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Authors	Mikelis Grivins (BSC), Emils Kilis (BSC), Pia Otte (RURALIS), Albers Auzins (AREI), Ieva Leimane (AREI) ***With contributions by***: Anda Adamsone-Fiskovica (BSC), Oksana Zabko (BSC), Sandra Sumane (BSC), Talis Tisenkopfs (BSC), Kristina Hiir (EMU), Rando Värnik (EMU), Kadi Kenk (EMU), Kristiina Kerge (EMU), Diana Mincyte (VU), Renata Bikauskaitė (VU), Aiste Bartkiene (VU), Jostein Brobakk (RURALIS)

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ABBREVIATIONS

AFA	Agriculture, forestry and aquaculture
BM	Business Model
BMC	Business Model Canvas
CBA	Cost-benefit analysis
CEO	Chief Executive Officer
CBI	Circular business initiative
STEEP	Social, Technological, Environmental, Economic and Political
WP	Work Package

1. INTRODUCTION

This report discusses circular business models in and across agriculture, forestry and aquaculture, and the contextual factors affecting these business models. The report is primarily based on the results of "WP3: In-depth exploration of intra- and cross-sectoral circularity in agriculture, forestry, and aquaculture (AFA)" of the CIRCLE project. More particularly, the report captures the results of "Task 3.1: Developing common methodology for the case studies", "Task 3.2: Exploring collaborative arrangements" and "Task 3.3: Cost-benefit analysis of selected circular business models". However, the claims presented in the report are also informed by the results of WP2 (Scoping and mapping the diversity and performance of cross-sectoral circularity) and WP1 (Conceptual and analytical framework).

WP3 assesses circular practices, social-material structures enabling circularity and performance of enterprises in closing bioresource loops on the level of cases. The CIRCLE project uses the following definition of a case: **case is both a circular business initiative (CBI) engaging with bioresources and a closed loop of the bioresources the CBI is part of**. Each case represents two things simultaneously – the CBI (a set of strategies that among other things allow valorising some bioresource residues and by-products) and a closed loop of bioresources that allows valorising the bioresource residue T3.2 delivers 12 case studies from four countries – Latvia, Estonia, Lithuania, and Norway (three case studies per country).

The project proposal defines that the case studies should "*analyse the circular business models and examine conditions and collaborative and governance arrangements that allow to make use of bioresources in a sustainable and efficient manner".* Based on these objectives three main research questions are posed to the case studies that are now raised in this report:

1. How circular business models are structured? How closed loops of bioresource use are linked to particular business models?
    a. How does the business model adopted by the initiative allow CBI to remain profitable?
2. What collaborative and governance arrangements and conditions enable and strengthen intra- and cross-sectoral circular business initiatives?
3. What contextual factors enable or hamper the development of circular business initiatives?
    a. What, if any, ethical concerns related to environmental issues are considered by the stakeholders? What role do the consumers and general public play in developing circular business initiatives?

The analysed cases were selected based on the following criteria: (1) Scope of the case; (2) Scale of the case; (3) Kinds of bioresources involved; (4) Areas of bioresource utilisation; (5) Sectors covered; (6) Links with the final consumer. The cases selected are presented in Table 1 (the executive summaries of the cases are available in the annex). The case studies were conducted in the period between September 2022 and August 2023. To support a joint approach for the partners' engagement with cases and comparability of the cases, a common methodology for the case studies was developed (see Task 3.1: Developing common methodology for the case studies). For each case study desk research and a set of interviews were conducted. Some case studies might have benefited from other, case-specific methods. The collected information was used to fill the case study template (that requested authors to present the data according to the main comparative categories). In each partner country, after the case studies were completed, a workshop was conducted, to discuss the findings emerging from the conducted cases.

Table 1. Case studies conducted in the CIRCLE project

No	Case	Brief description	Country
1	*HKScan*	Manure from pig farms used as fertiliser.	Estonia
2	*Võrtsukala*	Using by-catch to produce fishmeal.	Estonia
3	*Fibenol*	Using residual wood to produce lignin and wood sugars.	Estonia
4	*Very Berry*	Using berry processing byproducts in pharmaceutical and cosmetics industries.	Latvia
5	*Lielkrūzes*	Fertilising fields by sludge from fish ponds.	Latvia
6	*Auga Group*	Utilising manure as a source of biofuel production.	Lithuania
7	*Ekofrisa*	Utilising discarded buckwheat hull as a fuel source.	Lithuania
8	*Insectum*	Cultivating black soldier flies using food waste as a rearing medium.	Lithuania
9	*Grønne Folk*	Utilising waste vegetables as ingredients in ready meals for the consumer market.	Norway
10	*Invertapro*	Larvae production from food waste.	Norway
11	*Svanem Biogass*	Utilising waste and side-streams from both agriculture and aquaculture sectors to produce biogas.	Norway
12	*Following the requests of the representatives of the 12th case it is not disclosed here.*		

The report is structured in four main chapters. Chapter 2 focuses on the contexts shaping CBIs. It uses the STEEP approach to discuss the main factors affecting businesses trying to adapt circular practices and presents the key structural arrangements enabling CBIs. Chapter 3 engages with CBMs primarily focusing on ways enterprises capture, create and communicate value. Chapter 4 presents the results of the cost-benefit analysis that was conducted for all the CIRCLE project cases. Finally, chapter 5 presents the main findings emerging from the comparative analysis of case studies.

2. CONTEXT FOR CIRCULAR BUSINESS SOLUTIONS IN THE NORDIC-BALTIC REGION

This chapter provides information on the context in which the CBIs are embedded and the structural arrangements enabling or disabling CBIs. It contains aggregated information on the relevant background information that was identified affecting the operation of the CBIs across the 12 case studies in the Nordic Baltic region. Supplementary insights are also drawn from the results of WP1 (media analysis) and WP2 (overview of CBIs in the Nordic-Baltic region).

The analysis addresses three relevant aspects for thinking about the context and business ecosystem in which CBIs operate. These are 1) contextual factors and trends characterising the AFA sector and bioeconomy, 2) factors and trends enabling the CBI, 3) factors and trends limiting the potential of the CBI. To capture information related to the three categories we applied the STEEP model. STEEP stands for Social, Technological, Environmental, Economic and Political and it is a simple model to ensure that researchers capture relevant factors about the environment in which the business operates.

In addition to the STEEP context, CBIs frequently depend upon collaborative arrangements. Collaborative arrangements are essential for circular business models since the necessary economic system's change from a linear to a circular production goes beyond individual companies and requires that stakeholders who have not worked together before must collaborate. **In CIRCLE, we defined collaborative arrangements as partnerships of actors and stakeholders engaged in circular economy activity characterised by: (i) participation, (ii) vertical and horizontal coordination of action, and (iii) committed resources.** For the analysis, we distinguished four different types of arrangements including 1) **horizontal**, 2) **vertical**, 3) **public**, and 4) **informal** arrangements. A more detailed explanation of the arrangements is provided in the chapter "2.2. Structural arrangements".

