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TARGET CIRCULAR
Supporting SMEs to Success

Egidija Rainosalo, Hanna Tölli, Stephen Barry Hannon, Line Kjelstrup, Ann Kristin Nilssen, Sveinbjörg Rut Pétursdóttir and Niall O Leary

Advising businesses in the circular economy

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Advising businesses in the circular economy

Ideating and developing circular business opportunities

including case studies from forestry, marine and agriculture

Centria University of Applied Sciences

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Target Circular – Supporting Sustainable SMEs to Success

THE TARGET CIRCULAR project brings together partners from institutions in Ireland, Finland, Norway, Iceland, and Sweden. It draws on recent research into how companies can take a more evidence-based, structured approach to decision-making. Within the project, research partners work with SMEs to develop, pilot, and refine practical methods for rapid decision-making, using tools such as strategy mapping and the business model canvas. These same tools are also used to help SMEs progress toward circular-economy solutions and more sustainable business practices.

The project is co-financed by European Union funding programme Interreg Northern Periphery and Arctic.

Project Partners

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Contents

1 Introduction

The handbook to inspire, guide, and empower companies to recognize circularity not only as responsibility, but as competitive advantage and long-term value creation.

MOVING TOWARD a circular economy is a major change in the way companies create value. Instead of relying on constant inputs of virgin materials and producing large amounts of waste, circular approaches aim to keep products, components, and materials in use for as long as possible. Done well, this supports sustainable development by improving how efficiently resources are used, cutting waste, and strengthening economic durability—while also delivering environmental and social benefits.

This handbook is intended for business support organizations and provides practical guidance they can use when advizing companies on circular opportunities and implementation. By applying circular economy thinking, businesses can redesign processes so that by-products and discarded materials become inputs for new uses, resource consumption is reduced, and loops are closed across the value chain—capturing the idea that one actor's leftovers can become another actor's feedstock.

These strategies can deliver multiple advantages: streamlined operations, lower material and disposal costs, a smaller environmental footprint, and new revenue streams through services, reuse, refurbishment, remanufacturing, or recycling-based models. Circular practices can also make firms more adaptable to supply risks and price volatility, strengthening long-term competitiveness. Beyond operational gains, they may boost trust and visibility in the market, respond to rising expectations for sustainable products and services, and help organizations stay ahead of tightening policy and regulatory requirements. In summary, circularity offers a route to business growth that aligns profitability with sustainability.The handbook is structured to provide a comprehensive understanding of circular economy principles and their practical application. It begins with foundational concepts and inspirational examples, showcasing successful value chains and business models in sectors such as forestry, marine, and agriculture. These case studies serve to illustrate the potential of circular economy strategies to drive both environmental and economic benefits.

Next, the handbook moves beyond the conceptual discussion and concentrates on how organizations can apply circularity in real business settings. It introduces a selection of diagnostic tools that enable companies to benchmark their current practices against circular economy principles. The proposed analyses look inward, tracking inputs, outputs, and material movements, and revealing equipment, spaces, or resources that are not being fully used, as well as outward, by pointing to ways to identify partners and options in the wider market, such as secondary material exchanges, reuse networks, and raw-material information repositories. To support businesses in compliance and strategic alignment, the handbook also covers relevant legislation at multiple levels from general circular economy-related laws to industry-specific regulations in forestry, marine, and agriculture.

The final section of the handbook focuses on infrastructure providers in supporting the development of circular economy products and processes in the regions of Northern Periphery and Arctic.

This handbook highlights key applications of circular economy principles and assists in analysing their integrations within company's operations. After outlining preliminary ideas, it is recommended to utilize additional tools developed by the Target Circular – Supporting Sustainable SMEs to Success project for further evaluation of ideas and defining steps to implementation (Strategic Clarity Handbook).

2 Role of business support organization in developing circular economy value chains

- Inspire and encourage businesses to adopt innovative and sustainable practices.
- Equip companies with essential information and knowledge to be able to explore new opportunities.
- Help assess current situation and identify opportunities, provide tools and frame-works for doing so.
- Facilitate networking and assist in creating connections and partnerships for de-velopment of innovations and industrial symbiosis.
- Advice on access to financial resources, investment opportunities and grants to support companies development, investment.

Understand and inspire

- **Use real-world examples.** Demonstrate successful circular business models from relevant value chains (e.g., forest, seafood, agriculture).
- **Highlight opportunity, not obligation.** Frame circularity as innovation, new revenue potential, and risk reduction, not just waste management.
- **Encourage vision-setting.** Help companies imagine what circular success looks like in their industry and region.

2.1 Sustainable development main features

INTEGRATING SUSTAINABILITY into business development is no longer a choice, it's a strategic necessity. To succeed businesses must adopt practices that address environmental, social, and economic responsibilities in a balanced and holistic way. One of the most effective frameworks for achieving this is the circular economy, which promotes the responsible use of resources.

Environmental sustainability means that we measure our environmental performance and make sure that our business has a positive impact. There are many complementing metrics like for example greenhouse gas emissions, water and energy use, waste generation, and land use that can be used to show the ecological impact.

Social sustainability influences all human activities and is therefore strongly linked to the economic and environmental dimensions of sustainable business development. The main questions are what kind of social value our business produce and how we can help society with our business.

Economical sustainability means the standard financial accounting by measuring the economic performance of an organization or society in order to ensure long-term viability. Understanding the potential cost savings, investment requirements, and long-term financial benefits is important. The main focus in this handbook is to guide the company's transition to a circular

economy business (See tools in chapter 1.2.). If you wish to analyse broader each sustainability aspects (social, environmental), use Sustainability Workbook.

2.2 Example value chains and business models

2.2.1 Forest industry value chains in Finland

The forest industry refers to the industrial sector that utilizes forest wood resources as raw materials to produce various products. It covers the entire production chain, starting from forest management and harvesting to the further mechanical and/or chemical processing of wood.

- Mechanical forest industry includes production of wood products, such as lumber, plywood, chipboard, furniture, and wood materials used in construction.

- Chemical forest industry involves the production of pulp and paper, as well as the further processing of cellulose into products like cardboard, packaging materials, and other paper goods, textile, biofuel, etc. (Mäntyranta, 2019.)

Sustainable forest management practices are essential to ensure that forest industry activities do not deplete resources or harm ecosystems. In Finland, there has long been a strong focus on the resource-efficient utilization of wood raw materials. Measures, from legislation to industry practices, have been developed to ensure that these raw materials stay within the value chain and in products for as long as possible. The most effective way to preserve the value of wood is by producing durable, long-lasting wood products that maximize its lifespan and sustainability.

Forest management generates a substantial number of by-products during the maintenance, harvesting, and processing of forests, which are not suitable for the primary products (such as timber or pulp) (Figure 1).

Utilizing these by-products not only adds value to forest management but also promotes sustainability by minimizing waste and contributing to circular economy principles.

The main by-product from mechanical wood processing is tree bark, saw dust, wood chips, shavings, etc. It is worth noting that only about half of the raw material ends up as a product, i.e. sawn timber, and the rest half are by-products (Merivuori 2017, 30). To be profitable, the distance from the forest to the sawmill must not exceed 100–150 kilometres.

Figure 1. Forest management streams.

For examples of companies in the forest industry value chains, see Annex 1.

2.2.2 Seafood industry value chains in Norway

The seafood industry is among Norway's most important district industries.

The industry is represented throughout the country, but that is in the regions of western and northern Norway that the industry has the greatest importance for value creation and employment.

2022 was the best year ever for Norwegian seafood exports. In total 2.9 million tonnes of seafood to a value of NOK 151.4 billion last year. It is a record value and corresponds to 40 million meals every single day—all year round. Norway export 95 percent of what they produce. The seafood industry's value creation per employee is 73 percent higher than for Norwegian business without oil and gas (Mainland Norway/ Fastlands-Norge), while it is marginally lower than in the maritime industry. The seafood industry has the

strongest relative presence in rural municipalities of all the highly productive industries. The industry's district index is over four times as high as the industry with the second highest score.

In recent years, the industry, in close collaboration with the research institutions, has increasingly prioritized work on the development of technology for further conservation and utilization of marine residual raw material, especially for products within what is often called the high-value segment, and then preferably towards human consumption. Since the start of the 1990s, there have been consistent mapping consistent of analysis on degree of utilization, and application of marine rest raw materials originating from the Norwegian seafood sector. Total utilization of the rest raw material was stable in the period 2018–2021 (84%, 85% and 83%).

The increased utilization of marine residual raw materials in Norway faces several key challenges:

1. There is a lack of infrastructure and capacity, such as fishing ports, reception facilities, and processing plants, to handle larger volumes of residuals.

2. Access to raw materials is limited, as much of it is already in use, highlighting the need for an open marketplace, quality assurance, and stronger value chain cooperation.

3. Economic barriers, such as high costs, high risk, and limited investment knowledge, are especially evident in Northern Norway, where there is a lack of supportive financial infrastructure.

4. Navigating the regulatory framework can be complex and bureaucratic, with licensing constraints often hindering innovation and making it difficult for start-ups to act as first movers.

5. Companies frequently struggle to find sustainable, profitable markets and scale quickly, especially when launching novel products that require market creation.

6. Environmental impacts of processing and waste management must be carefully assessed.

7. Further research is needed on processing technologies, product development, nutritional content, and market dynamics.

8. Broad collaboration among government, industry, research institutions, and environmental organizations is essential to address these challenges and unlock the full potential of marine residual raw materials.

