VTT

Sustainable circular business:

Rethinking and disrupting linear value creation

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beyond the obvious

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Executive summary

In light of pressing environmental challenges, the call to act has never been more urgent. This new business environment causes new types of financial risks for companies – risks stemming from environmental degradation and the rising awareness of sustainability impacts among different stakeholders.

The need to change our current modes of production and consumption towards more sustainable ones is manifested in the new sustainability-related regulation in the EU region. New European regulation will make businesses accountable for the adverse impacts their value chain activities may create. Disclosing information on business models and strategies concerning sustainability impacts is also required. With the overall aim of creating more future-proof, competitive and sustainable business, the new regulation is aimed at creating a level playing field for businesses operating in Europe.

For all these reasons, new sustainable solutions and their holistic understanding are needed across value chains and product life cycles. From raw material processing to use and recovery for re-use, there is a pressing need to find more sustainable solutions.

Both in businesses and politics, the circular economy is often seen as one of the main tools in achieving environmental sustainability. In contrast to the current dominant linear economy model, the circular economy model aims to keep resources in use for as long as possible.

Yet, a circular economy and circular economy solutions are not automat-

ically sustainable. In some cases, circular solutions can even create more adverse environmental impacts than their traditional, linear economy alternatives.

In this paper, we call this dilemma of finding sustainable circular solutions the sustainable circular business challenge. Solving this challenge is essential for focusing our actions wisely. Otherwise, we risk wasting our resources on circular economy actions that may not bear the sustainability benefits that are so urgently needed.

While unsustainable business creates risks for both the planet and the business itself, solving the sustainable circular business challenge also offers business opportunities for companies that are well-equipped to seize the moment. Companies that invest in sustainability and understand their actual and potential impacts and risks along their value chains are highly likely to perform better in the future business environment. This means that business models and ways of producing and consuming that provide value with minimum impact will be, and already are, in high demand.

To better support businesses in the green transition, and to solve the sustainable circular business challenge, we must have a holistic understanding of the sustainability impacts of current and intended circular solutions and be prepared to reconsider how value is created.

To tackle the pressing environmental sustainability challenges, we should not settle for minor improvements. Rather, we should strive for business operations that are transformative and have significantly less adverse impacts. In other words, we should focus on finding ways of delivering and capturing value that go beyond the current ways of conducting business. We need to look beyond the obvious to find new opportunities for systemic change and be able to utilise this understanding to support strategic decision-making.

In addition to new technological solutions, we need a scientific understanding of sustainability impacts, reliable sustainability data, cooperation among value chain actor, and capabilities to imagine and design new business models. At VTT, we have a wealth of experience in each of these fields.

This white paper presents examples of VTT's broad expertise in developing more sustainable circular businesses to the benefit of companies and the broader society. The paper has been compiled by the experts of VTT.

1. The sustainable circular business challenge

> "Unless we act now, the 2030 Agenda will become an epitaph for a world that might have been." [1]
>
> — UN Secretary-General António Guterres

The world is facing severe environmental challenges. As the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Sustainable Development Goals (SDGs) 2023 reports confirm, this decade is critical: limiting warming to 1.5°C and even 2°C involves rapid and often immediate greenhouse gas emission reductions [2]. Our global population is growing exponentially, and our resources must be stretched further to accommodate that. In short, there is a pressing need to act.

Applying circular economy principles is widely considered as an essential tool in achieving environmental sustainability and resource sufficiency goals crucial for the necessary green transition [3] . Generally, this means replacing the linear economic system with a new one where resources are kept in use for as long as possible.

The circular economy is a key concept in several recent EU-level initiatives and regulations that have been introduced since 2020 under the European Green Deal (Box 1). With the overall aim of making the EU the first climate-neutral continent whilst ensuring its competitiveness, these initiatives introduce numerous new mechanisms that aim at phasing out unsustainable businesses.

Box 1

Examples of recent and upcoming initiatives, programmes and legislation under the European Green Deal

The European Green Deal has introduced a broad range of sustainability and circularity-related regulatory actions and other proposals that aim at making the EU's economy **sustainable and competitive** and reaching climate neutrality by 2050 [3]. These initiatives have both strategic and operational implications for businesses in the EU region.

- Circular Economy Action Plan (CEAP) (2020) [4]: The CEAP is one of the main elements of xthe Green Deal. It introduces both legislative and non-legislative measures along the entire life cycle of products addressing product design, circular economy processes, sustainable consumption and waste prevention.
- EU's classification system for environmentally sustainable economic activities ("EU taxonomy") (2020) [5]: Sets common criteria for environmentally sustainable economic activities to direct investments to sustainable economic activities needed for the green transition.
- Extended Producer Responsibility (EPR) concept under the revised Waste Framework Directive (WFD) (2023) [6]: The WDF sets the basic concepts and definitions related to waste management, including definitions of waste, recycling and recovery. Introduces the first EPR schemes for companies to take responsibility for the entire lifecycle of their products, with a particular emphasis on the product's end-of-life stage.
- Proposal for the Ecodesign for Sustainable Products Regulation (ESPR) (2022) [7]: The ESPR establishes environmental performance and information requirements for physical products, including the concept of a mandatory Digital Product Passport (DPP) to disclose that information. The information requirements cover, for example, product durability, reusability, reparability, energy and resource efficiency and environmental emissions.
- Corporate Sustainability Reporting Directive (CSRD) (2023) [8]: Requires a broader number of companies to publicly disclose sustainability statements based on the disclosure requirements as defined in the European Sustainability Reporting Standards (ESRS).
- Directive on Corporate Sustainability Due Diligence (CSDD) (2022) [9]: Requires large and high-impact sector companies to identify, bring to an end, mitigate and account for actual and potential adverse human rights and environmental impacts in the company's operations, subsidiaries and value chains, introducing also financial sanctions for non-compliance.
- Proposal for the Green Claims Directive (2023) [10]: Aims at regulating the environmental claims that companies make about their products or services to enable consumers to make more informed choices.

As these new EU initiatives have both strategic and operational implications, their impact on the future business environment should not be taken lightly.