2.1. STEEP ANALYSIS

The following chapter will discuss the findings related to each group of STEEP factors that form the environment in which the business operates.

SOCIAL FACTORS

The social dimension refers to a wide range of socio-cultural characteristics that affect the operation of the CBI and the prospects of the products and services that they provide.

One of the primary social factors affecting the development of knowledge-intensive CBIs that rely on cutting-edge technology and are based in more peripheral regions is **access (or lack thereof) to skilled labour**. Indeed, the depopulation and ageing of rural areas is an important obstacle to regional development, and it appears that is also a common barrier to building CBIs further away from the main population centres. This may not necessarily be an issue in industries that require incremental innovation to introduce circular principles into their production processes. However, CBIs that aim to benefit from recent technological advances and are based in rural areas face difficulties attracting skilled professionals with the requisite expertise, despite ICT advances that allow for remote working arrangements.

One can observe countervailing trends vis-a-vis **consumer acceptance** of circular and sustainable products. Several reports note growing demand for sustainably produced products. Several CBIs in different sectors indicated that consumer and client demand for products that meet certain

environmental criteria is growing, though there are important differences and nuances. Some products are simply circularly produced alternatives (e.g. food), while other are completely new and are effectively creating a new market niche (see the case of *Fibenol* in the annex) (see chapter Value creation). However, despite the generally positive trends, some enterprises noted that demand has not grown as fast as anticipated, in part due to the price sensitivity and limited purchasing power of customers in the region. In addition, country reports note a perceived ambivalence regarding the use of waste and byproducts in the production of consumer goods, but it should be noted that this reticence is almost absent regarding the production of green energy. This suggests that producers must be mindful of the specificities of their product from the perspective of consumer acceptance. However, it is also important to stress that consumers are not always aware of what circularity entails, and instead tend to focus on sustainable and "green" products, and this likely affects the way products are marketed.

The case studies also indicate a cautious and sometimes sceptical attitude on the part of consumers. This can take many forms. Fear of greenwashing was a common theme, but there is also a generally cautious attitude towards the products of different startups and the extent to which these companies will be sustainable. There are also concerns regarding the impact of increased commercial activity in particular sectors (e.g. forestry). Thus, certain practices are looked upon with suspicion, despite their generally resource efficient character. These anxieties, however, should be analysed in a contextually sensitive manner as they may reflect local developments in the sectors in question, and the cultural imaginaries surrounding these sectors, rather than broader trends in the sector as a whole.

The last point highlights the cultural dimension of circularity and the **traditions, beliefs and routines** that both novel and traditional forms of circularity must mesh with. As was previously noted, the use of waste in the production of consumer goods is seldom received positively by consumers. However, waste should be regarded as a cultural category that is much broader than the legal definition, meaning that a wide variety of products may face challenges when entering the market. However, this can also change over time. What is more, even if the resources are not strictly speaking waste, there may be a cultural aversion to the use of particular products (e.g. ones made from insects) and a sensory dimension (e.g. bad smell in the surrounding area) that hamper some CBIs. Thus, the use and adoption of certain products may hinge on broader cultural shifts.

TECHNOLOGICAL FACTORS

The technological dimension refers to research, technological advancements and innovation more broadly that creates the context in which a CBI develops and operates.

Our cases indicate that there are several background factors that shape the technological dimension of circularity. In addition to technological developments that have facilitated the introduction and implementation of loop-closing practices in particular, **digitalisation and automation** more generally featured prominently in the responses of our informants. This suggests that, unsurprisingly, the digital transformation has raised the overall level of technological sophistication and development across various industries and serves as the foundation for complex solutions that are specific to CBIs.

CBIs are affected by countervailing trends with regard to innovation and the **ability to benefit from innovation**. On the one hand, several case study reports note that specific initiatives and products are made possible by recent technological advances that have made certain production practices more feasible, though still expensive. However, at the same time there are knowledge and skill gaps that

cannot be easily filled. For instance, there is a scarcity of skilled labour or knowledge centres that would make the introduction of novel practices and production techniques easier, despite recent developments. Thus, we note a possible mismatch between the available technology and the human capital to benefit from recent advances, given the limited labour resources in the region.

Our cases also illustrate certain **synergies between circularity and the region** (Nordic-Baltic). The region is believed to be a good environment for technological experimentation, a testbed of sorts for various technological solutions. However, this should be regarded both as a strength and a weakness. On a positive note, several CBIs have developed in-house technological solutions that may give the company a competitive advantage in the local market. However, the relatively small size of the region and reliance on external technological inputs also presents a host of different challenges. For instance, sophisticated technological solutions may be more difficult to fix and require a combination of skills and infrastructure to implement and replicate. Indeed, infrastructure (or lack thereof) was noted as a source of concern for producers.

Likewise, our cases suggest the need to consider the importance of various **entanglements between technologies and between technological and policy development**. There are vulnerabilities and risks associated with strong interdependencies between different technological processes. Logistical processes can be both expensive and tightly regulated if the materials that are being used can be environmentally harmful, when not managed properly. Furthermore, our cases suggest that the level of technological development frequently outpaces the legislative framework. However, the broader policy and legal context can also be viewed in a more positive light. Specifically, the push for a transition towards greener and more sustainable production processes across various sectors has put pressure on companies to work on finding solutions that are both economically viable and meet ever-stringent environmental regulations. What is more, this has also provided a new way of marketing products.

Finally, our cases suggest that technologically speaking circularity is a **heterogeneous playing field**. Specifically, we note that there are both technologically advanced and novel solutions and more mundane and incremental innovations that depend largely on routine circular practices and waste-avoidance. Thus, we see both factories that house purpose-built, one-of-a-kind equipment and small-scale solutions that aim to capture value from discarded products and implement agroecological solutions. We also note that access to technological solutions is dependent on being integrated in networks in which this technology is developed. What is more, the knowledge and technology is not necessarily shared due to fear of competition in a niche market. Thus, mainstreaming of novel solutions is countered by barriers that prevent knowledge exchange.

ENVIRONMENTAL FACTORS

The environmental dimension refers to ecosystem factors, resources and environmental regulations that shape the operation of the CBI.

Unsurprisingly, it was noted that environmental factors play a crucial role in relation to CBIs. **Climate change** and public discourse about the influence of AFA sectors on the environment provide the necessary impetus for innovation (acting as a driver), while simultaneously limiting what can be achieved by specific CBIs (acting as a barrier). Interviewees noted that climate change has forced companies to develop sustainable solutions and production techniques that are resource efficient and have low environmental impact, or are even regenerative in nature (e.g. agroecological practices). Simultaneously, growing consumer and client demand for new and sustainable products was

mentioned by several respondents. This can also be seen as a contributing factor to innovation, and it creates a market for niche products that are frequently more expensive than conventionally made alternatives.