The concept of circular marine value chains has been effectively illustrated by the work of Blue Bio Clusters,

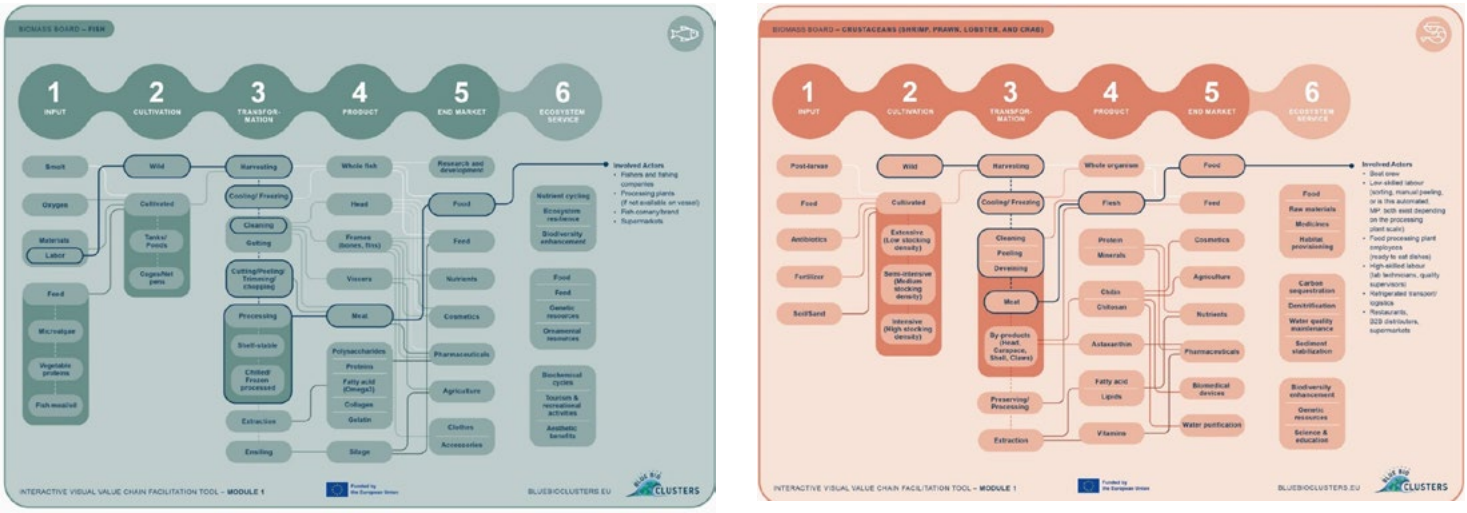

Figure 2. Visual Value Chain Facilitation Tool: a) fish value chain board, b) Crustaceans value chain board.

particularly through their Visual Value Chain Facilitation Tool. This interactive tool maps out value chains for various marine biomass streams, including fish and crustaceans, and highlights where by-products and residual streams emerge, as well as how these streams can be redirected into new uses. For instance, in the fish value chain board (Figure 1a), discard from processing (e.g. heads, frames, skins) is identified and linked to secondary applications such as feed, bioactive extracts, and biobased materials. In the crustacean board (Figure 1b), shells and exoskeletons are traced into chitin/chitosan products or bio-fertilizers. Blue Bio Clusters describe the tool as combining six biomass boards (including fish and crustaceans) with identification boards that allow stakeholders to "dive deep into the nuances of value chain analysis, identification and optimization" (Visual Value Chain Creation facilitation). The added value lies in showing not just the primary product flows, but also where residual streams can be captured and valorized—making the value chain more circular, resource-efficient and sustainable.

For examples of companies in the seafood industry value chains, see Annex 2.

2.2.3 Agriculture value chains in Iceland

Agriculture in Iceland is diverse and involves utilizing land and natural resources to produce food and other goods. It encompasses the entire production chain, from cultivation and livestock care to processing and distribution of agricultural products. In this project we interviewed three slaughterhouses and one greenhouse farmer.

- Meat processing includes the production of beef, lamb, and other meat products. Slaughterhouses in Iceland prioritize quality certification and traceability to ensure the safety and nutritional value of the products.

- Greenhouse farming in Iceland leverages geothermal energy and clean water to grow vegetables, herbs, and fruits. This approach supports sustainability and minimizes the carbon footprint, as the energy used is renewable.

Sustainable agricultural practices are a key to ensuring that farming activities do not deplete resources or harm ecosystems. In Iceland, there is a strong focus on efficient use of resources and reducing waste to promote circular economy principles.

In interviews with slaughterhouses in Northwest Iceland, it was highlighted that by-products such as offal and bones are repurposed for animal feed or other products. This reduces waste and increases value creation. Similarly, in greenhouse farming, organic waste is often utilized through composting or energy generation.

Only a portion of total agricultural output ends up as the primary product, such as lamb meat or vegetables. Most of the remaining by-products are raw materials utilized within a circular economy to minimize waste.

For examples of companies in the agriculture value chains in Iceland, see Annex 3.

Information and inspiration sources

To better understand how circular economy principles can be applied in practice, it's valuable to look at real-world examples where businesses have successfully turned waste into resources, optimized material flows, and created sustainable value. These cases offer inspiration and practical insights for companies looking to adopt more circular and resilient business models.

» **The Finnish Innovation Fund Sitra** (41 pioneering Finnish circular economy companies - Sitra)

» **Ellen MacArthur Foundation**

» **The National Platform for Circular Innovation in Ireland**

» **The Norwegian Centre of Circular Economy (NCCE)** (a business cluster and membership organization)

3 Analyse

» When working with clients, start by exploring how their business currently uses resources and where waste occurs. Use the 11 R's of the circular economy to identify opportunities to close loops and create value from what's already there.

» Once you've mapped these opportunities, apply the Circular Business Model Canvas to structure insights. Focus on what circular value the business can create, how it impacts stakeholders, and what changes are needed in operations, partnerships, and customer relationships to make it happen.

» Encourage small, practical steps first—circularity often grows best through experimentation and collaboration.

3.1 Analysis of company's position in respect to circular economy

3.1.1 Internal analysis of resources

This chapter is intended to function as a practical reference for people and organizations who want to choose secondary resources wisely, whether the next step is reusing, additional processing, recycling, or a new purpose altogether.

The circular economy is not simply a conceptual model; it is a deliberate business and policy strategy that replaces the conventional "take–make–dispose" logic with systems designed to restore and renew. Rather than treating outputs as end-of-life waste, circular systems keep resources circulating through repeated use and recovery. Within this perspective, value is found in materials, water and energy flows, as well as less tangible assets such as expertise, information, data, and time, each of which can be managed more effectively to prevent losses, reduce waste, and open up fresh possibilities for innovation.

Circular thinking though is applicable both for **improving the company's own operations as well as creating value beyond the company's boundaries**.

Internally circularity is about making internal processes, resource use, and systems more effective and reducing waste of resources. Company can use lean based tool to identify wasted resources and find ways to reintegrate them into companies' operations, thereby reducing waste and creating more sustainable economic and environmental internal systems.

The goal of creating **value from by-products or waste beyond the company's boundaries** is to generate new value propositions, strengthen customer relationships, and build circular ecosystems. This might need redesigning products and processes, partnering with other firms to reuse waste materials, finding new markets for waste or by-products, and rethinking the business model.

Within the following pages, the methodology for screening underutilized or wasted resources, a critical step in the journey towards identifying resources not only for internal, but also for external circular value chains is described.

Companies differ significantly in their operations, which means the approach to circular economy implementation should be tailored to each organization's level of maturity, operational characteristics, and types of waste generated. The methodology and tools serve as examples that can be adapted to meet the specific needs of different companies.

3.1.1.1 Material flow analysis (MFA)

Secondary resources are materials that arise as side streams, residues, or discarded outputs, they often

contain overlooked value. When these streams are recognized and managed intentionally, they can reduce dependence on virgin inputs, strengthen access to materials locally, lower purchasing and handling costs, and improve environmental performance. Capturing this value can boost an individual firm's productivity and market position, and, when adopted widely, can also support regional resilience and broader sustainability outcomes.

Residuals and waste can emerge across the entire industrial chain, not only at the end. Typical points include sourcing and receiving materials, production design and scheduling, processing and fabrication, finishing and post-production steps, equipment upkeep, warehousing, and final treatment or disposal.

Core phases of a material flow review:

- **Map inputs, outputs, and losses:** Track materials through each step, from incoming raw materials to outgoing products and residual streams, to determine where waste occurs and how much is created. Include losses linked to rejects and quality deviations, overproduction, equipment downtime and maintenance, spoilage/expiry, and similar causes. A practical way to do this is to document, for each process step, the key inputs and resulting outputs (products plus side streams).

- **Classify side streams:** Group residual streams into meaningful categories (for example: organics, metals, plastics, composites, chemicals, etc.). Note their condition and usability, including contamination, moisture, purity, and consistency.

- **Quantify economics:** Identify the costs connected to handling these streams (sorting, storage, transport, treatment, disposal fees) and any current or potential income from selling or valorizing them.

Prompts to guide the assessment:

- How are side streams separated during production, and what happens after production ends?

- What costs arise from managing these materials (e.g., treatment, disposal, compliance, logistics)? Which cost types are most significant?

- Do any side streams generate revenue today? If yes, roughly what share of overall turnover do they represent?

- If nothing is currently sold or reused, has commercialization or further processing been evaluated? What criteria influence the decision?

- Which operating practices are in place to prevent waste at source (process controls, design changes, planning improvements, training)?

- Have you tested digital exchanges or broker platforms for secondary materials (e.g., services like materiaalitori.fi)? Did you identify possible buyers or partners, and would you use such channels to sell your side streams?

- Is there an established way to measure and track these streams over time (quantities, quality, costs, destinations)?

- What practical barriers limit better management, e.g. capacity constraints, variable quality, missing partners, regulatory hurdles, lack of data, or internal ownership?

Extending the work: identifying circular options

Deepening this analysis usually takes several cycles as new data and opportunities appear. A useful progression is:

- **Start with prevention:** look for process, design, and planning changes that reduce or avoid the side stream altogether.

- **Check for internal reuse:** assess whether the material can be used directly within operations (for instance, reintroducing clean metal residues into production where technically feasible).

- **Explore new value routes:** consider whether the stream could support new products, applications, or services, potentially creating new markets or income.

- **Scan external demand:** use digital marketplaces and industry networks to identify sectors that can use the material as an input.

- **Learn from practice:** review existing examples and case studies to validate technical feasibility and partnership models.

- **Build a business case:** estimate handling requirements, investments, operational costs, and potential revenues for the most promising options.

Modified MFA tool was used to analyse waste streams from wood processing industry in Finland (Annex 1).

3.1.1.2 Analysis of intangible resources

Treating circular economy thinking as relevant not only to materials but also to **intangible assets**, such as know-how, employee time, and data, can greatly increase the return you get from resources you already have. When these assets are reused, shared, and intentionally managed, organizations can simplify work, make better choices faster, and spot new offerings or services that support long-term competitiveness and responsible growth.

A useful starting point is to examine day-to-day operations for forms of "invisible waste": expertise that stays locked in silos, time lost to avoidable delays, or data that is collected but never turned into insight. Once identified, estimate what these losses cost (in rework, slower throughput, missed sales, or unnecessary purchases), and then look for two kinds of opportunities: **(1) improving efficiency inside current operations** and **(2) creating new value streams through circular, service-oriented solutions**.

Time as an underused asset

Time is often lost through inefficient process steps, idle machine capacity, waiting between tasks, or mismatched staffing and demand—all of which reduce productivity without adding value. Circular-inspired approaches can help, for example:

- **Workflow redesign and optimization:** Using lean-style improvements and better production planning to cut waiting, reduce stoppages, and keep work moving smoothly.

- **Shared-use models:** Structuring access so that capacity is used across multiple users—think shared workspaces, shared vehicles, or community tool pools—so expensive assets spend less time sitting unused.

- **Digital matching platforms:** Using services that connect available labor or specialist skills with real-time demand, improving utilization of people's time and capabilities.

Knowledge as an underleveraged resource

Unshared expertise, dormant skills, and unused intellectual capital can limit innovation and slow improvement. Ways to prevent "knowledge loss" include:

- **Systems that enable sharing:** Creating internal knowledge bases, cross-company collaborations, communities of practice, or sector hubs that make lessons learned and best practices easy to find and build on.

- **Continuous learning:** Investing in regular training and upskilling so capabilities stay relevant and hard-won competence doesn't become outdated.

- **Mentoring and transfer mechanisms:** Pairing experienced staff with newer employees and supporting structured knowledge transfer, especially where skills are specialized or experience-based.