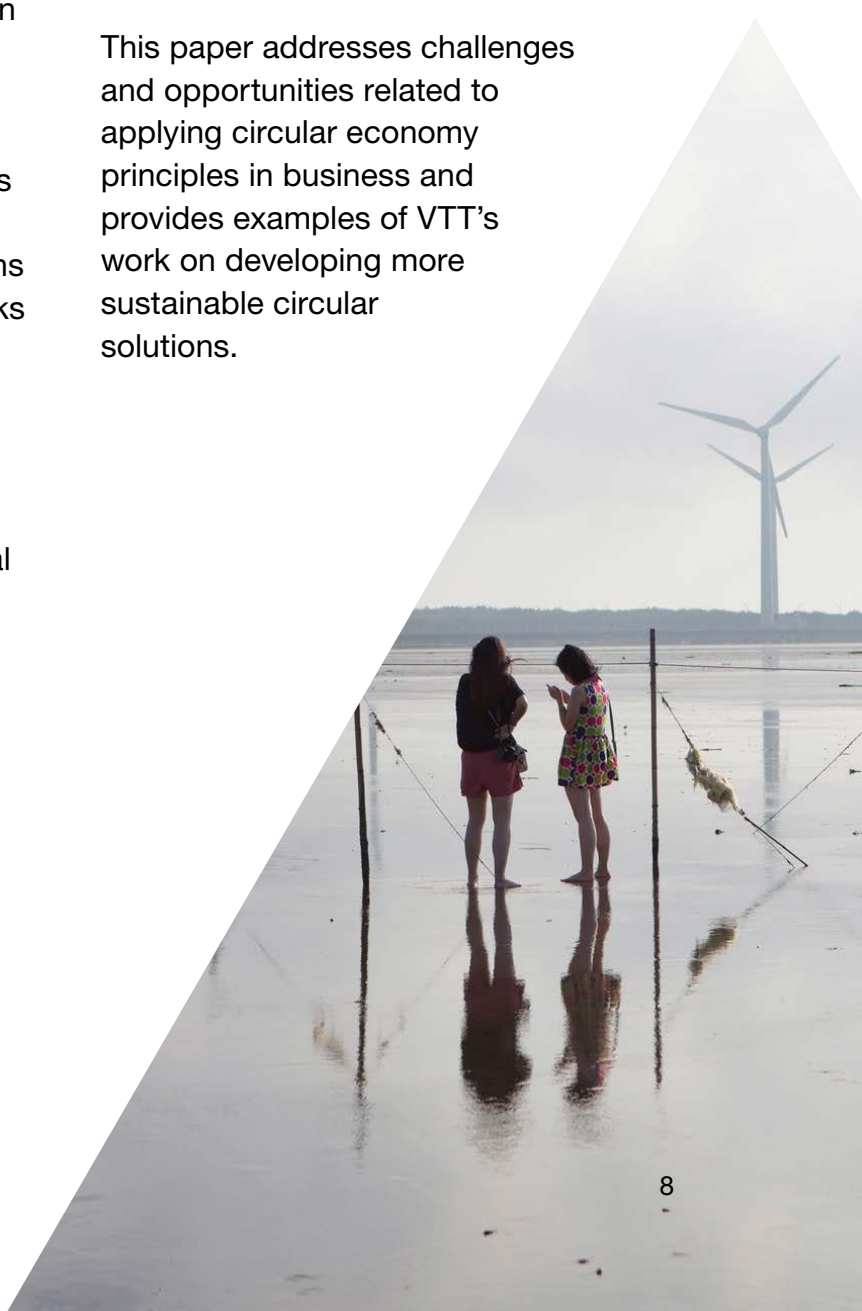
Although offering a promising alternative to the current linear make-use-dispose economic model, a circular economy is not automatically sustainable. This is because all circular solutions have environmental, social and economic impacts.

It is therefore essential to understand the various impacts and benefits that new circular business solutions can create. Otherwise, circularity actions originally aimed at advancing sustainability can create rebound effects that work against achieving the desired goals. Without careful assessment, well-intended circularity efforts may inadvertently result in environmental impacts resembling to maintaining business practices as usual.

What is more, applying circular economy principles without considering their various sustainability impacts can create new financial risks for businesses. The tightening of EU regulation will require companies to reduce and mitigate their adverse sustainability impacts along their value chains. Therefore, it is essential for businesses to understand what kind of sustainability impacts different circular solutions produce and what kind of financial risks can be involved.

To create better, more sustainable circular business solutions, we at VTT think it is important to raise more discussion and awareness on potential sustainability impacts, trade-offs and rebound effects associated with the circular solutions aimed at improving sustainability performance. Based on our extensive scientific expertise, we think it is necessary to develop and apply more rigorous, science and data-based approaches to respond to the pressing sustainability challenges properly. This type of impartial expertise is also required to support the systemic change that is needed not only for the circular economy, but for the sustainability transition as a whole.

This paper addresses challenges and opportunities related to applying circular economy principles in business and provides examples of VTT's work on developing more sustainable circular solutions.



2. Circular business solutions for sustainability

> “The circular economy is a transformational and systemic vision for a more ecologically effective economic system that works within planetary limits and thereby maintains and rebuilds natural capital. It is enabled by multiple, cooperative and simultaneous innovations at different scales in the wider socio-economic context involving regulation, policy and production and consumption systems [11]”
>
> — Roberta de Angelis, 'Circular economy: laying the foundations for conceptual and theoretical development in management studies'

Although the term ‘circular economy’ is widely used, defining a precise definition for it is not a straightforward task. Over one hundred definitions have been found in the academic literature [12]. Generally, the concept is taken to refer to a non-linear economic system where resources are kept in use as long as possible.

Often, a circular economy is also considered synonymous with a sustainable economy. However, as we explain in this paper, a circular economy and related circular business solutions are not automatically sustainable.

We believe that when defining the circular economy and implementing its principles in business, it is important to understand the various sustainability impacts that new circular solutions might have. This knowledge is also important for enabling a new, more regenerative economic system that would build and maintain our natural capital in socially and economically sustainable ways.