While recent advances and shifts in demand have increased the **availability and variety of environmentally friendly solutions**, this does not necessarily mean that such innovations are widely adopted. Indeed, our respondents note that linear practices remain entrenched, despite the general waste aversion of businesses. What is more, even if a company adopts a particular environmentally conscious solution, it should not be assumed that this decision is driven by environmental values. Rather, the company in question may be seeking to reduce costs or increase resource efficiency by extracting value from previously discarded materials.

In general, these shifts towards sustainability can be regarded as a response to hybrid challenges encountered by businesses. These challenges involve a combination of policy, environmental and economic factors, so looking at the environmental dimension in isolation is seldom informative. Stringent regulations, environmental conditions and volatilities in global markets force entrepreneurs to look elsewhere for resources that they had previously relied upon. Indeed, unpredictable changes in the global market because of sudden shocks (be they environmental or geopolitical), potentially compounded by adverse weather conditions in the local market were common factors that our respondents mentioned when talking about the way environmental factors shape their work. Thus, we see a combination of higher prices due to a scarcity of resources (e.g. mineral fertilisers) and **production difficulties** (e.g. due to floods or droughts). Likewise, the increasing stringency of environmental and health-related regulations affects production both in terms of production and distribution. This, however, is not determined solely by policy. The location of the facilities and the surrounding infrastructure also play a key role and can increase logistical costs and barriers for enterprises that do not have all the resources available on site. Indeed, the availability of resources that do not require massively complicated logistical solutions to transport is a key contributing factor to the development of CBIs.

Finally, we note that, while CBIs frequently characterise their practices as environmentally friendly, it is important to stress that the **environmental impact of particular innovations** is dependent on whether they are appropriately implemented. However, there is often insufficient research and data to assess the environmental impact of specific solutions beforehand. There is frequently a scarcity of knowledgeable specialists who could assist entrepreneurs in developing circular solutions that extract the most value out of certain products. This is true of all three AFA sectors, but it is especially prominent in the case of agriculture, though this observation may simply be due to the specificities of our selection of case studies.

ECONOMIC FACTORS

The economic dimension refers to the entrepreneurial and financial context in which CBIs operate.

From an economic standpoint, circularity can be seen as a form of **risk management**. Firstly, it is a way for businesses to diversify their activities, even if their primary focus is on linear production. Likewise, the implementation of circular principles and loop-closing practices can be a response to **increased costs and expenditures**. By using and re-using previously undervalued resources, companies can extract additional value or even develop new products that replace increasingly expensive materials (e.g. mineral fertiliser). This is especially relevant to respond to changes and volatilities in global

markets (e.g. increased energy prices, lack of imports from Russia and Ukraine). Finally, circularity can be seen as a future-proof business strategy to address the burdens of **legal requirements** or the expectation of increasingly stringent regulations. This motivates pre-emptive action that can lead to cost savings in the future. Again, our cases illustrate the need to look at business strategies from a hybrid perspective.

At the same time, it is important to note that CBIs face **competition from competitors** that sell cheaper alternatives. This is both a positive and a negative. While it encourages innovation to make products cheaper, it also reduces demand. However, in certain contexts there is increased consumer willingness to choose and pay for circular products (e.g. Norway). Nonetheless, the identification of **new distribution channels and markets** is key. Thus, a viable channel though which to sell the product and engage with consumer demand for niche products that have been produced in an environmentally sustainable manner is important for a CBI.

Simultaneously there is an issue associated with the **pricing of products** – it is not always clear what it should cost. An important challenge for CBIs is the lack of certification for circular products. While organic products can be certified, circular products currently do not have an associated or widely recognised certificate. This, however, means that there is no way for circular products to be easily distinguished from linear alternatives. Indeed, this creates difficulties when it comes to communicating the added value of products in a market with growing demand for sustainable products.

The CBIs we have looked at primarily draw on **private capital**, while public support (e.g. tax exemptions, subsidies) is limited. This suggests that CBIs benefit from private initiative, rather than public support. Likewise, our interviewees note a legal rigidity that constrains commercial activity organised around the closure of resource loops. However, there are also challenges related to private capital. For instance, there is a perception that CBIs are characterised by high risk, and there is a pervasive uncertainty about the economic viability of circular practices and returns of investments. Consequently, it is difficult to attract investments and access loans, though our respondents note a growing willingness to invest in "green" solutions.

While some interviewees note that technologies are expensive, there are nuances that require further exploration. First, expenses are frequently industry dependent and relate directly to the complexity of the production process. Indeed, agroecological practices require less investment than CBIs that require tailor-made equipment. Second, the extent to which **technological costs** are an obstacle may be related to the size of the business and its market presence.

POLICY FACTORS

The policy dimension refers to the political and legal environment in which a CBI operates.

From a policy perspective, it should be noted that the environment for CBIs is shaped by broader **European policy developments**. These range from the Green Deal and the EU circular economy action plan to various sector-specific initiatives and strategies and other more specific regulations (e.g. European Commission's regulations regarding the production of food using waste products). Furthermore, there are **national policies** that synergise with EU policy developments and attempt to implement these principles in local legislation. Now, these can be either enabling or hampering factors, depending on the situation, but they are fundamental to understanding the contexts in which CBIs operate and the specific regulations that apply to each sector and product.

Subsequently we must consider the role of local governments. Specifically, the **support (or lack thereof) from line ministries and municipal governments**. We observe that country reports reference incentives from which CBIs can benefit, but this is not a universal phenomenon that is equally available to all sectors. An example would be the public support schemes for biogas production in the farming sector in Norway. However, we also note that lack of public support is not an insurmountable obstacle in the countries represented in CIRCLE, and entrepreneurs are able locate funds elsewhere. Nonetheless, the allocation of public funds to certain activities can act as a signal of sorts to entrepreneurs in the country. Indeed, evidence from Latvia suggests that subsidies and public support that favours conventional practices in agriculture is an obstacle to circular innovation. The point is more general, however, and relates to the way entrenched business practices hamper circular initiatives.

Legislation and formal requirements can function as an impediment to entrepreneurship organised around the use of bioresources. Indeed, our cases paint a complex picture of the role of legislation. In some cases (e.g. manure, slurry), there is a clear framework for categorising products, and the guidelines that must be followed are transparent and easy to follow. In other cases, business owners noted legal rigidity (e.g. system for approval of bio-fertilizers from biogas plants). Furthermore, there are several instances where it was suggested that the legal framework lags behind technological development. Finally, there are issues with reporting and accounting according to official guidelines that hamper the everyday practices of businesses.

Finally, there is a key difference between rhetoric and practical measures. In other words, governments may have goals, ambitions and guidelines supportive of increased circularity across different sectors. This may even be shared across all levels of government. However, there may be a simultaneous lack of concrete measures to support CBIs. For instance, cases from Norway indicate a lack of instruments and measures to support circular start-ups, though such support measures are likely dependent on clarifying the specificity of CBIs in relation to start-ups in general. However, if we do not focus just on CBIs, innovative activities can be supported via EU funds.