Data as unrealized value

Data that is stored but not interpreted or is inaccessible to the right people represents missed potential for better decisions and improved performance. Circular-minded practices include:

- **Responsible data sharing:** Establishing partnerships or open-data approaches (where appropriate) so multiple actors can use information to improve sustainability performance, supply chain coordination, or customer value.

- **Analytics and AI for insight:** Applying modern analysis tools to turn raw datasets into actionable signals, optimizing operations, identifying inefficiencies, and forecasting risks or demand shifts.

- **Turning data into services:** Exploring data-based offerings (benchmarks, reporting, decision-support tools) that convert existing datasets into external value and revenue.

- **Closed feedback loops:** Feeding operational and product-use data back into design and process improvement so performance keeps improving over time rather than resetting each cycle.

Establish and maintain a database of companies' waste streams and by-products. Such information provides a critical foundation for promoting development of circular cases and facilitating establishment of new circular value chains.

3.1.1.3 Principles of circular economy: 11 R's

Transitioning to a circular economy requires a fundamental shift in mindset. Circularity and sustainability must be embedded in the core of business strategy and not treated as afterthoughts. From the earliest stages of planning, businesses should evaluate how their operations, products, and services align with the principles of sustainable development. This shift begins with rethinking traditional business models and redesigning the products to prioritize long-term value over short-term gains.

The circular economy adaption is guided by a set of strategies known as the 11 R's, which can be organized into three core phases: circular design, circular use, and circular value. Each phase represents a distinct stage in the lifecycle of products, and together they form a comprehensive, systemic approach to sustainability.

Circular Design focuses on the earliest stages of product development, where decisions have the greatest impact on sustainability. **Circular Use** ensures that products are kept in use for as long as possible through maintenance and recovery strategies. **Circular Value** captures the remaining value in products and materials that can no longer be used in their current form.

Each of the R's (figure 3) contribute to a more circular, efficient, and sustainable economy. Businesses can select and combine these strategies based on their operations, product life cycles, and sustainability goals.

For this transition to be successful, business advisors play a critical role. They must ask the right questions and guide companies in finding the most feasible approach. Use the tool in Circular economy toolkit (Tölli, Rainosalo, Hannon & Kjelstrup 2025, p. 8). The guiding questions help you determine your position in circular economy framework.

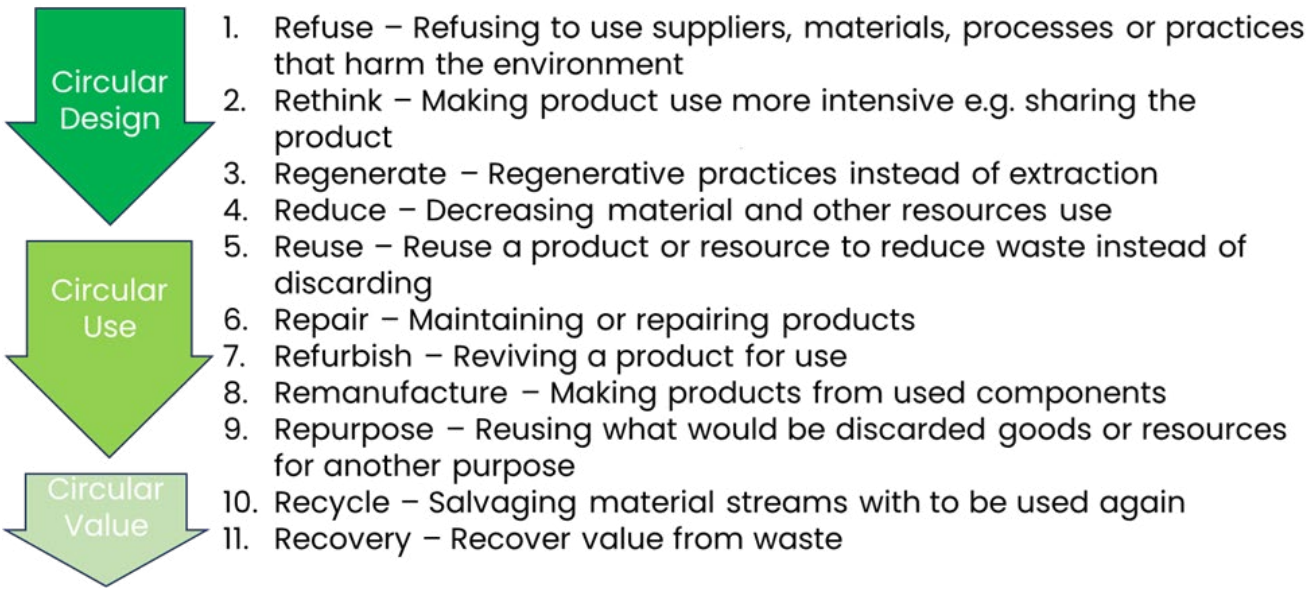

Figure 3. 11 R's.

Refuse (avoid waste before it happens)

- What can you stop doing because it doesn't create real customer value?
- Which materials/components should/could you ban or phase out because they prevent circularity?
- Where can you remove packaging or switch to returnable packaging?
- Can you provide the same customer outcome with less material or no physical product at all?
- Have you set environmental expectations for suppliers (e.g., packaging limits, materials policies, emissions, take-back)?
- Do you plan for what happens to your products at end-of-life (take-back, disassembly, recycling routes), or would you be willing to?

Rethink (change how value is created)

- Could you switch to alternative materials or equipment options with a lower footprint?
- Are you willing to collaborate with other firms, NGOs, or research partners to share expertise, resources, and pilots for circular solutions?
- Do you actively encourage staff to identify and propose sustainability improvements or new circular opportunities?

Regenerate (restore and renew systems)

- How far have you gone in adopting renewable energy in operations, and do you promote its use internally and externally?
- In what ways could your side streams be regenerated into inputs—turning waste into usable resources and reducing impacts?
- Have you joined efforts with suppliers to restore ecosystems (habitat protection, rehabilitation, regenerative practices)?
- Do you contribute to renewing natural capital through actions such as reforestation, water stewardship, or soil health initiatives?
- How do you manage water in a circular way, e.g. reducing consumption, limiting pollution, and supporting replenishment?

Reduce (use fewer resources for the same outcome)

- What actions are currently in place to cut material, energy, and water use?
- Have you looked at more circular sourcing and supply chain options (recycled inputs, certified sources, circular partnerships)?
- Do your products and services incorporate circular features such as durability, reuse potential, or upgradeability?
- Are there specific circular initiatives you want to start or expand?
- Could digitalization help reduce resource use (paperless processes, optimized routing, predictive maintenance, remote services)?

Reuse (keep products and components in circulation)

- What steps or processes exist to restore products so they can be used again?
- Are you interested in working with partners who can enable reuse of materials, parts, or products?
- Do you offer benefits that make choosing reused options more attractive than buying new ones?
- Would you participate in joint development projects to test and improve reusability in your offerings?
- Do you need support in communicating your sustainability and reuse options clearly?

Repair (extend life through fixes and maintenance)

- Is your product design set up to make repairs straightforward (access, spare parts, documentation)?
- Are there assets in your operations that could be maintained or repaired rather than replaced?
- Do you have repair partners or third-party service centers that can support customers?
- How do you motivate customers to repair instead of replacing (pricing, warranties, service bundles)?
- How do you explain the environmental and cost benefits of repair to customers?

Refurbish (restore to good working condition)

- Do you have approved refurbishment partners or in-house capability to refurbish products at scale?
- Are products designed so key parts can be replaced or upgraded easily during refurbishment?
- Have you considered a “refurbishment as a service” approach that bundles maintenance and periodic upgrades for customers?

Remanufacture (bring used products back to like-new)

- Do you collaborate with suppliers, remanufacturers, or industry groups to expand remanufacturing capacity?
- Are products designed for disassembly, replacement of worn components, and long service life?
- How do you manage remanufacturing to deliver consistent quality, efficiency, and reliability comparable to new products?

Repurpose (give materials and products a second life)

- Do you currently collaborate, or would you consider collaborating with organizations that focus on repurposing materials, so your products can enter second-life markets after their original use?
- How do you make sure the materials and components you use can be redirected into other applications (e.g., by choosing durable, versatile, and easily adaptable materials)?
- Would you be open to participating in R&D or pilot projects that test new repurposing options for your products or side streams?
- How much do you already use repurposed inputs in new products, and is there room to increase that share?

Recycle (turn end-of-life materials back into inputs)

- How have you designed your logistics and supply chain to make take-back, collection, and transport to recyclers as efficient and low-impact as possible?
- Do your products already include recycled content? What targets or programs do you have to increase recycled-material use over time?
- What are you doing to test or adopt newer recycling solutions (e.g., improved sorting, chemical recycling where relevant, higher-yield processes) to raise efficiency and reduce impacts?

Recover (extract usable value from what can’t be reused)

- Would you be willing to join research or pilot initiatives focused on improving material recovery?
- How do you use recovered materials in production today, and what actions help increase their share in new products (quality control, specifications, redesign, supplier agreements)?
- Which new methods or technologies are you evaluating or implementing to improve recovery rates and material quality from your products?

3.1.3 Circular Business Model Canvas

As a business advisor, you can use Circular business model canvas to identify the sustainability impacts of your client's business. The Circular Economy Business Model Canvas is based on the traditional BMC, but it focuses on identifying the circular value your business aims to create and understanding its positive and negative impacts (Figure 4).

The guiding questions help you determine what to include in each section.

<table>
<tr><td rowspan="3">Partners</td><td>Activities</td><td rowspan="3">CE value</td><td>Customer relationships</td><td rowspan="2">Customers</td></tr>
<tr><td>Resources</td><td>Distribution</td></tr>
<tr><td>By-products
and waste streams</td><td>Recovery</td><td>Services</td></tr>
<tr><td colspan="3">Costs</td><td colspan="2">Revenue</td></tr>
<tr><td colspan="3">Negative impacts</td><td colspan="2">Positive benefits</td></tr>
</table>

Figure 4. Circular Business Model Canvas. Enlarged tool Circular economy toolkit (Tölli et al. 2025, p. 22).

Partners. This section looks at the relationships you need to make a circular economy model work in practice. The aim is to identify the key actors in your ecosystem, understand what each party contributes, and clarify how value is shared so collaboration is attractive and sustainable for everyone involved.

- Which companies, organizations, suppliers, or individuals are essential for you to deliver value and succeed?
- What roles do they play—what capabilities, services, or specialist knowledge do they bring?
- What do your partners gain from working with you (commercial value, access, learning, shared impact)?
- Which initiatives or key tasks could you realistically co-develop or run together?
- What assets can they contribute to your business (materials, data, facilities, networks, expertise)?
- What can you offer in return (demand, visibility, data, co-development, capacity, revenue share)?

Activities. This part focuses on what your business actually does to create and deliver circular value. It helps you pinpoint the operational and strategic activities that enable circularity—such as reverse logistics, maintenance services, redesign work, or collaboration processes—and assess whether you have the skills and capabilities to execute them.