As noted, the circular economy can have many interpretations. Most of them include versions of the three basic so-called R strategies – Reuse, Repair, and Recycle. Altogether, 38 different R strategies have been identified in the literature [13]. In practice, the amount is even higher, and different R strategies often overlap with each other.

The R strategies cover various product life cycle phases from waste prevention to resource recovery. Elements of these strategies can also be found in circular design and business model strategies as well as in business models. The R strategies can also be likened to the EU’s Waste Framework Directive’s waste hierarchy levels [14] (Table 1).

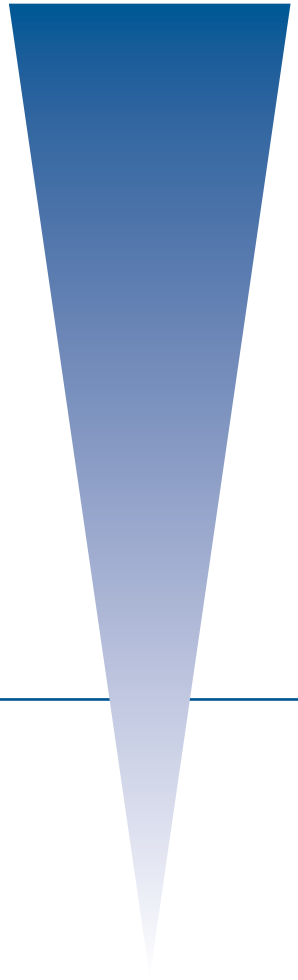
EU Waste Hierarchy [14]		R strategy examples [15]	Circular design and business model strategies [16]	Circular economy business models [17]
Product (non-waste) 	Preventation	• Refuse: Prevent raw materials' use • Reduce: Decrease raw materials' use • Redesign: Reshape product with a view to circularity principles	Narrowing strategies: Remove or dematerialise needs before production and consumption, leading to producing fewer, more sustainable products	
		• Reuse: Use product again (as second hand) • Repair: Maintain and repair product • Refurbish: Revive product	Slowing strategies: Prolong product's life-cycle before the product is recycled as material for other products using for example Product-as-a-Service (PaaS), Material-as-a-Service (MaaS) and life-cycle extension models	• Product life extension: Extend product lives. • Sharing: Increase utilisation of existing products and assets. • Product service system: Provision of services rather than products (physical goods). Product ownership remains with the supplier.
Waste phase	• Prepare for reuse • Recycling • Recovery • Disposal	• Remanufacture: Make new from second-hand product • Re-purpose: Reuse product but with other function • Recycle: Salvage material streams with the highest possible value • Recover: Incinerate waste with energy recovery	Closing resource loops strategies: Recover post-use elements and turn them into second-hand production inputs	• Circular supply: Replace traditional material inputs with renewable, bio-based, recovered ones. • Resource recovery: Produce secondary raw materials from waste.

Table 1. Levels of circularity and circular business model strategies

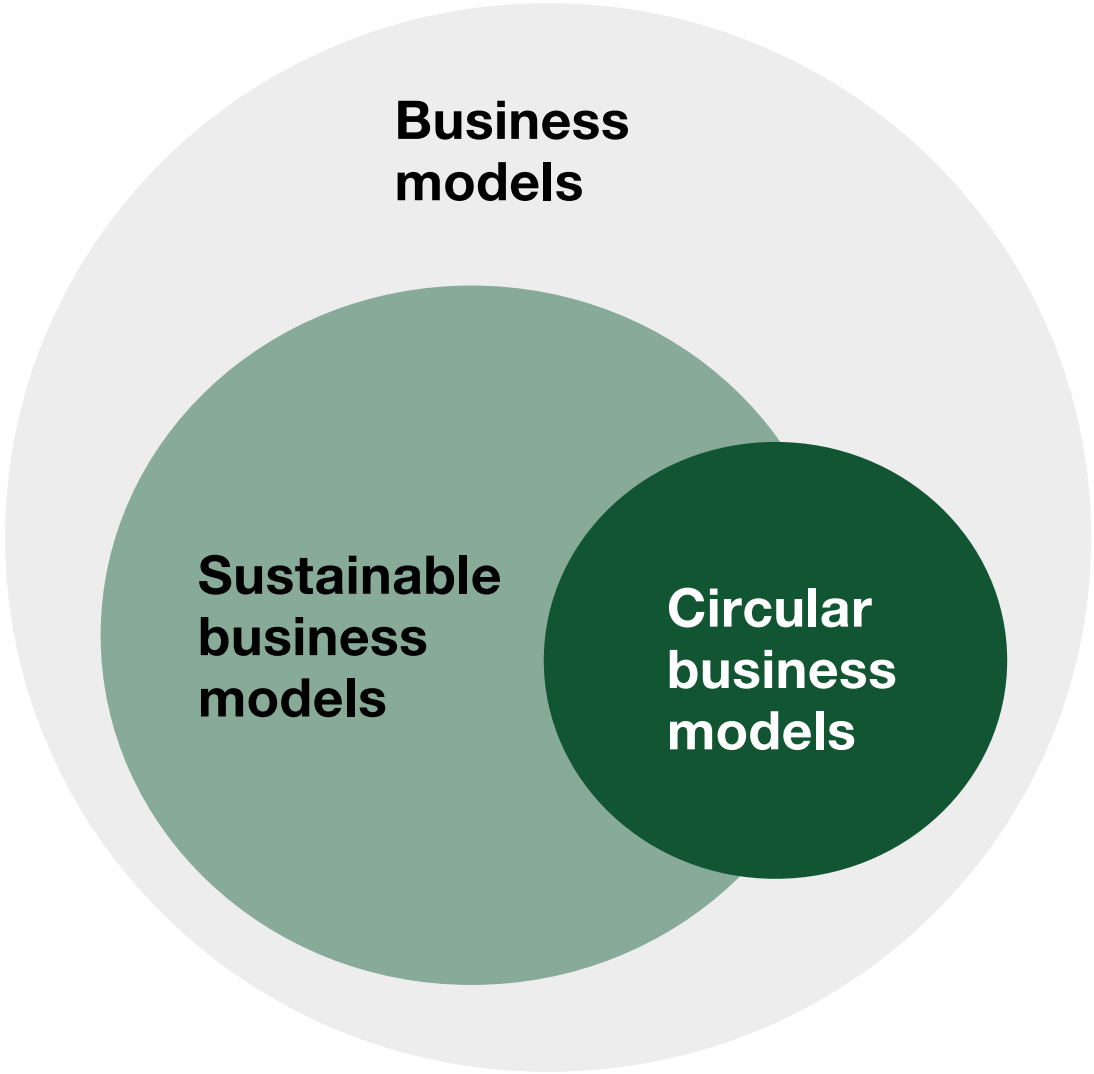


Figure 1. The relationships between business models, sustainable business models and circular business models [18].

