work is in development and relates closely to the sustainable food chain as well as e.g. energy procurement in the real estate sector.
Circular innovation	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf .	The need for circular innovations is emphasized in connection to several actions e.g. related to transforming waste into resources, or developing new circular service models. The sustainability agenda includes a network for big industry and a network for SME's that are discussing new innovative sustainability solutions. Innovative circular consumption initiatives exist, driven mostly by the 3rd sector, linked to reuse, recirculation, and sharing, but most initiatives are small-scale and do not show large-scale economic potential.
Circular consumption	Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/de-	Several actions are planned in 2021-22 to support sustainable and circular consumption patterns, including a guide for circular services (such as repair), actions to support the sharing economy, and consumer guides on different products with traffic

[269] Ålads Landskapsregering (2017). Strategi för att förhindra att plast och mikroplast sprids i miljön. https://www.regeringen.ax/sites/www.regeringen.ax/files/attachments/page/plaststrategi_-_strategi_for_att_forhindra_att_plast_och_mikroplast_sprids_i_miljon.pdf

	fault/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf	light[270]. The strategic goal for circular consumption patterns includes targets for reuse and recycling.

Sources

Bärkraft (2020). Hållbar dagligvaruhandel och grossist Färdplan, ansvarsfördelning och tidsplan - Version 1, 7.2.2020

Bärkraft, (2019). Den hållbara industrin på Åland. Åtgärdsplan 2020-2030, https://www.barkraft.ax/sites/default/files/attachments/timeline/den_hallbara_industrin_pa_aland_atgardsplan.pdf

Bärkraft.ax (2019). Development and sustainability agenda for Åland. https://www.barkraft.ax/sites/default/files/attachments/page/media/development-and-sustainability-agenda-for-aland-2017-03-01.pdf

Ålads Landskapsregering (2017). Strategi för att förhindra att plast och mikroplast sprids i miljön. https://www.regeringen.ax/sites/www.regeringen.ax/files/attachments/page/plaststrategi_-_strategi_for_att_forhindra_att_plast_och_mikroplast_sprids_i_miljon.pdf

[270] One interesting example is the Åland index for consumer footprint developed by Ålandsbanken.

Annex 2. Stakeholder workshops

National stakeholder workshops were held in Denmark, Finland, Iceland, Norway and Sweden in the time 28.1. – 10.2.2021.

The workshop agenda included presentation of the project, presenting and discussing the potential of selected areas.

Participating organisations are listed in the Table 1.

Table 1. Stakeholder workshop participants

Workshop participants	
Denmark 28.1.2021	Technical University of Denmark Danish Business Authority Aalborg University Danish Agriculture & Food Council Environmental Protection Agency Confederation of Danish Industry The Danish Construction Association
Finland 10.2.2021	Association of Finnish Municipalities Business Finland Finnish Environment Institute (SYKE) Motiva Ltd. Natural Resources Institute Finland (Luke) Statistics Finland The Finnish Innovation Fund Sitra
Iceland 16.2.2021	Ministry for the Environment and Natural Resources The Farmer Association FENÚR (Waste Association) Green Building Council Iceland Green by Iceland KMPG Association of Aluminum Producers Association of Local Authorities Travel Industry Association (SAF) Financial Services Association (SFF) Fisheries Iceland (SFS) The Environment Agency
Norway 5.2.2021	Norsk Industri (Federation of Norwegian Industry) Eyde Cluster Avfall Norge NCCE (National Centre for Circular Economy) SSB (Statistics Norway) KLD (Ministry of Climate and Environment) Virke (Federation of Norwegian Enterprise) Samfunnsbedriftene (Organisation for social enterprises) SINTEF Nordic Innovation
Sweden 4.2.2021	Circular Sweden IVL Swedish Environmental Research Institute Swedish Environmental Protection Agency Lund University

	IDC West Sweden & Circular Hub Cradlenet ReSource Återvinningsindustrierna City of Gothenburg Region of Skåne Confederation of Swedish Enterprise The National Agency for Public Procurement RISE Research Institutes of Sweden

Table 2. Workshop agendas

Denmark 28.1.2021	•Introduction to project •Introduction to workshop •Interactive session1: selecting areas •Interactive session2: evaluating selected areas •Interactive session3: feedback on selected areas •Concluding remarks
Finland 10.2.2021	14.00 Tervetuloa ja tavoitteet 14.15 Kiertotalouden mielenkiintoiset alueet Suomessa 14.45 Pohjoismainen kiertotalouspotentiaali 15.20 Yhteinen keskustelu 15.50 Yhteenvetoa ja seuraavat askeleet 16.00 Tilaisuus päättyy
Iceland 16.2.2021	10:00 Kynning á verkefninu 10:10 Kynning á fyrstu niðurstöðum samantektar um helstu tækifæri hringrásarhagkerfisins á Íslandi 10:30 Umræða um þessar fyrstu niðurstöður a) Hvaða hugmyndir/vangaveltur vöknuðu 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? 11:15 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? 12:00 Málstofulok
Norway 5.2.2021	• Round-table introductions of participants • Brief presentation of the project • Facilitated discussion • Summary / wrap-up
Sweden 4.2.2021	9:30 Introduktion till projektet och preliminära resultat 9:50 Diskussion kring preliminära resultat (bikupa) 10:05 Gemensamdiskussion kring preliminära resultat 10:30 Paus 10:35 Gemensamdiskussion fortsatt 11:15 Diskussion kring nordisk potential och uppsummering 11:30 Slut