- Which core actions in your business generate circular economy (CE) value?
- What skills and competencies do you already have to carry out these activities effectively?
- Which activities are most important for building and maintaining customer relationships?
- What are the critical steps in producing, delivering, and supporting your products or services?
- What do you do to secure the inputs you need for operations (procurement, sourcing, contracting)?
- What work is required to develop logistics, reverse logistics, and supply chain collaboration?

Circular economy value. This section is about your value proposition: what problem you solve, what customers gain, and what makes your offer distinct—especially in a circular context. It also encourages you to think about how the value proposition may need to evolve as customer needs, regulation, and market expectations change.

- What customer or societal problem are you addressing?
- What is your core offer, and why does it matter to customers?
- What sets your offer apart from alternatives in the market?
- Which product/service features are most important to your customers—and why?
- How will you keep improving the offer as customer expectations and needs evolve?

Resources. Here the focus is on the resources your business depends on and how they are sourced, managed, and optimized. In circular models, resources include not only materials and energy but also how you design for reuse, repair, and recovery (often described through the 11R strategies).

- Which natural resources and materials are critical for your business?
- Which of the 11R strategies are most relevant to your operations today (and which could be added)?
- Where and how do you obtain these resources (sources, suppliers, geography, contracts)?
- Are there collaborations in place that improve sustainable sourcing or responsible resource management?
- Have you explored clean technologies or operating practices that reduce resource use and impacts?

Customers. This part helps you define who your model serves and how customers influence circular performance. Circularity often depends on customer participation, returns, correct use, maintenance choices, so understanding customer roles and incentives is central to making the model function.

- Who are your priority customer segments, and which ones drive most of your value?
- Who ultimately uses the product or benefits from the service (end user vs. buyer)?
- How do you build, maintain, and deepen relationships with customers over time?
- Are additional circular services needed (maintenance, upgrades, take-back, resale, reuse support)?
- Can customers play an active role in lifecycle management (returns, repair choices, correct disposal)?
- In what ways does customer behavior affect whether your circular model works in practice?

Customer relationships. This section examines how you attract, support, and retain customers over time, and how their experience connects to your value proposition. It also emphasizes feedback loops, how you learn from customers and improve your offering, since circular solutions often require ongoing engagement rather than one-time transactions.

- Who exactly are you creating value for, and what do they care about most?
- Who is the “core” customer group you must serve exceptionally well?
- What typical use situations connect directly to your value proposition?
- What does the end-to-end customer journey look like (from awareness to use to end-of-life)?
- What do you do to retain customers (service plans, communication, loyalty, upgrades, guarantees)?
- How large is the target market, and what is the realistic growth potential?
- How do you collect customer feedback and turn it into concrete improvements in your offer?

By-products and waste streams. This section helps you map what material side streams your operations produce and what they mean for your business. The goal is to make these flows visible, understand whether they create costs or value, and identify where there may be potential for reuse, recovery, or new revenue opportunities.

- What waste streams arise from your activities and processes?
- Which by-products or side streams are created alongside your main outputs?
- Do these streams currently bring in revenue, or do they mainly generate handling and disposal costs?

Distribution. This part focuses on how your offering reaches customers and how effectively you communicate your value proposition. It covers sales and delivery channels, relationship management, logistics and inventory, and the role of partners or intermediaries, especially relevant when circular models add services like maintenance, take-back, or return logistics.

- How do you make your value proposition visible and convincing to target customers?
- What customer relationship practices or processes do you use today (sales, onboarding, support, after-sales)?
- How is your product or service delivered, accessed, or provided to customers?
- What are the main channels through which customers receive your products or services (direct sales, distributors, online platforms, service contracts, etc.)?
- Are intermediaries or distribution partners involved in reaching end users? If yes, what roles do they play?
- How do you manage inventory and availability (stock levels, lead times, forecasting, spare parts)?
- Are there specific regions or markets where distribution is currently concentrated—and are there areas you want to expand to?

Recovery. This section examines what happens when a product reaches the end of its use phase. The focus is on whether valuable materials and components can be captured instead of lost—through reuse, dismantling, remanufacturing, or recycling. It also helps you assess how practical recovery is (collection, processing, costs) and how strongly it contributes to sustainability targets by reducing environmental impacts and dependence on virgin resources.

- Which materials, parts, or components could be recovered or recycled from the product?
- Are there elements that can be removed without difficulty and used again as components?
- At end-of-life, can the materials be collected, sorted, and processed efficiently?
- What environmental benefits does recycling or recovery deliver in your case (e.g., emissions, waste reduction)?
- To what extent could recovery replace virgin raw materials in your supply chain?
- How does recovery and recycling contribute to your company's sustainability objectives and reporting needs?

Services. This section focuses on service models that keep products and value in circulation longer. Circular services can range from maintenance and upgrades to usage-based models (leasing, rental, pay-per-use). The aim is to evaluate which services fit your offer, how they support circular principles, what customers gain, and what capabilities or partners are needed to deliver them reliably and at scale.

- What services do you provide (or could you introduce) to extend product life (maintenance, repair, refurbishment, upgrades)?
- Could the customer be offered "access" instead of ownership (leasing, rental, subscription, right-to-use)?
- In what ways does the service reduce waste or extend useful life compared with a traditional sales model?
- What additional customer benefits does the service create (convenience, predictability, lower upfront cost, better performance)?
- Is the service option simpler, more affordable, or more responsible for customers than buying a new one?
- How could the service model strengthen customer retention and long-term relationships?
- How is the service delivered (digital tools, physical visits, on-site support, local service points)?
- Do you need partners to run the service effectively (logistics, repair network, spare parts, IT platforms)?
- How will you ensure consistent service quality, response times, and availability as demand grows?

Revenue. This section clarifies how your circular offering generates income and whether the revenue model is realistic and scalable. The goal is to make your earning logic explicit (what you charge for, who pays, and when), and to check that pricing supports both customer value and business viability.

- What are your main sources of revenue (product sales, services, subscriptions, leasing, pay-per-use, spare parts, take-back value, resale, etc.)?
- What level of revenue do you expect to generate, and what assumptions are behind that estimate (volumes, uptake, margins, retention)?
- What factors guide your pricing decisions (cost structure, customer willingness to pay, competitors, contract length, risk, sustainability value, regulatory incentives)?

Costs. This section focuses on the cost structure behind your business model, including both fixed and variable costs. In circular models, costs may shift,for example toward maintenance, reverse logistics, sorting, refurbishing, or data systems, so it's important to understand the biggest cost drivers and where efficiency gains are possible.

- What are the most important cost items in your model (fixed and variable), and which ones are likely to grow as you scale?
- Which inputs are most expensive, both technical resources (equipment, labor, IT, logistics) and natural resources (materials, energy, water)?

Negative Impacts. This section helps you identify and manage the environmental downsides of your value proposition. The aim is to understand where impacts occur across the lifecycle (materials, production, transport, use, end-of-life) and to explore how circular strategies, such as the 11R approaches, could reduce harm or unlock overlooked value.

- In what ways does your offering create environmental impacts, and where do you have the strongest ability to reduce them?
- Have you assessed lifecycle impacts (e.g., through an LCA or similar method), and what were the main hotspots?
- Are there specific design choices, materials, or features that reduce environmental burden (or could be improved)?
- Are there additional revenue opportunities you may have missed that could emerge from applying the 11R strategies more fully?
- What practices are in place to continuously improve environmental performance over time (targets, monitoring, redesign cycles, supplier engagement)?

Positive Benefits. This section highlights the environmental value you deliver and how you make it credible and understandable to customers. It supports both internal strategy (what to improve next) and external communication (what benefits you can confidently claim and measure).

- What measurable environmental benefits does your product or service provide (energy savings, lower waste, waste valorization, reduced emissions, reduced virgin material use)?
- How do you communicate these benefits to customers in a clear and trustworthy way (labels, data, reporting, customer tools, case examples)?
- Do you have ongoing innovation or R&D to strengthen these benefits further over time?
- Which product features or design choices are specifically intended to improve environmental performance (durability, repairability, modularity, recycled content, lower energy use, etc.)?

3.2 External analysis of potential

Support companies in exploring digital platforms for secondary materials as alternatives to disposal. These marketplaces can help open new revenue opportunities by transforming waste into someone's raw material and finding new cooperation partners for the circular cases.

Use the information you've gathered from other businesses to identify potential synergies. Help connect companies that could benefit from each other's materials, by-products, or expertise — turning isolated waste streams into shared opportunities for circular collaboration.

3.2.1 Marketplaces for secondary resources

Marketplaces for secondary raw materials and by-products are rapidly evolving across countries. Below, the most relevant and well-established digital platforms are presented, offering companies new opportunities to valorize their by-products and reduce waste.

Finland

There are nearly a dozen digital marketplaces in Finland for business by-products and waste streams: https://net.centria.fi/wp-content/uploads/2023/04/Digital-marketplaces-for-companies_FINLAND-1.pdf.

The best known and most used of these is Materiaalitori. It is a marketplace for the exchange of waste and production by-products from companies and organizations. It also allows users to search for and offer related services, such as waste and by-products management or expert services.

Access to this marketplace is free of charge and open to the industry.

» Under the new Finnish Waste Act, waste holders requiring municipal secondary waste management services exceeding €2,000 per year are obliged to list it publicly on Materiaalitori for at least 14 calendar days to allow potential reuse, recycling, or commercial recovery before waste is finally disposed or incinerated (Laki jätelain muuttamisesta 29.3.2019/438).

The Materiaalitori (Ympäristöministeriö) is part of the Finnish Industrial Symbiosis (FISS-Model). The Materiaalitori.fi can be used to indicate the resources available, the resources needed or the related services. In Finland, Motiva Oy coordinates the FISS-Model and brings together a network of regional actors to connect resource providers and users on the ground. Motiva Oy is a Finnish government company for sustainable development, which encourages the efficient and sustainable use of energy and materials. Motiva provides public administrations, companies, municipalities and consumers with information, solutions and services to help them make resource-efficient, effective and sustainable choices.

KiertoaSuomesta is a digital marketplace that focuses on biobased by-products from primary production and industry. The main target groups are companies in agriculture, forestry and the food industry producing biobased side and waste streams, as well as industry and the public sector that use these raw materials.

Norway

In Norway there are very few digital marketplaces for business by-products and waste streams: https://net.centria.fi/wp-content/uploads/2023/04/Digital-marketplaces-for-companies_NORWAY-1.pdf.

Even though there are few established players, and most are in a start-up phase, there can be seen growth emerging in both the private and public sectors.

Ireland

In Ireland there are very few digital marketplaces for business by-products and waste streams in food and agriculture: https://net.centria.fi/wp-content/uploads/2023/04/Digital-marketplaces-for-companies_IRELAND-1.pdf.

Iceland

There are found many digital marketplaces in Iceland for business by-products and waste streams: https://net.centria.fi/wp-content/uploads/2023/04/Digital-marketplaces-for-companies_ICELAND-1.pdf.