Different R strategies can be applied as parts of current, linear business models. They can also form the basis for alternative business models and other circular business solutions. However, the resulting sustainability impacts are not automatically positive. That is to say, circular business models and other solutions can be sustainable – or unsustainable (Figure 1).

Therefore, it is essential to understand the various sustainability impacts, trade-offs and rebound effects that may arise from applying different R strategies, along with the accompanying new business models and other circular solutions, while also taking into account the specific context (Box 2).

Box 2

Understanding sustainability impacts, trade-offs and rebound effects

Circular solutions can lead to different sustainability outcomes. Understanding these is essential for arriving at more sustainable circular business solutions.

The **life cycle thinking (LCT**) approach provides practical tools for understanding and identifying relevant sustainability impacts. **The life cycle assessment (LCA)** builds on this approach. The LCA can be applied at the level of a singular product (a physical product or a service or a combination of them) or at the level of an organization [19].

A proper LCA should include the consideration of potential **trade-offs**. All decisions involve trade-offs: gains in one area at the expense of losses in another area [20]. For example, in Product-as-a-Service (PaaS) and sharing-based circular business models, the environmental performance of sharing and renting can be even worse when compared to the traditional ownership of goods [21]. Moreover, as PaaS models can help to maximise the service life of a physical product and offer the user a care-free product and a lower initial investment, offering these services can result in additional management, monitoring and logistics costs for the company. The model may also lock users into long service contracts increasing users' future switching costs, potentially diminishing their interest in using such services.

In addition to impacts and trade-offs, also the potential **rebound effects** should be properly understood. The term **circular economy rebound (CER)** refers to a situation where the eco-efficiency benefits of the new solution are offset by an increase in production or consumption [22,23].

Navigating this ocean of impacts, trade-offs and rebound effects is not an easy task. Rather, it is highly challenging to design and implement sustainable circular business models and other solutions without trade-offs and rebound effects [24]. However, these aspects need to be properly understood to make informed strategic and other business decisions.

Moreover, the more transformative and disruptive business models that focus on regenerative business and sufficiency are less commonplace, despite their recognized importance for future flourishing economies [25,26,27,28]. Therefore, sustainable circular business models and other circular solutions need to be considered as a part of larger, interdependent systems and phenomena. This is essential for creating systemic change that is needed to arrive at a more sustainable economy, as implementing circularity strategies commonly requires cooperation between different organisations and their stakeholders.

3. Research collaboration for sustainable circular business

VTT's sustainable circular business expertise stretches from strategic to operational-level challenges. Our work covers product and service design, technology development, sustainability assessments and circular business model development.

In addition, our experience extends to collaborating with individual companies as well as broader ecosystems.

Our experts have extensive experience in facilitating ecosystems and co-creation processes, involving relevant stakeholders across value chains to develop solutions for tackling large-scale global challenges.

Furthermore, we have extensive access to scientific knowledge, high-quality databases and the skills needed to analyse vast data sets and apply the latest scientific insights to practice.

The following chapters feature case examples from our research collaborations and expertise, aimed at developing more sustainable circular businesses

3.1 Case: Sustainable business models in textile industry for climate transition

Sustainable business models offer an alternative approach to business. The commonly used business model canvas tool can be adjusted to integrate sustainability and circularity into business design [29].

To substantiate the sustainability benefits of a circular business model, quantitative methodologies like life cycle assessment (LCA) should be used to provide more robust evidence.

This approach is integral to the EU-wide CRAFT-IT4SD project, as part of which the climate impacts of selected fashion business models are evaluated through LCA. The aim is to understand how these models can support and advance sustainable climate transition not only in fashion but also across other sectors.