2.2. STRUCTURAL ARRANGEMENTS

This section summarizes the findings on four different types of arrangements including 1) horizontal, 2) vertical, 3) public, and 4) informal arrangements and their role for the implementation of circular solutions.

- **Horizontal arrangements** were defined as linked actors that share common interests and have relative power balance between them. In our case studies we can identify several forms of horizontal arrangements.
- **Vertical arrangements** designate product movement along the supply chain – from resources, through producers to consumers. They look at supply chain relations recognizing the binding obligations, technological dependencies and imbalances in power that characterize the interlinkages between the actors engaged. These types of arrangements can be in form of financial dependency (powerful actors to which circular businesses have to deliver their products and do not have negotiating power).
- **Public arrangements**: This includes public interventions, that have influenced the CBI's ability to close the business model loop, such as regulations that have opened the need for new practices but also support institutions that have allowed the initiative to close loops.

- **Informal arrangements** include arrangements that are based on trust and experience instead of formal contracts and documentation.

Several arrangements can be present at the same time in one CBI and some arrangements are more of external character while others are more internal. For example, public arrangements provide the external context in which vertical and horizontal arrangements can evolve. They can be also part of the political context in the STEEP model.

Furthermore, horizontal arrangements are often informal while vertical tend to be formalized through contracts. Hence, collaborative, structural arrangements are interwoven but to gain a better understanding of the nature of these different types of arrangements we constructed this somewhat artificial division.

HORIZONTAL ARRANGEMENTS

In our case studies we can identify several forms of horizontal arrangements. Some CBIs in our case studies show horizontal arrangements related to ownership and management of the company/initiative. They are based on **family relations** where family members have equity shares in the company, such in the case of *Svanem Biogas* in Norway. In this case these CBIs do not depend on external investors and banks that would influence decision-making and the company's focus. However, they depend on the quality of family relations.

Furthermore, regarding collaboration we can see that many initiatives across the four countries show mutual relationships with other stakeholders, particularly a **collaborative network with educational institutions, community organisations and NGOs.** Particularly relevant actors appear to be universities and research institutes. In this case the CBI provides evidence/ data to researchers, while the research partners explore innovative ways to utilize circular products, build more knowledge on them or even use them for testing production methods. In some cases, the CBIs are partners in international research projects such as HORIZON 2020 with other circular companies. This type of collaboration can help circular businesses, especially start-ups to cover some costs associated with licensing and research. However, this type of collaboration can also have challenges in some cases as reported from Estonia. Research organisations are very focused on publishing which can take time and the research process can be too time demanding for CBIs who are interested in quick, practical and user-friendly results. Furthermore, there can be legal challenges in this form of collaboration as, for example, how to formalize scholarships for interns from abroad.

Many CBIs are characterized by a **relationship between companies** that have a mutual interest and are linked in a non-hierarchical way through a system of co-dependence. This can be for example utilizing waste generated by other companies, or the collaboration between several companies that leads to a joined sale of waste materials. Some CBIs choose to outsource part of the distribution service to companies with the right equipment and skills. The size of engaged actors is also affecting their willingness and need to collaborate. For example, in the case of biogas plants – actors producing large amounts of waste/ residues might decide to develop a biogas plant on their own.

VERTICAL ARRANGEMENTS

Vertical arrangements designate the organisation of the supply chain. Vertical arrangements assess relations recognizing the legal obligations, various inter-dependencies and power imbalances that

characterize the supply chain and allow some actors to impose rules regulating the dynamics across the supply chains.

This can be, for example, organic waste used by one company and generated by other companies and where relationships are not always mutually beneficial between **different companies**. Interdependency is one of the factors that characterize vertical arrangements. The level of reliance between two or more actors might differ and in more established supply chains it can be that these relations are completely asymmetrical. However, we also see that in newly emerging supply chains there is a mutual dependency – actors depend on one another for the supply chain to operate. This can be interpreted as a possibility for more solidarity across the supply chain. However, it can also be seen as a source of risks.

Some CBIs work closely with **certification and accreditation bodies** to ensure compliance with national standards and regulations. Some cases of CBIs integrate and coordinate various stages of the supply chain within the company's operations. This type of vertical integration can enable the company to have control over the branding, packaging design, and labelling of its products, ensuring consistency and compliance with regulatory requirements. Some CBIs have vertical formal arrangements involved in the business operation run by the company both for ensuring input supplies and product sales. These include international, national, and local firms as collaboration partners. In some cases, CBIs collaborate with **private banks** who play a role in determining the scale at which circular solutions are applied. Banks are becoming more interested in providing funding for sustainable projects, but their main focus is still economic profit.

The case studies show that this type of interdependency as described here is crucial for the operation of CBIs. They build the basis for circular products but can also be a danger to the sustainability of CBIs when conflicts arise between different partners.

PUBLIC ARRANGEMENTS

Public arrangements can be enabling and limiting for the implementation of circular solutions in our case studies. They very much align with the political dimension in the STEEP model. Several CBIs included in this study have received **financial support from different national and European funding agencies** that promote innovative products, start-ups and environmentally friendly production processes to engage with new products produced in a circular way, assist in designing the business model, and build circular production sites. The availability of public funds plays a role in enabling investments more generally but also allows introducing, maintaining and upscaling specific circular solutions. In some cases, companies had already implemented circular practices prior to a public focus on the circular economy and without promoting them as particularly circular. Still, public support is pushing the adoption of the practice and is one of the factors explaining the prevalence of particular solutions (like biogas plants). The long-term effects of this process are ambiguous. Also, there is some tentative evidence that the publicly supported solutions when implemented are not always working as efficiently as envisioned. This means that a more careful monitoring system allowing assessment of the results should be established.

There is also evidence that in some cases, **regulations at the national and international level** can be limiting for CBIs. There might be different ways this happens. However, mainly legal barriers are associated with the novelty of the solutions that are required to close bioresource loops. For example, in the case of using waste-fed larvae for human food, the European Commission has complicated

regulations to allow for this. In other cases, public arrangements support the start-up of circular business practices but not the operation of the circular production facilities, which can make it challenging to maintain the operation of circular facilities, especially in the first operational phase (for example, *Svanem Biogas* from Norway). Norway includes support schemes for starting up biogas units but not for the operation. This limits the possibility of sustainable products entering the market and limits how certain circular products can be sold and used.

The reports from partner countries also illustrate that in some cases public arrangements are planned to lower the bureaucratic load on stakeholders for implementing their CBIs. In Estonia, for example, public agencies conduct research to develop values for different types of manure to allow their use without constant need for laboratory tests.

INFORMAL ARRANGEMENTS

Informal arrangements include arrangements that are based on trust and experience instead of formal contracts and documentation. Levels of trust can define the willingness to collaborate. It often relates in our case studies to characteristics of the chief executive officer (CEO) of the CBI.