3.2.2 Information databases for secondary raw materials locally, regionally, nationally

This chapter introduces key information databases that provide insights into the availability and flow of raw materials at local, regional, and national levels. By analyzing these data sources, businesses can identify complementary material streams, enabling resource synergies, economies of scale, and more profitable, scalable, and resource-efficient circular solutions.

Finland

Biomassa-atlas is a geographic information viewing, analysis, and reporting service for forest, agricultural, manure, and waste biomass data.

The quantities of biomass are based on models formed from field observations, measurements, registry data, satellite images, and literature, providing justified estimates of the amounts formed and the available potential. Biomassa-atlas is maintained by Natural Resources Institute Finland (Luke). Field, manure and waste data will be updated every three years, and forest data every five years.

Example of Bioatlas use is related to the forestry case 1 in Perho (Annex 1). The programme is used to assess the potential of the Central Ostrobothnia region, where the municipality of Perho is located for forest by-product flow. The region covers an area of about 646 000 hectares. The programme estimates the side-stream potential of forests in Central Ostrobothnia for the period 2026-2035 as 200 810 m^3/year for energy wood from thinnings. Of this, 14 800 m^3/year is estimated to be less pulpwood. The total canopy mass, i.e. branches and tops, is estimated to be about 129 000 m^3/year, of which the largest share, 66 000 m^3, consists of pine canopy mass. Stumps are estimated to accumulate at around 154 000 m^3/year (Luonnonvarakeskus; Videnoja 2024).

Norway

In Norway, an annual update is conducted on the various by-products generated by different sectors of the seafood industry, such as salmon, cod, and herring. The data provides insight into which parts are produced, in what quantities, and in which regions they are generated. It also offers a general overview of how these by-products are utilized. The data is openly available to the public form Marint restråstoff.

There have been attempts to develop digital marketplaces that go beyond the open database, aiming to provide datasheets with essential information on quality, quantity, composition, and more. However, no one has yet succeeded in bringing such a tool to market.

- » Understand Market-Specific Regulations Early.
- » Research National Regulations of the market (e.g., FDA for the USA, NMPA for China).
- » Partner with local consultants or distributors familiar with market-specific rules.
- » Use export promotion agencies or trade organizations to gather insights.
- » Identify IP requirements and engage IP protection specialist early.

3.3 Legislation and certification

When supporting companies in developing or validating their circular business models, it's essential to **address legal and compliance aspects early in the process**. Bringing this perspective into the initial business development stages helps avoid costly adjustments later and ensures that circular ideas are both innovative and compliant.

Encourage your clients to discuss relevant legislation, regulations, and standards with their stakeholders during the validation phase. This includes environmental, product safety, waste management, and trade regulations that could affect the feasibility or scalability of their business model. When necessary, advise them to seek expert legal or regulatory advice to assess potential impacts.

If the business model involves exporting products or materials, clients should also **review the applicable legislation and compliance requirements in the target**

markets to ensure market access and avoid trade barriers.

Additionally, if the company develops new processes, technologies, or materials as part of their circular transition, it's important to consider how these innovations can be protected through intellectual property (IP) mechanisms. **Early IP planning safeguards the company's competitive advantage** and supports long-term growth.

Below are brief examples of key regulations and legislative frameworks. There are many additional laws, standards, and compliance requirements within and beyond the EU market, depending on the specific application or product. The legislation examples listed here are among the most common for circular economy initiatives, as well as for wood, agriculture, and aquaculture products.

3.3.1 General CE and sustainable development related legislation which applies to all types of companies

European laws and regulations are aimed at making our society more sustainable. Much of these new laws and regulations fall under the Green Deal, with Fit for 55 as an interim goal. With all these directives and regulations, the EU aims to contribute to climate neutrality from different perspectives. Circulaw is a platform where local authorities can have insight into the obligations and opportunities that arise from European laws and regulations (Circulaw).

3.3.1.1 Nature Restoration Law

Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration

The law is a key element of the European Green Deal and the EU Biodiversity Strategy and builds on existing EU environmental legislation. It sets specific, legally binding targets and obligations for nature restoration in terrestrial, marine, freshwater, forest, agricultural and urban ecosystems.

Key targets of regulation

- By 2030, at least 20% of the EU's land and sea areas must be restored. By 2050, all ecosystems in need of restoration should be covered.
- By 2030 planting at least three billion additional trees at Union level.
- By 2030, countries must ensure no net loss of urban green spaces and tree canopy cover. From 2031, there should be an increasing trend in urban green spaces.
- Countries must inventory artificial barriers in water systems and restore at least 25,000 km of rivers to free-flowing conditions by 2030.
- Measures must be put in place to reverse the decline of pollinator populations by 2030.
- Each Member State must prepare a national restoration plan by 2026, detailing how they will meet these restoration targets. The European Commission will oversee these plans.
- The baseline for monitoring the progress of Regulation (EU) 2024/1991 on Nature Restoration is generally set at the condition of ecosystems and biodiversity levels as of 2024. This includes key metrics like the extent of urban green space, tree canopy cover, and the status of habitats and ecosystems.

3.3.1.2 EU Renewable Energy Directive (Directive (EU) 2018/2001), RED III

Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

The primary objective of RED III is to accelerate the transition to renewable energy across the EU in line with the European Green Deal and climate neutrality by 2050. RED III aims to raise the overall EU renewable energy target for 2030 to 40% of the Union's total energy consumption.

The forest industry is directly impacted by RED III, especially regarding the use of biomass. This is due to concerns that biomass (e.g., wood, agricultural residues) can lead to deforestation, biodiversity loss, and carbon emissions if not managed sustainably. The goal is to ensure that biomass contributes to carbon neutrality without negatively affecting ecosystems or carbon sinks.

- The forest industry must follow stricter rules around sourcing biomass from sustainably managed forests. This includes ensuring that biomass used for energy production doesn't come from deforested areas and is not causing biodiversity loss or carbon debt.

- The directive emphasizes accurate carbon accounting in forest management to ensure that the carbon released from burning biomass is balanced by the carbon sequestration in growing forests.

3.3.1.3 ISCC – Voluntary Global Sustainability Certification System

The International Sustainability and Carbon Certification (ISCC) is an independent multi-stakeholder initiative and leading certification system supporting sustainable, fully traceable, deforestation-free and climate-friendly supply chains. It is voluntary, applicable for all markets and all sustainable feedstocks, including agricultural and forestry biomass, biogenic wastes, circular materials, and renewables (ISCC).

3.3.1.4 Requirements for environmental documentation

The EU has already introduced and will continue to introduce increasingly stringent requirements for environmental documentation. This entails significant changes in how environmental impact must be documented and reported.

The most important requirement is that the documentation must be based on Life Cycle Assessments (LCA), for which various standards have been developed.

The key standards are:

- ISO 14040 – 14044: For conducting Life Cycle Assessments (LCA).

- Product Environmental Footprint (PEF): Based on the ISO standard and developed by the European Commission.

- Environmental Product Declarations (EPD): Also based on the aforementioned ISO standards but established under a separate ISO standard (widely used in the construction industry).

Companies that adapt to the new requirements will gain a competitive advantage in both the European and global markets. While product documentation is voluntary, if a company's customers wish to make environmental claims in their marketing, suppliers must be able to provide the necessary environmental information.

3.3.2 Forest industry specific legislation

The EU does not have a separate, unified forest law, as forests and their management are under the jurisdiction of the member states. However, the EU can influence the use and protection of forests through other legislative areas, such as environmental, climate, and biodiversity laws.

Forests play a crucial role in the EU's **climate strategy** (as carbon sinks), its **biodiversity protection** efforts, and its **renewable energy** policies (as a source of biomass). The forest industry in the European Union (EU) is subject to a range of laws, policies, and regulations which address multiple aspects of forest use, including forest conservation, timber production, forest restoration, and the prevention of illegal logging.

3.3.2.1 EU Timber Regulation (EUTR) (2013)

Regulation (EU) No 995/2010 of the European Parliament and of the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market.

Table 1. Differences between voluntary certification systems PEFC and FSC.

Feature	PEFC	FSC
Structure	Decentralized, endorses national standards	Centralized, global standards
Approach	Balanced: Economic, social, and environmental	Strong focus on environmental and social criteria
Geographic Reach	Largest area certified, popular in Europe	Smaller area but higher global market recognition
Certification Process	Flexible, country-specific standards	Rigid, globally uniform standards
Stakeholder Focus	Local forest owners, industry	NGOs, indigenous communities
Market Recognition	Growing, popular in commercial sectors	Strong in premium, high-value markets
Cost	More affordable, especially for small owners	More expensive, suited for large operations

Regulation's objective is to prevent illegal logging and ensure that timber products sold within the EU are from legally harvested wood.

- **Due Diligence System:** Traders placing timber or timber products on the EU market must exercise due diligence to ensure that the wood comes from legally sourced forests. This includes gathering information about the source of the timber, such as the country of origin, the harvesting practices, and relevant permits.
- **Prohibition of Illegal Timber:** It is illegal to place timber on the EU market if it is not proven to be legally harvested.
- **Penalties and Sanctions:** Member states are required to enforce penalties for non-compliance with the regulation.

3.3.2.2 Voluntary certification systems PEFC and FSC

The PEFC (Programme for the Endorsement of Forest Certification) and FSC (Forest Stewardship Council) certificates are the most recognized forest certification systems globally. Although neither PEFC nor FSC are EU certificates, both systems complement EU environmental policies by encouraging sustainable forest management globally, which helps member states meet biodiversity and climate targets. For example, certified wood products may support compliance with EU regulations such as the EU Timber Regulation (EUTR), which aims to prevent illegal timber from entering the EU market.

Both PEFC and FSC offer credible, third-party validation of sustainable forestry practices. Which certification is chosen depends on the specific goals, markets, and preferences of the forest owners and companies involved.

The main differences between PEFC and FSC are presented in the Table 1.

3.3.2.3 Comparison of National Forest Acts

The comparison of Forestry Laws between Ireland, Norway, Finland, and Iceland is presented in Table 2.

Table 2. Comparison of Forestry Laws: Ireland, Norway, Finland, and Iceland.