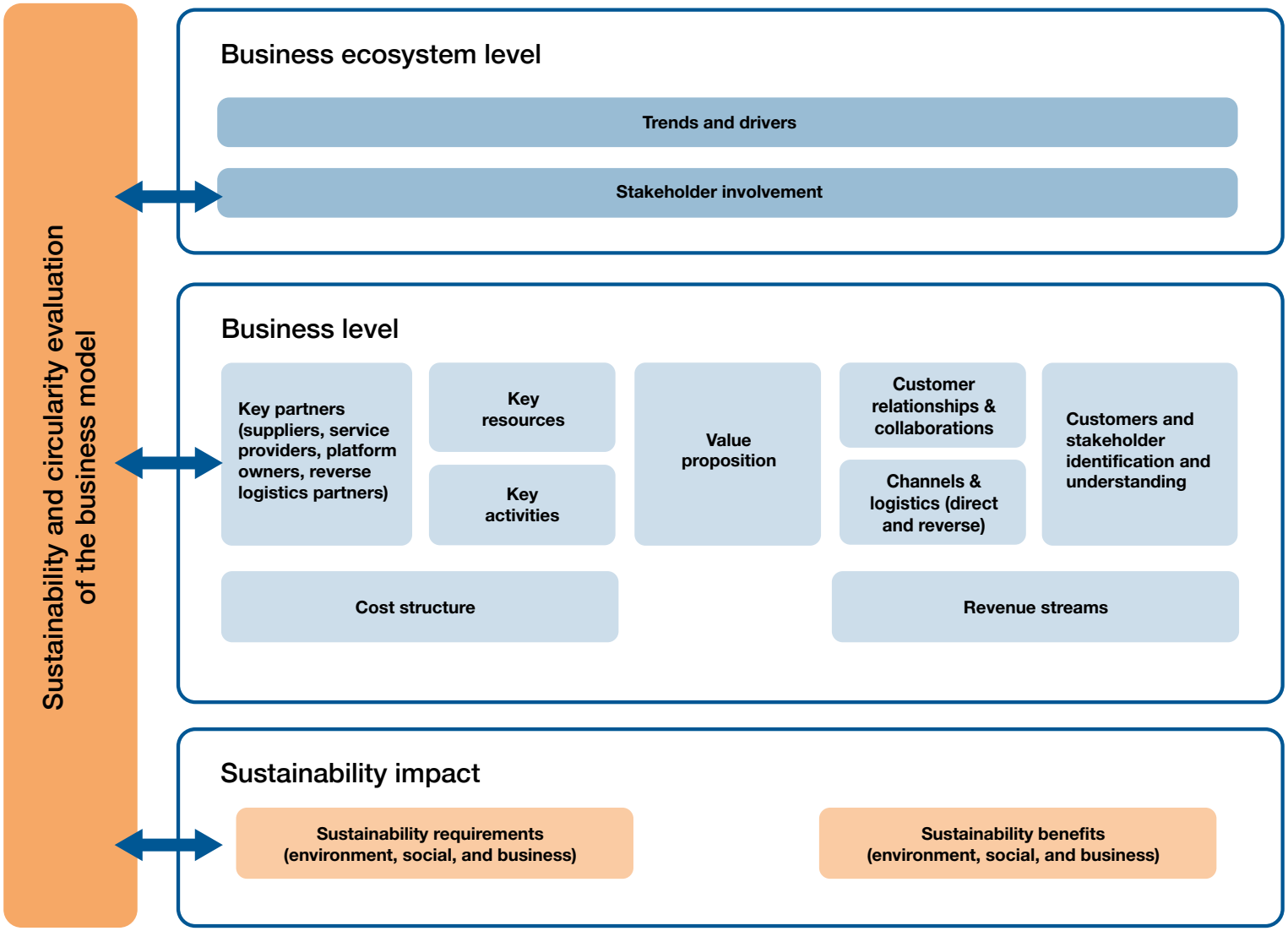


Figure 2. A Framework for Sustainable Circular Business Model Innovation [29].

Project and case companies	The CRAFT-IT4SD [30] (Craft Revitalization Action for Future-proofing the Transition to Innovative Technologies for Sustainable Development) project (2024-2026) works to unlock the potential of European cultural and creative sectors and industries (CCSIs) in advancing the green transition. As part of the project, the climate impacts of business models are calculated for four selected case companies that represent sustainable fashion approaches in the textile ecosystems of Denmark, Finland, Romania and Spain.
Circular business aspects	Circular business models can include various approaches that apply different levels of circularity, ranging from resource recovery to removing or dematerialising needs. To support fashion and clothing companies in aligning with the EU Strategy for Sustainable and Circular Textiles [31] and the EU's climate targets, a deeper understanding of the climate impacts of diverse circular models is needed.
Sustainability impacts	Circular business models offer various sustainability benefits, but the impacts and their magnitude vary. Quantitative assessments like LCA help identify high-impact areas. Combining LCA results with additional insights gained from the CRAFT-IT4SD project on crafts, new technologies, customer behaviour and value creation provides scientific, fact-based evidence for sustainability improvements and policy interventions for unlocking the CCSI potential in the green transition.

Table 2. Understanding the potential of sustainable business models in fashion to advance sustainable climate transition

The CRAFT-IT4SD project demonstrates how to leverage VTT's expertise in sustainable business models in a practical business context.

Generally, in a VTT circular business model development project, the scope can be customised to meet an organisation's specific needs. The project can tackle specific challenges such as climate impacts, or adopt a more comprehensive approach. The scope can also include global trends, ecosystems, value co-creation, scenario work and strategic perspectives [29,32]. VTT's strong expertise in business models, strategic foresight, sustainability assessments and scientific research methods enables a critical and holistic analysis of business models and their alternatives.

3.2 Case: Removing plastic materials from rivers: From waste to value

Collaboration on research projects with VTT can benefit both large and small companies. Smaller companies, for example, often bring valuable contributions to developing sustainable circular solutions but may lack the resources that larger companies have.

The Kelmuvex [33] innovation collaboration project, funded by Business Finland (2021-2023) and coordinated by VTT, aimed at creating new holistic and cost-efficient solutions for the identification, tracking, recovery and valorisation of discharged plastic waste in rivers. The project participants included Finnish technology companies of different sizes and waste management organisations in South-East Asia (Table 3).

In the project, VTT researched financial models and business ecosystems to support the participants in creating global value chains and locally adapted business models. Among various methodologies employed, system dynamic modelling was utilised to complement VTT's technological expertise in creating a holistic understanding of the global business environment.

Project and participating companies	Kelmuvex - New solutions for discharged plastic waste was an international collaboration project, funded by Business Finland (2021–2023) and coordinated by VTT [33]. The project consortium included company partners of different sizes and expertise: RiverRecycle, Wimao, Lamor and Valmet. RiverRecycle develops solutions for plastic debris recovery, while Wimao provides technologies for plastic waste recycling. Additionally, Lamor offers waste and water management solutions, and Valmet serves as a technology provider for the process industry.
Circular business aspects	Collaborating with land-based waste management is essential for scaling up the collection of plastic debris to achieve economies of scale. Advanced plastic waste technologies for mixed waste can be used to create raw materials, for example, for the chemical industry or the construction industry. The revenue from advanced plastic waste processing can be used to finance the costs of plastic debris collection.
Sustainability impacts	By processing the collected waste into new materials and other products, significant climate impact reductions can be achieved. Plastic waste recovery has both direct and indirect job creation potential in waste collection and processing. The waste collection benefits the aquatic ecosystem, mitigates microplastic pollution and supports fishing, water transport and tourism as well as the recreational use of waterways.