Case studies illustrate that if the CBIs are led by experienced CEOs with a large **network of informal contacts within the industry and with researchers**, it can help CBIs to develop. The way the role of these networks manifests differs from case to case and can even take anecdotical forms. Cases also illustrate that the CBIs do not shy away from benefiting from these contacts. Several cases illustrated a willingness to cultivate strong personal relations with key partners – scientists, funders, entrepreneurs providing waste, etc. For example, some CBIs were strongly engaged with early career researchers who were working to produce new knowledge relevant to the business. Local networks enable enterprises to overcome issues that a typical CBI would face such as getting access to resources and distribution. A number of these CBIs have started by building upon resources locked in local communities. However, the strong dependence on networks, local resources and a few actors can make these CBIs also sensitive to local shifts, such as, for example, the decision not to grant funding or donate waste can substantially limit companies' abilities to invest or to evolve and transform. Finally, the CEO's reputation as a passionate person with an established network helps the CBIs in its operation on a basis of trust and recognition. Furthermore, proactive CEOs, who invite experts (formally or informally) if expertise is missing within the company, are presented in case study reports as relevant for implementing circular solutions in the company.

We can see that besides the social connections of experienced CEOs, CBI's **access to financial capital** via informal networks can play an important role as well. In some cases, the CBIs are run by wealthy entrepreneurs who have resources to ensure the financial viability of the company.

3. CIRCULAR BUSINESS MODELS

Circular business models (CBMs) designate entrepreneurial activities that incorporate closed bioresource loops. In the context of CBMs there often is an inseparable link between the enterprise and the supply chain that enables reuse of bioresource byproducts. As CIRCLE cases illustrate – successful attempts to benefit from these byproducts often is a collective effort of several companies. There are just a few cases in the project that illustrate how an enterprise can do this on its own. Still, while a successfully closed bioresource loop relies upon a supply chain, how various enterprises from across the supply chain profit from the practice differs. In CIRCLE, we are focusing on enterprises that are taking the key role in closing the loops and bringing together other enterprises needed for this. When the report refers to CBMs, it refers to these key enterprises that have taken the lead in closing the loops.

In this report a business model (BM) is a set of activities and internal organisational arrangements envisioned for and implemented by the enterprise as well as the common practices associated with these activities and arrangements. While in general one would expect that a business model would also generate profits, the cases illustrate that not all of them do that and not all of them are expected to. To analyse CBMs a simplified Business Model Canvas is used. To discuss CBMs, this chapter is structured in three sections: (1) value creation, (2) value capture, and (3) value proposition. **Value creation refers to the income and cost flows linking these to the characteristics of the CBMs. Value capture focuses on technical processes that allow adding value to the bioresource residues? Value proposition deals with target markets and statements enterprises employ in working with these markets.**

To simplify the analysis, we have identified four sub-sets of CBMs (see Table 2). The four groups differ in terms of whom they are perceiving as the main customer and what is the product sold by the enterprise. The four groups of enterprises are not always fully exclusive.

Table 2. The four groups of CBMs identified in case studies.

Benefiting internally	Business to Business		Business to Consumer
	Service	Product	
CBMs closing bioresource loops to secure some internal needs of the enterprise.	CBMs closing bioresource loops and selling parts of this practice as service to other enterprises.	CBMs closing bioresource loops and producing products that can be sold to other businesses.	CBMs closing bioresource loops and by doing so producing products that can be sold to consumers.

VALUE CREATION

While in public discourses closing the resource loops is often framed as an environmentally responsible thing to do (even by the cases considered), during the interviews the enterprises engaged in the circular use of bioresources mainly presented the circular? practice as a pragmatic/ economic choice. From 12 cases included in the CIRCLE project, only two clearly expressed environmental concerns as a key motivator to engage with these practices, i.e. *Lielkrūzes* and *Auga Group*. However, it was also evident that the *Lielkrūzes* case is in general somewhat different from other cases included in the study – circular solutions were just one of the many environmentally responsible practices the enterprise was engaged in. Meanwhile, most of the enterprises engaged in circularity quite pragmatically –

perceiving the given practice through the benefits circular resource use could bring to the enterprise. The perspective on what is the best way the enterprise could create value from closed resource loops differed.

From the cases, we can identify four key considerations that motivate enterprises to look for ways to close bioresource loops. These are: (1) creating new products; (2) reducing costs; (3) optimising the use of resources; and (4) implementing solutions due to regulatory demands. The cases also illustrate that none of the four is exclusive – however, it seems that in each case there is usually one that dominates the decision-making. It can also be suggested that the motivations that push enterprises to close bioresource loops affect their openness to various technological, social and legal solutions.

- **Creating new products**

Some of the enterprises across the four countries became engaged with circularity because they saw an empty market niche that they could penetrate with a new product. For example, *Insectum* – an enterprise producing insect protein – saw that there is a demand for new sources of protein and that waste could be used to produce the product taking the niche. Some enterprises like *Fibenol* use circular solutions to create new niches. *Fibenol* noticed that the existing practices for closing residual wood loops could be made more efficient. The company envisioned how wood chemistry could allow the production of products of higher value, such as high-purity lignin and wood sugars. *Verry Berry* did the same thing while assessing ways to benefit from the byproducts of berry processing. Instead of using it in compost, the company found a market for the residues in the pharmaceutical industry. Another example of this is *Grønne Folk* (Green People) - an enterprise specialising in utilising discarded vegetables as ingredients in ready-made meals for the consumer market. Also, *HKScan* and *Auga Group* serve as examples illustrating how new products can be developed.

An enterprise that is motivated by the possibility of developing new products must make sure that it successfully integrates into the existing market. Primarily, this means that the product must be in a competitive price range. Several of the enterprises explained that they would need to substantially increase the processing capacity to cut the costs of the final product. Also, some of the built solutions were highly energy intensive. For example, maintaining an insect farm in the Northern part of Europe requires a lot of heating which adds to the costs. As a result, the cases reported that they struggle to offer the final product in the price range that can compete with conventionally produced alternatives. Cases report that there are other challenges as well: for example, enterprises struggled to establish a link to the markets, some struggled to convince consumers that their products were good, some of the cases faced issues related to logistics, both up- and down-stream, while some faced difficulties to work with the existing legal framework.

- **Reducing costs**

Some of the enterprises claim that they have been motivated by the possibility of reducing input costs and becoming more independent from the global supply chains. Especially with the recent spikes in fertiliser and energy prices, some enterprises were looking for ways to use the bioresource residues to increase independence from upstream suppliers. *Lielkrūzes* are an example of this thinking. Bioresource residues in this context were seen as a gateway to overcome immediate and future shocks. Enterprises producing energy and digestate from slurry and other biomaterials fall into this category. A different example of this approach is the *Auga Group* in Lithuania. The enterprise has been developing biogas-powered vehicles, allowing farm operations to function without fossil fuels by

utilising manure as a source of biofuel production. However, a caveat needs to be made here – it is not just the resilience that motivates these enterprises. Additional push to engage in these practices comes from the need to find a use for the residuals that, if not dealt with, could lead to fines.