Feature	Ireland (Forestry Act 2014)	Norway (Forestry Act 2005)	Finland (Forest Act 1996, rev. 2014)	Iceland (Forestry Act No. 33/2019)
Primary Focus	Sustainable forest development, environmental protection	Multifunctional: biodiversity, recreation, culture, economy	Sustainable production with biodiversity consideration	Afforestation, erosion control, carbon capture
Felling Control	Felling licence required	Regulated, with mandatory reforestation	Allowed with flexibility; regulated for sustainability	Limited harvesting; mostly young forests or state-owned
Afforestation Approval	Required >0.1 ha, subject to EIA/AA	Regulated through land-use plans	Required in some cases	Required for larger-scale planting
Replanting Obligation	Yes, mandatory after felling	Yes, legally required	Yes, but flexible methods	Yes, required especially on public land
Biodiversity Protection	Strong – linked to EU Directives	Strong – Nature Diversity Act integrated	Moderate – valuable habitats defined	Moderate – focused on ecological restoration
Forest Owner Autonomy	Moderate – permits and oversight	Moderate – guided by multifunctional values	High – owners have significant discretion	Low to moderate – most forestry is public or subsidized
Public Participation	Required for felling and afforestation in sensitive areas	Yes – landscape, recreation, heritage considered	Limited – mostly in protected areas	Minimal – but public forests are widely used for recreation
Certification Practices	PEFC (voluntary)	PEFC dominant	PEFC & FSC both common	Limited – not widespread due to small commercial sector
Supervising Authority	Dept. of Agriculture, Food & Marine (Forest Service)	Norwegian Agriculture Agency + local municipalities	Finnish Forest Centre	Icelandic Forest Service (Skógræktin)

3.3.3 Marine Industry specific legislation

The EU Bioeconomy Strategy (European Commission 2025) is a key policy document that promotes the sustainable use of renewable biological resources from land and sea (forests, crops, fisheries, aquaculture, algae) to produce food, materials, chemicals, energy, and other bio-based products

Products based on marine by-products have significant potential in the EU market but require comprehensive documentation of safety, traceability, and environmental impact. Businesses that meet these requirements can capitalize on growing consumer demand for sustainable and innovative products.

While EU compliance establishes a strong baseline, adapting to US and Asian markets requires adjustments in labelling, regulatory approval, and product positioning. In the USA, focus on FDA requirements, clean-label trends, and sustainability. In Asia, tailor products to diverse local regulations, preferences for functional benefits, and often stricter import processes.

3.3.3.1 Food Safety Regulations

Hygiene Requirements: The EU enforces strict hygiene standards (Regulation (EC) No 178/2002) including HACCP (Hazard Analysis and Critical Control Points), Regulation (EC) No 2073/2005 sets microbiological criteria for seafood processing

3.3.3.2 Sustainability, Traceability and Labelling

IUU Regulations: The EU's regulations to prevent Illegal, Unreported, and Unregulated (IUU) fishing require traceability documentation for all seafood imports.

Eco-labelling: Products marketed as sustainable often need certification, such as MSC (Marine Stewardship Council) or ASC (Aquaculture Stewardship Council), to comply with consumer expectations and EU guidelines.

Seafood sold in the EU must follow specific labelling rules under EU Regulation No. 1379/2013, including details

Table 3. Difference between MSC and ASC labelling.

Feature	MSC (Wild-capture)	ASC (Aquaculture)
Product Type	Wild fish and shellfish	Farmed fish and seafood
Certification Focus	Fishery sustainability	Responsible aquaculture practices
Label Color	Blue 	Green 
Environmental Metrics	Stock health, ecosystem impact	Waste, feed, chemicals, biodiversity
Social Standards	Not primary focus	Strong emphasis (labor, communities)
Traceability	Yes, chain-of-custody standard	

about the species, production method (wild-caught or farmed), and the fishing area.

3.3.3.3 Specific EU regulations for products based on marine by-products

The EU has detailed standards for seafood products, including storage and transportation (Regulation (EC) No 853/2004), packaging (Regulation (EC) No 852/2004 and 853/2004), and others mentioned below.

Products based on marine by-products, such as ingredients for food, cosmetics, and dietary supplements, are subject to specific EU regulations. These rules vary depending on the intended use and product category, focusing on safety, quality, traceability, and sustainability. Below is an overview of key regulations for specific products:

1. **Food and Dietary Supplements**

   Novel Food Regulation (EU) 2015/2283: Ingredients derived from marine by-products that were not widely used in the EU before 1997 may be classified as ”novel foods.” Approval requires documentation of safety, nutritional value, and potential health effects.

   Hygiene and Safety: Products must comply with general food safety regulations (Regulation (EC) No 178/2002) and hygiene standards, including HACCP requirements for production and processing.

   Traceability: Marine raw materials must be traceable to their origin (fisheries or aquaculture) in line with food safety and IUU fishing regulations.

2. **Cosmetics**

   Cosmetics Regulation (EC) No 1223/2009: Ingredients used in cosmetics must undergo safety assessments, including marine-derived substances such as collagen, oils, or bioactive compounds. Products must undergo a cosmetic safety assessment and be registered in the EU’s Cosmetic Products Notification Portal (CPNP) before entering the market.

   Environmental Considerations: Sustainability and documentation of environmental impact may be required, particularly for marine ingredients sourced from wild populations.

3. **Ingredients for Pharmaceutical Products**

   GMP Standards (Good Manufacturing Practice): Marine-based ingredients for pharmaceutical use must comply with stringent GMP requirements to ensure consistency and safety.

   REACH (Registration, Evaluation, Authorization and Restriction of Chemicals): Bioactive compounds from marine by-products used as chemicals may need to be registered under REACH to ensure safe use.

4. **Environmental and Sustainability Requirements**

   EU Taxonomy for Sustainable Finance: Products utilizing marine by-products can benefit from positive classification as sustainable under the EU taxonomy if they demonstrate efficient resource use and minimal environmental impact.

5. **Labelling, Marketing, and Health Claims**

   For food and dietary supplements placed on the European market, products must comply with the Food Information to Consumers (FIC) Regulation (EU) No 1169/2011, which ensures accurate labelling of ingredients, allergens, and origin. Dietary supplements must also adhere to the provisions of Directive 2002/46/EC, which sets limits for vitamins and minerals. Nutrition and health claims must comply with Regulation (EC) No 1924/2006 on nutrition and health claims, meaning that any claim regarding the beneficial effects of a product or ingredient must be scientifically substantiated and approved by the European Food Safety Authority (EFSA). Products are not allowed to suggest that they can prevent, treat, or cure diseases.

   For cosmetics, products must use correct ingredient labelling according to the INCI system (International Nomenclature of Cosmetic Ingredients), and marketing claims must be truthful and not misleading, in line with Cosmetics Regulation (EC) No 1223/2009.

Expanding Beyond Europe: Regulatory Tips for the US and Asia

Products based on marine raw materials have markets just as large in the US and Asia as in Europe, but navigating the regulatory landscape outside the EU requires careful preparation. Business developers aiming for these regions should start by identifying the primary regulatory authority in each market – for example, the FDA in the US, SAMR in China, or MFDS in South Korea – and understand whether their product is classified as a food, dietary supplement, cosmetic, or pharmaceutical.

Early engagement with local regulatory consultants is highly recommended, as requirements such as GRAS notifications (US), “novel food raw material” approvals (China), or function claim registrations (Japan) can significantly affect time-to-market. Developers should also anticipate differences in documentation needs, such as safety dossiers, proof of traceability, or even animal testing in some Asian cosmetic markets. Building regulatory compliance into the business plan early, setting aside resources for approvals, and establishing strong local partnerships will help reduce risk and accelerate entry into these high-potential markets.

Norway provides numerous examples of innovation stemming from the use of by-products and residual materials from the marine sector. Significant learning has been gained, and a wealth of knowledge can be drawn from established companies working in these areas, as well as from research and development institutions.

One useful resource is the report Utfordringer som hindrer økt utnyttelse av marint restråstoff og marine arter (‘Challenges that prevent an increased utilization of marine residual raw materials and marine species in Norway’) (Birthe Vang, Berntssen, Ørnsrud, Sele, Solstad, Eskildsen Pleym, Svorken, Steinsholm, Aas, Kokkali, Carvajal & Dragøy 2021). The report, unfortunately only available in Norwegian, can be translated for those who wish to gain deeper insight into the full range of opportunities and challenges associated with commercializing products from marine raw materials. It provides an overview of current regulations governing the use of residual raw materials and by-products for human consumption and animal feed, discusses market and regulatory barriers that may limit business development, presents examples of certification and labelling schemes, and includes information on limit values for contaminants in feed, food, and feed products.

3.3.4 Agriculture specific legislation

CAP (Common Agricultural Policy) plays a crucial role in shaping sustainable agricultural practices in the EU. Recent reforms have aligned CAP with the goals of the circular economy:

- The CAP now includes eco-schemes that incentivize farmers to adopt more sustainable practices, such as improving soil health, reducing fertilizer use, and promoting agroecological methods. While Finland and Ireland implement EU CAP with national implementing laws, Norway and Iceland have also national agricultural policies.

- Measures to reduce food waste at the production level through better management of crops and livestock.

3.3.4.1 Farm to Fork Strategy

The **Farm to Fork Strategy** is a part of the European Green Deal and focuses specifically on creating a sustainable food system. It integrates circular economy principles by:

- Promoting sustainable food production, reducing food loss and waste, and improving food safety

- Setting targets to reduce pesticide use and chemical fertilizers, both of which are key to minimizing waste and improving sustainability in food production.

3.3.4.2 Waste Framework Directive

This sets the legal foundation for waste management in the EU and aims to reduce waste generation and improve recycling. Key provisions which are related to the agri-food sector include:

- Food waste reduction: The directive includes provisions that encourage Member States to adopt national measures to reduce food waste, including through the establishment of food waste prevention programs.

- Organic waste recycling: The directive promotes the recycling of organic waste, which is highly relevant to the agri-food sector, including through composting and anaerobic digestion.

Comparison of food-waste regulation relevant for company operations and circular business models is presented in Table 4.

Even when food waste recycling is encouraged, additional legislation on **animal by-products, fertilizers, feed, and environmental permits** often determines whether organic waste can legally be used as a new raw material. Early regulatory screening is essential before developing new circular products or services.

Table 4. Comparison of food-waste regulation relevant for company operations and circular business models.

Business relevant aspect	Ireland	Norway	Finland	Iceland
Primary focus	Waste Management Acts 1996–2023; Waste Management (Food Waste) Regulations 2009 (as amended, incl. 2024)	Food Waste Act (2025); Pollution Control Act (1981); Regulations on fertilizing products	Waste Act (646/2011); Government Decree on Waste (978/2021)	Waste Management Act No. 55/2003; National Waste Prevention Programme; Food-Waste Action Plan (2021)
Policy objective	Reduce landfill disposal of food waste; ensure compliance with waste hierarchy	Prevent and reduce food waste across the food value chain	Implement waste hierarchy with emphasis on separation, data, and recovery	Reduce waste generation and improve resource efficiency
Who is directly regulated	Commercial food businesses (hospitality, catering, retail, food processing)	Companies across the food value chain	Food business operators and municipalities	Municipalities; companies indirectly via local systems
Operational obligations for companies	Mandatory segregation of food waste; use of authorized collectors/ treatment	Food-waste assessment, prevention measures, and mandatory reporting	Separate collection of bio-waste; record-keeping on food waste	Compliance with municipal collection and treatment schemes
Use of food waste as a raw material?	Yes, through authorized treatment pathways (e.g. AD, composting); permits may be required	Yes, strongly encouraged when it prevents waste and creates value	Yes, reuse and recovery promoted under waste hierarchy	Yes, encouraged but dependent on municipal arrangements
Use for animal feed	Possible but strictly regulated (animal by-products and feed rules apply)	Allowed under strict hygiene and feed-safety rules	Allowed only for specific streams under regulation	Very limited and tightly controlled
Use for fertilizers / soil improvers	Allowed via authorized composting or AD; fertilizer regulations apply	Clearly regulated; waste-derived fertilizers permitted under national rules	Allowed under fertilizer and waste legislation	Allowed through authorized treatment processes
On-site treatment (biogas, composting)	Possible but permit-dependent; more common for larger operators	Supported if compliant with pollution and fertilizer rules	Possible with environmental permits and municipal coordination	Limited by scale and local infrastructure
Redistribution (donation, re-sale)	Encouraged but voluntary	Actively promoted as a priority before disposal	Encouraged through guidance and best practice	Encouraged via national strategies

4 Knowledge and infrastructure providers

Connect your organization and the companies you support with specialized service providers that can assist with ideation, technology development, technology transfer, product testing, and circular business model innovation.