Table 3. From waste to value: Building global value chains and locally adapted business models that utilise plastic waste from rivers

The Kelmuvex project demonstrates how research collaborations with VTT can unite different actors to address collective challenges.

VTT has strong expertise in building project consortiums and acquiring funding for innovation ecosystems enabling the co-development of new, more sustainable circular business solutions. Through research collaboration projects, participants can leverage VTT's extensive scientific knowledge and practical expertise to solve concrete business challenges, test new solutions in practice, build networks, engage different stakeholders and build market demand.

3.3 Case: Exploring circularity alternatives in the textile sector

Research project collaboration can lead to the establishment of active, long-term industry networks.

In the textile sector, VTT has actively contributed to the establishment and continuous development of the Telaketju network. Telaketju is an active collaboration network working towards achieving more sustainable textile production, use and cycles (Figure 4). Since the initiation of the first projects in 2016, a total of seven projects have received funding from different funding agencies, with Telavalue (2022-2024) being the latest [34].

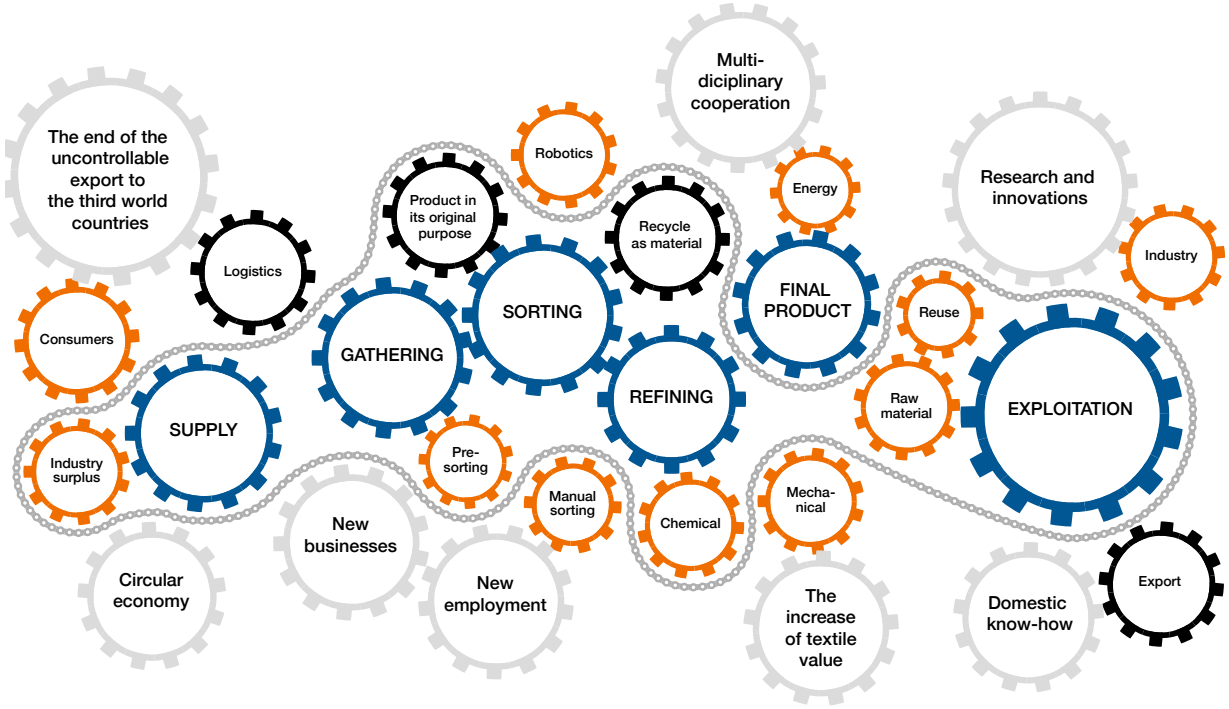


Figure 4. Themes of Telaketju activities (image: Inka Mäkiö, Telaketju) [34]

Project and participating companies	Telaketju [34] is an active industry network that advances textile circularity. The network has formed around seven consecutive research collaboration projects that have received funding from several funding agencies such as Business Finland, the Ministry of Environment, the Ministry of Economic Affairs and Employment and The Finnish Innovation Fund Sitra. The projects have involved dozens of partners, including research institutions, textile companies, municipal waste management organisations and non-profit organisations such as re-use centres and charities.
Circular business aspects	The seven research projects have focused on different aspects of circularity within the textiles industry. These have included textile recycling technologies, ecosystems and collaborative models, circular design and circular business models. For example, business models based on Product-as-a-Service (PaaS), on-demand production and extended lifetime have been explored. The participants have been actively involved in building value chains and infrastructure for separate collection of textile waste as well as its processing, recycling and utilisation in various applications.
Sustainability impacts	The research collaboration projects have sought to develop new circular solutions to advance more sustainable textile value chains. In addition to supporting the development of new recovery and recycling technologies, an economic model has also been created. The projects have increased the participants' understanding of the sustainability impacts of textile production, use and recycling, enabling them to build more sustainable future textile ecosystems and value chains.

Table 4. Long-term industry network and collaboration: Value from circular textiles

As the Telaketju example shows, continuums of research collaboration projects enable coordinated and efficient industry-wide collaboration, allowing participants to focus on their distinct areas of interest.

With the support of the Telaketju projects, the Finnish textile sector has become one of the textile recycling forerunners in Europe. Finland was prepared to begin the separate collection of textile waste as early as 2023, two years ahead of the mandatory collection requirement set by the EU for 2025. Furthermore, new partnerships and companies have been established, and new recycling infrastructure investments made. Moreover, companies along the textile value chain have adopted and are planning to adopt new, more sustainable business models.

3.4 Case: Advanced circularity modelling in the battery value chain

Modelling circularity can provide insights for product design and the development of business models.

To increase the understanding of the material flows and value chains in circular economy, VTT has developed a system dynamic material flow modelling approach. The approach has been first applied to better understand the electric vehicle (EV) battery value chain (Figure 6), developed as part of the Circular Design Network project (Table 5).