Many of these enterprises have received public funding to cover at least some part of the costs of the infrastructure needed to reuse residues of bioresources. Some of the cases explicitly note that the accessibility of public funding has made the decision to invest easier. Furthermore, the enterprises that are in this group in general have chosen very mainstream solutions, for example, by focusing on the production of biogas and using it to produce energy. These solutions require a high entrance fee, yet they have a rather well-established set of technological solutions. A typical biogas processing facility (as it is captured by the CIRCLE cases) would use some of the produced electricity to power the farm facilities while the remaining part would be fed to the public grid. It also recovers heat from the plant. Finally, the digestate can be used as a fertiliser in the fields.

- **Optimising the use of resources**

There are also those enterprises that engage with bioresource residues because they are looking for a way to use the resources available to them more efficiently. For this group, it is not the goal to develop a completely new product. These enterprises have a well-functioning business model and can, in fact, function without additional engagement with leftovers. For example, *Very Berry* would still exist if it was not selling residues of berry processing. Still, enterprises representing this group perceive the residues as a potential opportunity to improve the efficiency of the enterprise and as a possibility to ensure some additional profits. It can mean that enterprises might be looking for ways to eliminate costs related to the disposal of residues. Yet, in other cases it means that enterprises are actively searching for ways to turn the residues into a sellable new product.

Very Berry is an example of this approach. The enterprise has found a way to sell byproducts of berry processing, yet it is not at the moment adding any additional value to these residues. Until now the enterprise has identified a market that would be interested in the leftovers and has started storing the residues so that it could sell them in bulk. Meanwhile, *Ekofrisa* uses buckwheat husks to produce a variety of products for a wide range of markets. To some extent, *Grønne Folk* - the enterprise that has been described earlier, could be also mentioned in this group. Finally, by selling pig slurry *HKScan* has changed it from a cost into a business case.

- **Engaging regulations**

Regulatory demands are a strong motivator for many of the enterprises. At least one of the enterprises explicitly stated that the future fines were a key motivator to introduce solutions that allow closing bioresource loops.

- **General considerations**

The solutions available to process the bioresource byproducts are constantly changing and new solutions are constantly being introduced in the market. For example, currently, only a small fraction of the revenue of *Very Berry* is generated by the sales of berry processing byproducts. However, some of the leftovers produced by the enterprise contained quince seeds. Experts in the workshop suggested that if the enterprise learned how to produce oil from these seeds, the revenue coming from the

residue processing would significantly increase, and this shift could potentially turn it into an important income source for the enterprise.

Furthermore, the significance of the closed bioresource loops within the enterprise can change depending on the contextual factors. While only one enterprise presented potential future fines due to non-compliance with the legislative norms? as the main motivation to introduce circular solutions, several other cases reported that subsidies and stricter regulations were affecting the decisions of entrepreneurs. This indicates that the enterprises open to exploring new ways to use byproducts of bioresources have a dynamic path ahead of them, and that their business model can change due to shifts in technologies and regulations.

The cases in general also struggle with the fact that closing resource loops is still costly and thus – products produced circularly are often comparatively expensive. It has been illustrated in this chapter that some groups of enterprises suffer from this more than others. What needs to be added here, is that the matter of the high price of the final product is structural. *Svanem Biogas,* a biogas plant in Norway illustrates that, to be economically sustainable, the balance between in-transportation of bio-residuals and the market price for biogas compared to natural gas and fossil energy needs to be right. Currently, the prices for alternatives to biogas are too low, so biogas needs extra support and production subsidies, particularly if the biogas plant is not large enough. This means that medium-sized plants such as *Svanem Biogas*, are struggling and might not be able to find a balance that would make them more competitive.

Finally, the value creation dimension should also be considered in the context of relations between the enterprise and suppliers of residues. Many of the cases included in the study are currently receiving bioresource residues for free or as a barter. While we cannot predict how this will change, we can expect that in the future these relations will take one of the two forms. On the one hand, some enterprises might be able to pay for the residues in the future. In fact, some of the cases analysed are trying to do this already (e.g. *Svanem Biogas*). This might create completely new dynamics in the sector. One way this could happen is that the largest plants processing bioresource residues would manage to reduce the production costs allowing them to allocate resources to pay the suppliers, which would give them more residues to increase their production even further. On the other hand, it is also a plausible scenario that with the tightening of environmental regulations costs of any unused residues could increase, creating a situation where the owner of residues would be interested to pay to get rid of leftovers. This scenario would help all engaged producers to bring down the prices of the final product.

VALUE CAPTURE

While there are different ways enterprises are trying to benefit from the circular use of bioresources, the principles that allow them to do so and the issues that they encounter are somewhat similar across cases and across the four partner countries. From the 12 cases that have been analysed, the following 6 key factors of value capture have been identified: (1) collaboration efforts; (2) inter- and intra-organisational structure; (3) availability of knowledge and experience; (4) steady resource flow; (5) developing technologies and infrastructure; (6) and multifunctionality. The relations between the factors and groups of CBM are illustrated in Table 3.

Table 3. Factors of value capture and their importance for the different groups of CBMs.

	Benefiting internally	**Business to Business**		**Business to Consumer**
		Service	**Product**	

Coordinating efforts	Not important	Crucial	Somewhat important	Somewhat important
Inter- and intra-organisational structure	Important	Important	Somewhat important	Important
Availability of knowledge and experience	Important	Important	Important	Important
Steady resource flow	Not important	Not important	Crucial	Crucial
Developing technologies and infrastructure	Important	Important	Important	Important
Multifunctionality	Not important	Important	Important	Important

- **Coordinating efforts**

This group of factors largely links to the claims made in chapter "2.2. Structural arrangements".

For many of the cases included in this study, engaging in the circular use of bioresources requires rethinking links the enterprise has both upstream and downstream of the supply chain. Collaboration is essential in ensuring a coordinated change across the supply chain. Consequently, for several cases the attempts to close bioresource loops were possible only because of the engagement of a very diverse set of actors who have come together to make sure that the enterprise can function and profit from the circular solutions. The effort to collaborate can come from the need to establish a constant flow of resources that the enterprise can work with. The supply chains for bioresource residues are not necessarily established, and thus, for CBIs finding partnerships that can be used to establish the flow of residues can be a central task. On the other hand, the technologies that allow the processing of bioresource residues can be costly and thus, guarantees from surrounding actors is a way to reduce risks and justify these investments. On other occasions, partners might be necessary to raise the capital needed to introduce the technology or to make future investments.

In practice, this means that the founders of the CBI are surrounded by a diverse set of actors – including financial institutions that support the sustainability transition, representatives of local municipalities or the state, local farmers, waste processing facilities, and many others. This can also manifest as long-term contracts with retail chains looking for environmentally friendly products to offer customers or looking for ways to deal with discarded products.