A LIST of relevant service providers supporting agriculture, marine & aquaculture, and forestry sectors in the Northern Periphery and Arctic (Norway, Finland, Iceland, Ireland) are gathered in **Annex 4**.

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Annexes

Annex 1. Examples of companies in the forest industry value chains in Finland.

Enhancing Value Chain Collaboration in the Wood Industry in Perho, Finland

As part of the Target Circular project, data was gathered to map and analyze the value chains within Finland's sawmill and wood product industries. The focus area for this research was the municipality of Perho in Central Ostrobothnia, which is an ideal setting due to the strong local presence of both sawmill operations and timber construction businesses.

The project interviewed three local wood processing companies to identify their waste and by-product streams, their quantities and their utilization and ideated cooperation potential to improve circularity of all companies. The interviewed companies are located within a 10-kilometer radius of each other. Tools presented in this handbook were used to analyse side and waste streams, their current utilization routes and further ideated value chain creation for those streams.

The first case was sawmill JET-Puu (https://www.jet-puu.fi/en). This company is part of JETTA-Group and subsidiary of housing building factory JETTA-Talo. About 25% of the production goes to the local building factory, 30% to the to the domestic construction industry and the remaining 45% is exported to Central Europe and China. All wood raw material used in production is Finnish spruce.

Adapted MFA tools were used to perform initial analysis of wood waste streams (Table 1 and 2).

Company sells all the side and waste streams and earns around 1,6 mln € (20% of turnover), average price is 40 €/m^3

Picture 1 visualizes inputs, outputs and utilization of side and waste streams of JET-Puu Ltd.

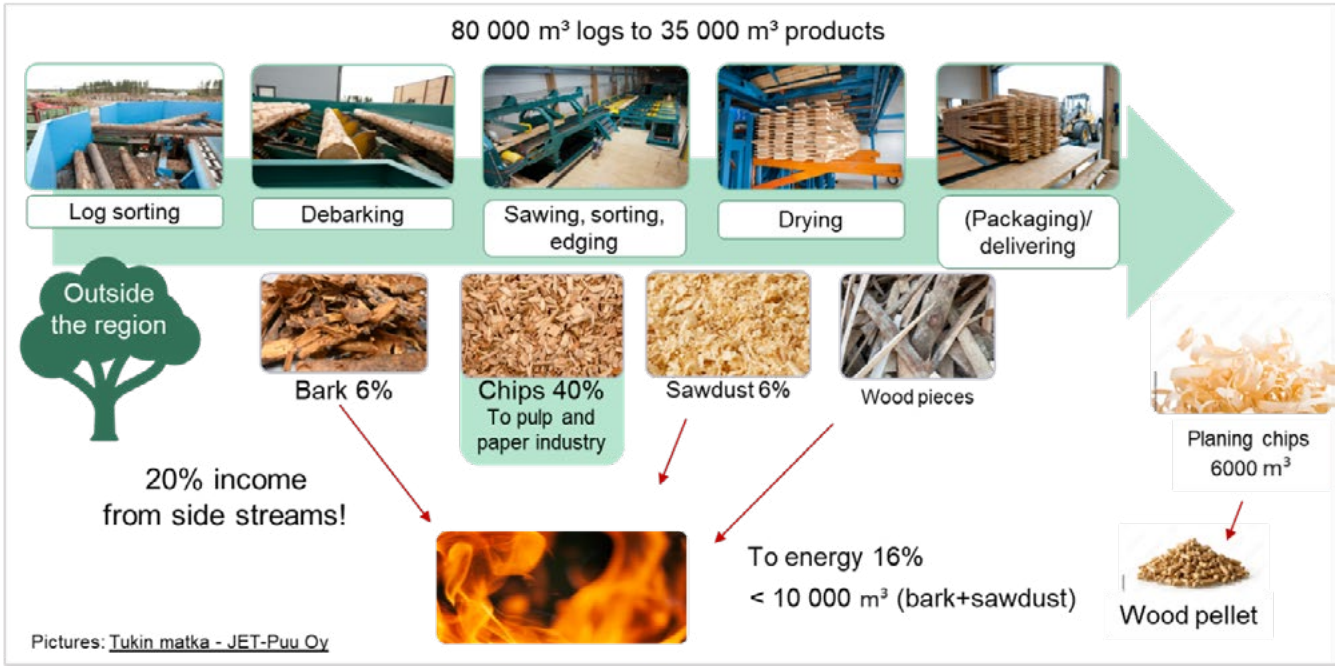
Although the company is managing its by-products efficiently and does not generate wood-based waste, the value of its wood material could still be increased. Material currently directed to energy production could potentially be upgraded for pulping or other higher-value applications, creating added economic and material efficiency benefits.

Table 1. By-products: analysis of wood material flows, energy and other inputs excluded.

Production process step	Inputs to process and product output			
	Input	Amount per year	Product	Output, product
Debarking	Wood logs	80 000 m^3	Debarked wood log	
Sawing	Debarked wood logs		Raw sawn boards	
Planing	Sawed boards		Planed boards	
Cutting, trimming	Planed boards		Ready boards	35 000 m^3
Painting	Boards	3000 m^3	Painted boards	3000 m^3

Table 2. Side and waste streams and their disposal.

Production process step	Type or name of by-product or waste	Amount in form disposed	Category and composition, other remarks about the quality	Current disposal or utilization
Debarking	Bark, spruce	4 800 m³ (6 %)	Solid	Energy recovery, own
Sawing 1	Wood chips, spruce	32 000 m³ (40 % from logs)	Solid	Sold to pulping factory
Sawing 2	Saw dust	4 800 m³	Solid, clean	Energy, external user
Planing	Shavings	15 000 loose-m³	Solid, clean	Made to pellets, bedding material for local farmers
Trimming, cutting	Off cuts	1 000–1 500 loose-m³	Solid, dry, clean. (crushing needed)	energy production, external user



Picture 1. Inputs, outputs and utilization of side and waste streams of JET-Puu Ltd.

The second case was a house building factory JETTA-Talo Ltd, that manufactures house-packages from large elements (https://jetta-talo.fi/). The company uses timber that JET-Puu produces. This saves logistic costs as well as reduce transport emissions. When operating at full capacity, the factory consumes approximately 12 000 m³ of sawn timber per year, about 10% of which is waste. The building factory generates a wide range of other by-products and waste as shown in the Picture 2. Unlike a sawmill (JET-Puu), the factory does not receive any revenues from by-products rather pays for freight and gate fee for recyclers. Moreover, the quantities of by-products and waste streams are not monitored with the same degree of accuracy as by Jet-Puu.

Picture 2. A building factory generates a wide range of by-products and waste. Photos: Jet-Puu.

The third case was a ready-to-use sauna construction company Ehta Ltd. (https://www.ehta.fi). The raw material used is almost entirely Finnish spruce. At the factory, waste is reduced by controlling material flows, using standard products and optimizing process steps. The company generates about 20 m³ of waste wood per year. The wood is incinerated for heating the building and, outside the heating season in summer, is sold on a small scale for firewood. The planing process produces annually about 100 m³ of chips, which is delivered to local district heating plant. Metal waste is collected for recycling. Non-recyclable packaging plastic is also left over from the process. The surplus cardboard is used to protect the floors before the sauna is used by the customer. Picture YY shows by-products and their annual amounts (Picture 3). Interviews revealed that the problem with waste streams is the small amount of waste and high disposal costs.

The challenge company is facing is related to small amount of waste streams. Company stores waste streams and expects to deliver it for recycling when bigger amount is generated.

Picture 3: By-product and waste streams of sauna construction company. Photos: Hanna Tölli.

Conclusions and Recommendations for Further Analysis

» All three factories use Finnish spruce, which means their wood material by-products are compatible.

» Jet-Puu has the most developed utilization of by-products and could be potential coordinator for better utilization of by-products from two other companies.

» Coordinated chipping of clean wood from all three companies would increase the volume delivered to the pulp factory and would likely result in higher revenues for all parties.

» Instead of incineration, the Ehta Group could redirect clean shavings for use as animal bedding, a product that is likely more valuable than energy generation.

» Clean wood by-product could be chipped and delivered to pulp company, process coordinated by e.g. JET-Puu.

» There are nine additional wood-processing companies in the Perho region. Analysis of quality of their by-products and waste streams could potentially reveal addition-al volume of material available for higher-value products, potentially in a more cost-effective way.

» Additional analysis is recommended to identify higher-value products, such as chemical building blocks, composite materials, or other advanced wood-based products.

Utilization of birch bark – Innomost Ltd

About 10% of the wood is bark. It is estimated, that about three million tonnes of conifer bark and 0,15 mln tonnes of birch bark are obtained as a by-product of the forest industry every year in Finland (E. Verkasalo at al, 2017). Bark in most cases is used for energy production.

Finnish company Innomost Ltd valorize birch bark which they source from Metsä Group, a leading Finnish forest industry company. The origin of wood is known, and the chain of custody certification provides the proof that origin, legality and sustainability are realized throughout the supply chain. Metsä Group supports PEFC (PEFC/02-31-03) and FSC® (FSC-C014476) certifications.

Birch bark is highly rich in chemical compounds, that allow to target multiple products for multiple applications. Suberin, betulin, cellulose, tannin and other compounds from birch bark have potential in cosmetic's industry, coatings, additives to plastics, etc. Value of those products is much higher than in energy recovery. Furthermore, they are replacing synthetic fossil oil-based ingredients or other unsustainable products.

Innomost Ltd's first market entrance products are ingredients for cosmetics. Suberin and betulin are used in skincare, haircare, body care, decorative cosmetics, and oral care products. These products replace environmentally harmful ingredients such as microplastics and unsustainable products like palm oil, offering benefits like deep cleansing, skin regeneration, and anti-aging properties. Innomost's products from birch bark are currently being tested in a range of new applications, including barrier coatings, adhesives, packaging, and textiles.

Picture 4. Betuinno™ Betulin and Suberinno™ Suberin are products used in many applications. Photo: Innomost Oy.

Sawdust – filler/reinforcement for 3D printable and recyclable plastics

Sawdust most commonly is used as an energy source though direct incineration. Other potential uses include bioethanol production, supplying the pulp industry for cellulose recovery, and serving as a component in the manufacturing of particle boards.