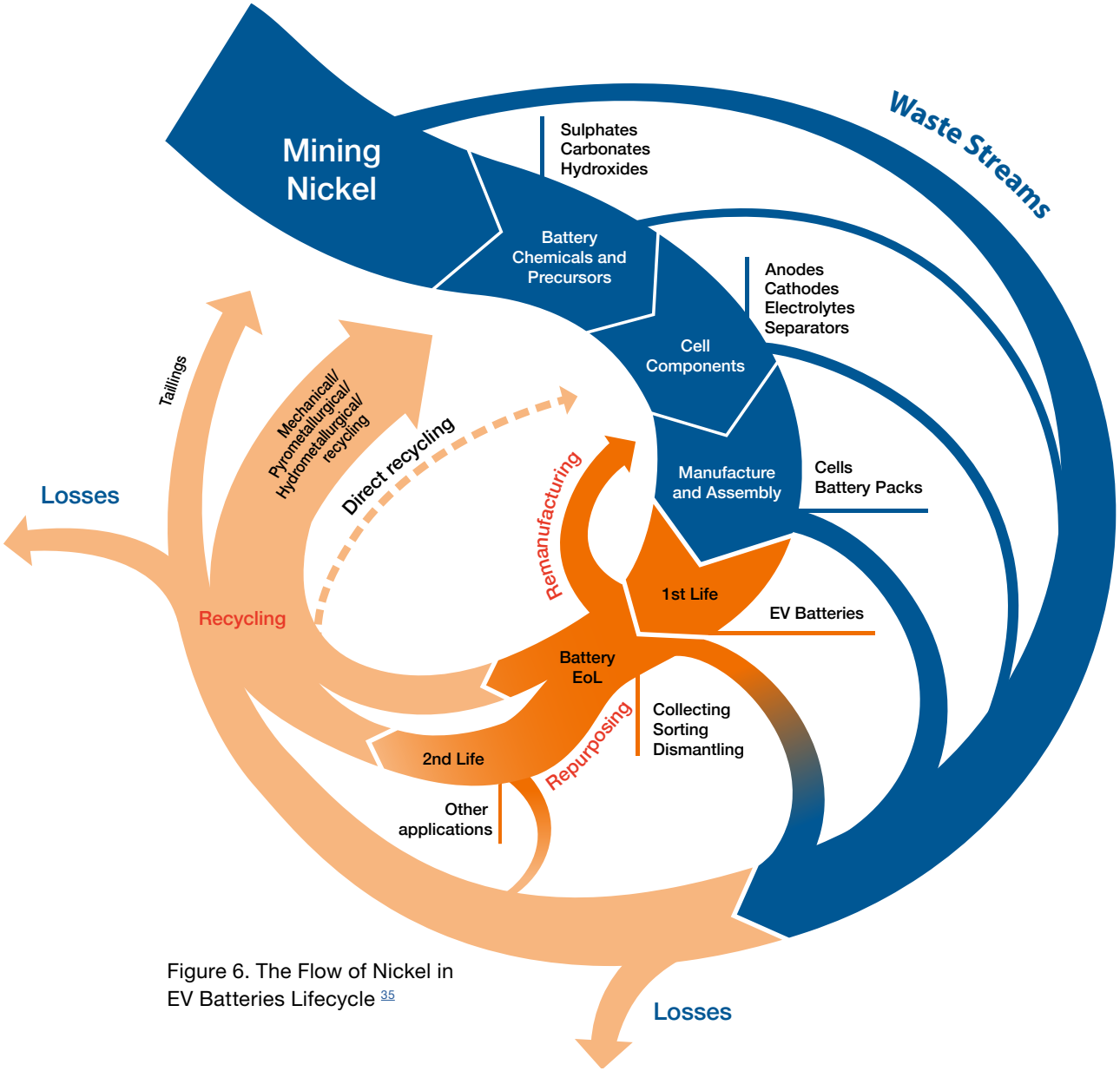


Figure 6. The Flow of Nickel in EV Batteries Lifecycle [35]

Project and participants	The Circular Design Network project [36] (2020-2022), funded by the Academy of Finland, was a collaboration project between Aalto University, Geological Survey of Finland GTK, Natural Resources Institute Finland (Luke), The Finnish Environment Institute (SYKE) and VTT. The project aimed to create new methods for processing and refining data into system-level understanding and models. The nickel flows in the Finnish battery value chain were modelled as part of the project to better understand the increasing nickel raw material needs resulting from electric vehicle (EV) use, nickel material flows and their potential circularity scenarios along the whole battery value chain [37,38,39]. The modelling efforts are ongoing in the current project, Batcircle 2.0 [40].
Circular business aspects	The effects of different R strategies were studied in eight different scenarios. The circularity scenario modelling was used to evaluate the demand for nickel, the amount of nickel-related waste originating from EV batteries and the effects of the different R strategies (recycling and life extension, i.e., remanufacturing and repurposing). The scenarios provided insights into circular business model ideas.
Sustainability impacts	All modelled R-strategies were found to reduce the demand for primary materials and generate less waste compared to the non-circular alternatives.

Table 5. Circularity scenarios and circularity modelling of nickel flows for the Finnish battery value chain

The Circular Design Network project showcases how product and business model development can be enhanced by system-level approaches.

VTT's knowledge in circular design and dynamic material flow modelling can be applied to diverse sectors and contexts. Dynamic material flow modelling can create added value for understanding the circular economy potential of critical raw materials and strategic raw materials across various value chains. The model has also been used for modelling the circular economy potential of lithium [41].

3.5 Case: Environmental benefits of a remanufactured laptop

While all products and organisations currently have negative environmental impacts, some can also generate positive environmental benefits.

The environmental handprint is a novel method that focuses on identifying and quantifying the positive environmental impacts of a product or an organisation. The method is based on life cycle assessment (LCA) methodology that is used for calculating negative environmental impacts, often referred to as a footprint [42].

Ekox [43], a Finnish IT company specialised in the remanufacturing of laptops, wanted to understand and communicate the positive environmental impacts of their product. To calculate an environmental handprint for their product, Ekox collaborated with VTT (Table 6).