- **Inter- and intra-organisational structure**

In several cases, it has been observed that CBIs are trying to identify the best legal or organisational solution for the envisioned activity. Identifying the best legal and organisational form seems to have an impact on the perceived and real opportunities of CBIs. Consequently, solutions adopted by the cases studied vary. For example, the organisational structure of *Insectum* has been characterised as a biotechnology-focused startup. This has allowed the enterprise to start the business, yet it is also now hampering its development. The same is true in the case of *Grønne Folk* – the enterprise started as a startup, yet soon realised that it had to become more established if it wanted to reach its objectives. A different approach chosen by some of the cases was to create a separate legal entity focusing on

circular solutions. For example, biogas plants built next to cattle farms can be established as a separate entity. Presumably, this allows the enterprise to deal with potential challenges and look for investments more efficiently. Also, we can presume that in cases when circular solutions are a part of a larger cluster of activities, creating a new enterprise allows the entrepreneur to protect the existing, well-functioning activities it is engaged in. This important aspect, however, only emerged during the fielwork, rather than as part of the initial questions designed for all the case studies. Thus, more research is needed to provide definitive answer on the role of inter- and intra-organisational structures of CBIs.

- **Availability of knowledge and experience**

Several cases demonstrated that the technological solutions introduced to close bioresource loops can emerge in diverse contexts. All four considered national contexts have at least some general support structures (such as financial support, access to at least some well-established example cases, informative support, etc.) in place to facilitate bioresource-related innovations. However, even with this general support, there are some technological areas and some sectors more prone to be associated with solutions offering new ways to close bioresource loops. To rephrase – while some innovations are anticipated, some seem to emerge out of nowhere.

The solutions adopted by the CBIs grow out of the prior information available to the persons involved in their initial development. The complexity and the novelty of the various solutions are directly linked to networks surrounding the case. Several cases have clearly shown that they are cultivating strong relations to science to ensure a more radical and data-based approach to the search for solutions (e.g. *Fibenol*, *Võrtsukala*, *Invertapro* and *Auga Group*). On the one hand, cases tend to lean towards solutions that have been already proven successful (for example *Ekofrisa* or *Verry Berry).* The biogas plants represent this approach. On the other hand, for some actors, the new solution aimed at closing the bioresource loops is a culmination of a longer process. Among the CIRCLE cases, some enterprises have grown out of previous personal experience with waste management and solutions to eliminate waste. Finally, for some enterprises, the closed bioresource loops are a result of a longer search for an efficient way to eliminate waste. In these cases, the solution introduced might neither be the first nor the only solution aimed at making the resource use more efficient. In all the cases, this previous or contextual interest in waste management has allowed the entrepreneurs to harvest knowledge to decide on solutions that would be most suitable under their conditions.

- **Steady resource flow**

Once the investments are made, the enterprises must work to justify them. Among other things, this means ensuring that the technological solutions are working to their full capacity. Without such an effort a company might struggle to cover the initial investment. Furthermore, it might also struggle to keep the prices of the final product competitive. This also means, as it is discussed in some of the CIRCLE case studies, that further upscaling of closed loops of bioresources might help the enterprise lower the price of the final product or to get a better price. Cases like *Fibenol*, *Insectum*, and *Svanem Biogas* illustrate that increasing the scale of production is one way to reduce costs. Meanwhile, *Very Berry* illustrates that selling larger amounts of byproducts can result in a better position when negotiating prices for the product.

All of these considerations are strongly linked to a steady and sometimes increased access to bioresource residues. Cases like *Very Berry, HKScan, Auga Group Võrtsukala* and *Ekofrisa* produce

utilised byproducts on their own. *Fibenol* is a part of well-established timber industry. *Svanem Biogas* has contracts with nearby livestock farmers allowing it to rely on the slurry from these farms. On the one hand, cases illustrate that enterprises are looking for ways to secure the existing resource flows through contracts binding suppliers with processors (like in the case of *Insectum*, *Invertapro* or *Svanem Biogas*). However, while the case study reports provide little information on the exact relations between suppliers and processors, the existing insights communicate at least some misalignment (from cases to case the misalignment can be differences in expectations, financial capabilities, infrastructure connecting the two groups, geographical distance between the two groups) that needs to be addressed. On the other hand, cases also illustrate that enterprises are tempted to attract the highest amount of waste possible (see *Grønne Folk*). There are some issues linked to this process. Firstly, entrepreneurs tend to develop solutions that would be able to work with the highest diversity of waste. This creates a situation where there is little incentive to consider the most effective use of each waste stream. Instead, considering all available by-products as input (not regarding the most efficient use of these resources) for the developed loop becomes the end goal on its own. Secondly, the sustainability of closed bio-resource loops is not just linked to processing but to the transportation of materials as well. Large-scale facilities demanding a large quantity of resources might tend to look constantly outward to ever broader territories for the input materials. Consequently, the transporting of the materials (such as slurry) becomes an issue on its own – these facilities require large amounts of materials, yet transporting some of these materials is costly and might require infrastructure that is not yet in place.

Furthermore, many cases have managed to introduce circular solutions due to the available public funding. This suggests that the need for external funding sources pushed the enterprises to engage with practices which they felt could receive support from public funds. Consequently, some solutions have received more interest from entrepreneurs than others (for example, biogas production).

- **Developing technologies and infrastructure**

Bioresource loops can be closed both by using highly innovative and traditional solutions. Cases like *Lielkrūzes* illustrate that there is space for traditional forms of implementing circular use of bioresource. However, in general, the case studies demonstrate that novel technologies and novel entrepreneurial forms are an important prerequisite for closing the bioresource loops. Furthermore, it can also be observed that new solutions are constantly emerging creating ever-new ways how bioresources could be used. *Fibenol* and *Very Berry* are cases illustrating how high-tech and new solutions create new ways to engage with bioresource residues.

While the technologies have been advancing, enterprises were also expressing doubts regarding the possibility of adopting these technologies for local needs. Often particular modifications had to be made to solutions that were tested elsewhere. This required local knowledge that might not exist. As illustrated by *Võrtsukala* - an enterprise whose main activity is retail sale of fish, crustaceans and molluscs in specialised stores - research holds an important role in bridging the knowledge gaps.

- **Multifunctionality**

Many of the cases have found multiple income sources from different activities that they link to the closed bioresource loops. There are cases, like *Very Berry*, where circularity is on its own a secondary source of income for the enterprise. However, there are also cases, where circularly produced products are the primary source of income, yet the entrepreneurs also have identified other potential income

sources emerging from the closed loops. Developing a solution for closed bioresource loops is a knowledge-intensive process. Most of the cases illustrate that at least some part of the adopted solution requires modifications either in technologies, in the supply chain organisation, or in the management of the enterprise. Thus, several enterprises have been looking for ways to monetise the unique experience it has. Patenting the knowledge (as has been done by *Fibenol*) or advising others (sometimes free of charge but with a perspective, that this might be a paid service) are some of the ways enterprises can gain some extra benefits from their activities. Some of the cases have also been collaborating with scientists thereby attracting some of the resources needed through this collaboration. Among those who have pursued this route, one can mention *Lielkrūzes, Very Berry*, and *Võrtsukala*.