Sawdust is increasingly being used as a filler in plastic composites, helping to reduce the need for fossil oil-based materials. This wood-plastic composite (WPC) not only contributes to sustainability but also provides functional

improvements. For example, sawdust can help to reduce thermal expansion and contraction, which is a common challenge in plastic product manufacturing. Other benefits of incorporating sawdust or wood fibers into plastic composites include:

- Adding wood fibers can increase the stiffness and strength of the plastic, making the composite more suitable for structural applications.
- Wood-plastic composites often have a more natural look and feel, making them appealing for products like decking, furniture, and interior panelling.
- Wood fibers improve the thermal and acoustic insulation properties of the material, making it more suitable for use in construction or home products.
- Wood-plastic composite products are often recyclable, meaning they can be reprocessed into new products at the end of their life cycle, contributing to a circular economy and reducing environmental impact.
- Since wood fibers store carbon, using them in composites can result in a lower overall carbon footprint compared to traditional plastics.

Centria together with industrial partners is developing 3D printing technology, which utilize WPC, consisting of 50% of plastic and 50% of saw dust, to produce recyclable molds for manufacturing composite products, such as boats (Picture 5). Manufactured mold is fully recyclable and can be used to replace virgin materials at its end-of-life. This innovative approach significantly reduces the mould production carbon footprint. Additionally, it creates new revenue opportunities by shifting from the traditional linear model of selling molds to offering a closed-loop service. In this model, company would manage clients' mold waste, recycling it into new materials, thereby enhancing not only their own but also their clients' environmental sustainability.

Picture 5. Mould making process: printing, milling, sanding, coating. Photos: Simo Huhtanen.

Waste paper and cardboard into thermal insulation for construction industry

Every day, tons of old newspapers are collected and sent for recycling usually back to paper. Innovative Finnish company Termex-Eriste Oy converts them into cellulosic fibers, which are blown into building cavities for thermal insulation. This insulation is not only a cost-effective alternative to traditional methods but also environmentally friendly and offers superior performance (https://termex.fi/en/products-and-solutions).

Annex 2. Norwegian circular marine value chains

Prawn shell waste into health supplement

Picture 1. PreCardix product package. Photo: PreCardix/ Stella Polaris.

PreCardix (Picture 1) is an innovative product developed from shrimp shells, which are generated as a byproduct of shrimp processing. After peeling, approximately 50% of the shrimp's weight remains as shells, which would otherwise go to waste. By utilizing these shells, PreCardix harnesses the natural bioactive compounds found in shrimp to create a valuable ingredient with potential health benefits. The development of PreCardix not only adds value to what is typically a discarded material but also contributes to more sustainable seafood processing practices, transforming shrimp shells into a high-quality, functional product for various applications.

Salmon skin into leather-like material

Norway produces over 1.3 million tonnes of salmon annually, generating substantial byproducts, including skin. If all salmon were processed into fillets in Norway, roughly 91,000 tonnes of salmon skin could theoretically be available each year. A portion of that is processed domestically is collected and transformed by Norskin (https://www.norskin.no/) into durable, sustainable leather-like material. Norskin's salmon skin is featured in the Public chair by NCP (Picture 2), where the seat is upholstered with salmon skin, and other components of the chair are made from recycled materials: the frame from recycled steel, the backrest from recycled plastic from the salmon farms, and the cushion foam from seaweed-based foam, combining innovation with sustainability.

Beyond leather, salmon skin has potential applications in collagen, nutraceuticals, and bioplastics.

Picture 2. Chair utilizing salmon skin. Photo: NCP.

Annex 3. Meat processing company, Iceland

Analysis of Kjötafurðastöð KS cases in Iceland

Kjötafurðastöð KS operates in the food industry, focusing on meat processing, including slaughtering, cutting, deboning, and packing of meat products. The company processes sheep, cattle, and horses, producing raw meat and offals sold domestically and internationally, either frozen or chilled. Packaging materials include vacuum films, plastic bags, and cardboard boxes.

The company generates significant quantities of by-products and waste during its processes. These are categorized by their production phase and current utilization.

Table 1. By-products and waste from meat processing.

Production phase	By-products/waste	Amount/year	Utilization/disposal
Slaughtering - blood	Sheep, cattle, and horse blood	394,000 L	Drainage
Slaughtering - heads	Sheep, cattle, and horse heads	48.3 tons	Incineration/landfill
Slaughtering - skins	Sheep skins, cattle hides, and horse hides	83,000 pcs	Export
Slaughtering - feet	Sheep and horse feet	173,8 tons	Landfill
Slaughtering - offals	Various offals, tripes, and fat	~400 tons	Landfill
Slaughtering - sick animals	Sheep, cattle, and horses	31.7 tons	Landfill
Meat cutting - bones	Lamb, cattle, and horse bones	145.9 tons	Landfill/incineration

Current Challenges

- Waste Disposal Costs. Costs are incurred for labor, transportation, container rental, and waste disposal. Incineration requires additional oil and disposal costs for remains.
- Low Utilization of By-Products. Significant quantities, such as blood and offals, are discarded rather than utilized for higher-value products, representing missed opportunities for economic and environmental benefits.
- Infrastructure Limitations. Processing by-products for sale or repurposing would require new production processes and investments, limiting the company's ability to reduce waste streams effectively.
- Lack of Circularity. While some by-products like skins and hides are exported, others (e.g., blood and bones) are not integrated into circular economy practices, leading to significant waste.

Potential for Improvement

Drawing parallels to other industries, such as Finland's forest and wood sectors, innovative utilization of by-products could enhance the value chain and reduce waste:

- Blood: Could be processed into fertilizers or bioproducts for industrial applications, similar to Finland's valorization of birch bark.

- Bones and Offals: Potential exists for conversion into animal feed, biofuels, or high-value materials for pharmaceuticals and cosmetics.
- Skins and Hides: Current export could be expanded to include domestic processing for higher-value products, such as leather goods.
- Meat Waste: Repurposing into pet food or other feed applications.

Circular Economy Integration

- Monitoring and Data Collection. While by-products sold as raw materials for feed are monitored, systematic tracking of all waste streams would improve insights into efficiency and areas for potential reuse.
- Collaboration Across Industries. Partnerships with companies in different sectors (e.g., biofuel, pharmaceutical, or cosmetic industries) could open new markets for by-products, as seen in Finland's use of wood-plastic composites.
- Technology Investments. Investment in processing technology, such as bio-extraction or anaerobic digestion, could enable higher-value utilization of waste streams.
- Regulatory Support and Knowledge Sharing. Awareness and application of international best practices in circular economy could help align the company with sustainability goals.

Lessons from Other Industries

Forest Industry in Finland: Demonstrates how by-products like sawdust and bark are converted into fillers for recyclable plastics or bioethanol.

Wood Industry: Collaboration between companies like JET-Puu and JETTA-Talo reduces waste and transport costs, offering a model for integrated value chains.

Conclusion

Kjötafurðastöð KS has opportunities to enhance the circularity of its by-products and waste streams. By adopting innovative processing technologies, fostering cross-industry collaborations, and improving waste management practices, the company can transition towards a more sustainable and profitable operational model.

Annex 4. Service Providers in NPA area

Table 1. Service providers supporting agriculture, marine & aquaculture, and forestry sectors in the Northern Periphery and Arctic (Norway, Finland, Iceland, Ireland).

Organization name	Country	Website for further information
Research and development services (academic organizations and research and development organizations)		
Natural Research Institute (LUKE)	FI	https://www.luke.fi/en/services
Centria University of Applied Sciences	FI	https://net.centria.fi/en/rdi/
Oulu University	FI	innovationcentre@oulu.fi
University of Eastern Finland	FI	https://www.uef.fi/en/research
Oulu University of Applied Sciences	FI	https://oamk.fi/en/
University of Lapland	FI	https://ulapland.fi/en/frontpage/
Lapland University of Applied Sciences	FI	https://lapinamk.fi/en/services/business-services/
UiT Arctic University of Norway	NO	https://en.uit.no/forskning/forskningsgrupper
NIBIO	NO	https://nibio.no/en
MTU, Circular Bioeconomy Cluster	IE	https://cbcsw.ie/
Atlantic Technological University	IE	https://www.atu.ie/research/research-centres
University College Cork	IE	https://www.ucc.ie/en/sustainability-institute/
University of Limerick	IE	https://www.ul.ie/research/institutes-centres
Technological University of the Shannon	IE	https://research.tus.ie/en/organisations/
Technogical University Dublin	IE	https://www.tudublin.ie/research-innovation/
IDEAM Cluster	IE	https://ideam.ie/
Celignis	IE	https://www.celignis.com/
Digital Manufacturing Ireland	IE	https://www.dmireland.org/
Irish Manufacturing Research	IE	https://imr.ie/
Centre for Applied Bioscience Research	IE	https://www.cabr.ie/
MATIS	IS	https://matis.is/en/
University of Akureyri	IS	https://www.unak.is/
University of Island	IS	https://english.hi.is/research
Sectorial associations providing consultancy and networking specifically for agriculture, marine & aquaculture, and forestry sectors		
The Finnish Forest Centre (Metsäkeskus)	FI	https://www.metsakeskus.fi/en
Proagria	FI	https://www.proagria.fi/en/services
Pro Fish Association	FI	https://prokala.fi/
Macon Oy	FI	https://www.macon.fi/en/
Digipolis Oy	FI	https://www.digipolis.fi/
CodCluster	NO	https://www.codcluster.no/
NCE Aquaculture	NO	https://nceaquaculture.com/
Niotech North	NO	https://www.biotechnorth.no/
Icelandic Ocean Cluster	IS	https://sjavarklasinn.is/en/

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Organization name	Country	Website for further information
Southern Scientific	IE	https://southernscientificireland.com/
Circuleire	IE	https://www.circuleire.ie
Irish Bioeconomy Foundation	IE	https://bioeconomyfoundation.com/#
Biorbic	IE	https://biorbic.com/
Business support organizations providing general services: consultancy, networking, business development, funding		
Kokkolanseudun Kehitys Oy	FI	http://www.kosek.fi/
Business Oulu Oy	FI	https://www.businessoulu.com/
Micropolis Oy	FI	https://www.micropolis.fi
Kaustisen seudunkehitys Oy, (Kase)	FI	https://kaustisenseutu.fi/yrittajille/
Toholammin kehitys Oy	FI	http://www.toholamminkehitys.fi/yrityspalvelut/
Sievin Teollisuuspuisto Oy	FI	https://www.sievi.fi/elinkeinopalvelut
NIHAK Oy	FI	https://www.nihak.fi
Business Rovaniemi Oy	FI	https://businessrovaniemi.fi
SSNE	IS	https://www.ssne.is/
Vestfjarðarstofa	IS	https://www.vestfirdir.is/
SSV	IS	https://ssv.is/
Austurbrú	IS	https://austurbru.is/
Eimur	IS	https://www.eimur.is/
Orkídea	IS	https://orkidea.is/
Tinkr	NO	https://www.tinkr.no/
Knowledge Transfer Ireland	IE	https://www.knowledgetransferireland.com/
Local Enterprise Offices	IE	https://www.localenterprise.ie/

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