Figure 8. Image: Ekox

The Ekox environmental handprint calculation illustrates how VTT can support companies to understand their potential environmental benefits in a science-based manner.

The background assumptions and data used in both footprint and handprint calculations can vary a lot. In both cases, it is essential to set the calculation boundaries correctly when calculating and using the results of the assessment to avoid misleading environmental claims or double accounting. Additionally, even with a handprint, the product or organisation will still have a footprint. Targets are therefore needed for both: minimising the footprint and enlarging the handprint.

VTT has extensive experience in scientific footprint and handprint assessment methodology development and the application of these methodologies in practice. Providing a scientific basis for environmental claims is one of the main goals of the Green Claims Directive [10] proposal.

Company	Ekox Finland [43] is a Finnish IT sector company that produces laptops for both B2B and B2C laptop users by re-using laptop components. Through re-use, Ekox extends the life cycle of these components.
Circular business aspects	The business model of Ekox combines different circularity strategies. Approximately 70% of the used laptop materials received can be reused in the production of an Ekox laptop, thereby extending the life-cycle of these materials. Ekox also provides maintenance and repair services for its remanufactured laptops, applying the principles of the Product-as-a-Service (PaaS) model.
Sustainability impacts	The environmental handprint was calculated by comparing an Ekox laptop to a typical new laptop. Laptop remanufacturing reduces the need for primary raw materials. In addition, less energy is needed during production. By offering remanufactured laptops, Ekox can replace new laptops and reduce the negative environmental impacts of laptop use that relate to the primary raw material and energy consumption in the production phase.

Table 6. Scientific evidence on life cycle extension's sustainability impacts – Calculating the environmental benefits of a remanufactured laptop

3.6 Case: Emission reductions from reusing steel components

Reusing products and materials can result in significantly lower greenhouse gas (GHG) emissions compared to recycling and can facilitate the development of new, more sustainable business models.

The GHG emission reduction potential of re-use was demonstrated in the PROGRESS research collaboration project, led by VTT in 2017-2020 [44] (Table 7). The project investigated the reuse of steel-based components sourced from both current and planned single-storey steel buildings (SSBs) utilised in industrial, commercial, sports, exhibition and warehouse facilities across different sectors

The PROGRESS project demonstrates how VTT can help companies identify and select the circular actions with the greatest impact.

Figure 4. Single-storey steel buildings (SSBs). Image: VTT

Based on the project outcomes, several national guides for steel reuse were developed, for instance in the UK, Sweden and Finland [45]. The project outcomes have also been used to develop international standards such as the harmonized product standard EN 1090-2. Many of the outcomes are directly applicable to all building typologies, and can be adapted for other building materials such as wood and concrete.

Project and participating companies	The PROGRESS – Provisions for a greater reuse of steel structures research collaboration project, led by VTT in 2017-2020 and funded by the European Commission, focused on increasing the share of reused steel components in single-storey steel buildings (SSBs) to decrease greenhouse gas (GHG) emissions [44]. The project participants represented research institutes, universities, industry organisations and companies. Among the company participants were Ruukki Construction, Paul Kamrath Ingenieurrückbau, Ramboll Finland and Peikko Group, representing steel manufacturing, fabrication, demolition and deconstruction operators. Project activities continue in the ADVANCE – Accompanying Measure for Dissemination, Valorisation and Collaborative Exploitation of Circularity of Constructional Steel Products project (2023-2025).
Circular business aspects	Several case studies on the SSB component reuse were conducted in Europe. Circular business models were reviewed, developed and tested. These models included, for example, a buyback scheme for steel sandwich panels and the reconstruction and reconditioning of existing steel frames and trusses.
Sustainability impacts	Steel production typically accounts for 75% of the energy consumption and a large portion of the CO_2 emissions of the SSB component production. Steel reuse resulted in a substantial CO_2 emission reduction by eliminating the need for re-melting. The reuse shortened transport distances as materials were not sent back for recycling and supported also local and regional economies. However, further effort has to be made to reduce the costs of reuse, particularly in material testing.

Table 7. Reuse of constructional steelwork from single-storey halls

3.7 Further examples of VTT's sustainable circular business expertise

Handbooks	Carbon handprint assessment: Carbon handprint guide V. 2.0: Applicable for environmental handprint [46]
Research reports	Business model development: Business models and product groups for Product Service Systems (PSS) in the Nordics [47]
Methodology development	Environmental handprint methodology: The environmental handprint approach to assessing and communicating the positive environmental impacts [48] Sustainability assessment methodology: ORIENTING - Operational Life Cycle Sustainability Assessment Methodology Supporting Decisions Towards a Circular Economy [49]
Piloting facilities	Technological development, piloting and upscaling facilities for co-developing circular solutions: VTT Bioruukki [50]
Spinn offs	Textile fibre production from waste: Infinited Fibre Company [51]: Concrete with a carbon-negative sink: Carbonaide [52] Chemical recycling of plastics: Olefy Technologies [53] Wood-based material to replace plastic, paper and canvas: Paptic [54] Food protein production with a microbial cell factory: Onego Bio [55]

Table 8. Selected examples of VTT's expertise in developing and supporting more sustainable circular business

4. Solving the sustainable circular business challenge together

Achieving a sustainable circular economy that maintains and rebuilds natural capital requires impactful actions both now and in the near future. The severe and pressing nature of current and anticipated environmental challenges means that we cannot settle for just minor improvements.

At VTT, we believe in going beyond what is currently taken for granted and designing new, compelling futures that create more space for sustainable circular business.

To arrive at new, impactful solutions, we need multi-disciplinary, science-based thinking and analytical skills. We believe that novel solutions with less adverse impacts can be created and new, more regenerative business practices commercialised globally. This requires collaborative efforts among multiple stakeholders across value chains and ecosystems, integrating sounds scientific expertise in technology, business and sustainability with methodological precision into actual real-life contexts.

At VTT, we are well-positioned to support businesses in the necessary transition towards sustainability. We are prepared to provide our support for companies seeking to challenge themselves and develop their business towards more sustainable ways of operating and creating value.

Contact us

Want to know more? Get in touch!

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