VALUE PROPOSITION

The role of the circular use of bioresources differs from one case to the next and is strongly linked to the overall strategic significance of the circularity in the CBI. The significance of these practices is linked to the target groups the enterprises are working with and the perceptions of the optimal strategy to monetise their practices. The strategies enterprises adopt are presented in Table 2.

Benefiting internally. There is a clear group of enterprises that has been motivated to introduce circular solutions to support their internal needs and visions. However, an analysis of practical solutions applied makes this group less coherent. Firstly, as has been illustrated by WP2, enterprises often prefer to establish a new legal entity that maintains the circular solutions. Thus, while the activities of the formally segregated enterprises are clearly interlinked and they might be managed as one entity (which seems to be often the case), the activities take place within a cluster of enterprises. This results in a situation where the legal structure of the cases is highly complex, incorporating several different actors linked into a joint network. Secondly, while the current solutions adopted are mainly focusing on engaging with enterprise's local needs, the long-term vision of these enterprises might be to commercialise the practice and try to offer it in the market. This, however, might require some changes in the supply chain. In this case, the decision to adopt the circular use of bioresources links to the case perception and interpretation of the market processes of key persons in each CBI. Context description in chapter "2.1 STEEP analysis" provides the main arguments cases might consider.

Part of the cases considered in the CIRCLE project have engaged with circular solutions (a) to cut costs and improve the future independence of the enterprise. Given the turbulent contextual processes affecting the costs and accessibility of inputs, these enterprises speculated that, for example, closing the loops by using the slurry or other biowaste/ byproducts/ or residues to produce energy and fertilisers will help them be more self-sufficient. For other enterprises (b) the perceived future costs (in the form of fines and taxes) related to high levels of waste production were the motivator to consider new ways to deal with waste. Finally, for some enterprises, the main motivator to test the new circular technologies was (c) the potential future business opportunities. These enterprises envisioned a market shift in the future that would allow them to benefit from the newly adopted circular resource use.

Providing services to other businesses. There are two general ways enterprises are presenting their services to other actors. On the one hand, the cases collaborate with potential upstream partners presenting the latter with an opportunity to deal with or even benefit from their bioresource leftovers. This offer goes hand in hand with the increasing legal pressure on enterprises to introduce more sustainable production practices.

On the other hand, several of the enterprises are working with very novel solutions. Their engagement with new practices, technologies and organisational solutions puts them in a unique position where they can offer knowledge to other actors interested in potential benefits from closed loops. Consequently, several of the studied cases claim that in the long-term they see themselves also as advisors who can help the next generation of enterprises adopt the practice most efficiently. In some cases, enterprises were also presenting themselves as a test site that allowed actors (including scientists) interested in the technology to observe the practical functionality of the solution which was perceived as a gateway allowing them to sell the equipment needed to introduce the solution. Still, while during the interviews enterprises were presenting themselves in this way, none of them had managed to fully benefit from this vision yet. Instead, it seemed like a long-term vision that might bear fruit sometime in the future.

Providing products to other businesses. Most of the enterprises were providing some kind of products to their consumers. These most commonly were – biogas, electricity and fertilisers. The enterprises were benefiting from the public financial incentives (allocated through various mechanisms explicitly linked to circular practices). However, when talking about working with business partners, none of the cases indicated that the circularity was an additional selling point allowing to secure deals. Instead, it was mentioned again and again, that the deals are mainly affected by the price and, to be able to sell their product, the enterprises needed to offer a product that can compete with other products on the market.

Providing products to consumers. Only some of the enterprises were selling their products directly to consumers. None of those were explicitly communicating to consumers the circular production practices adopted by the enterprise. Instead, the circular practices were part of a broader narrative of environmentally friendly production methods. Enterprises that can be mentioned here are – *Very Berry*, *Ekofrisa*, *Grønne Folk* and *Lielkrūzes*.

4. COST-BENEFIT ANALYSIS OF CIRCULAR BUSINESS INITIATIVES

- **General approach for qualitative and quantitative CBA of circular business models**

Cost-benefit analysis (CBA) is a systematic approach that allows estimating the strengths and weaknesses of two or more alternatives applied to engage the same challenge. This approach analyses the expected balance of benefits and costs, including both tangible and intangible ones. According to the basic principles of CBA, benefits and costs are usually expressed in monetary terms, however, it can be conducted as a qualitative analysis as well, and we have used this approach in CIRCLE (see below).

There are several ways to carry out CBA. One of the ways is to perform it in the form of a financial analysis in the order to assess the profitably of the project (initiative, business model, etc.) by considering cash inflows and outflows. The purpose of the financial analysis is to assess the project from the financial perspective of its owner (and/or key stakeholders). The other way, CBA can be carried out as a socio-economic analysis (also called "economic analysis"). **The purpose of socio-economic analysis is to appraise the project's (business model's) contribution to the welfare of society**. Since socio-economic analysis provides a wider perspective, it was considered as the most appropriate for the assessment of innovative circular business models and was used in the framework of CIRCLE.

We used the guide by the European Commision (EC)[1] as well as the basic principles of CBA to assess the socio-economic benefits and costs of circular business models implemented in the analysed case studies. Based on the information availability, both quantitative and qualitative approach was applied to describe the specific CBM and to present its contribution to the wellbeing of society.

The main principles (concepts) that we employed within the CBA are the following:

- **Opportunity cost** – the input and output as well as external effects of CBMs have been valued at their social opportunity costs. In the case of the presence of significant market distortions so-called shadow prices have been used. Proxies have been used to assess opportunity costs if the pricing of relevant resources or goods are not established yet.
- **Long-term perspective** – a long-term outlook has been applied. Costs and benefits have been identified and assessed for a time period of at least several years. If the net annual benefits are positive for the whole period, shorter periods have been applied to avoid overestimating the total net benefits.
- **Microeconomic approach** – the assessment of CBMs' impact on society has been conducted by considering direct effects (e.g., direct employment, direct external environmental effects caused by CBMs). Indirect and wider effects have been excluded from the scope of the CBA as they are typically excluded due to the risk of double-counting and the lack of proper techniques.
- **Incremental approach** – costs and benefits have been identified and assessed by comparing a circular business model scenario with a counterfactual baseline scenario, which reflects a typical practice (business model) that pertains in the absence of CBM (see below).

[1] European Commission, 2014. Guide to cost-benefit analysis of investment projects

The choice of the appropriate baseline scenario (the typical way the industry engages each of the byproducts considered in the CIRCLE project case studies) is a significant element of CBA that may affect its results. As the implementation of CBMs quite frequently involves a transition away from linear business practices, linear or weakly (partly) circular business models were used to define the baseline scenario for many cases. Nevertheless, some cases are related to areas where circular practices are common. Thus, for these cases, baseline scenarios that involve a typical or relevant circular practice were chosen.

Quantitative analysis was based on quantitative assessments and calculations. Economic net present value (ENPV) and benefit/cost ratio (B/C ratio) was used to measure the socio-economic performance of circular business models. We applied a social discount rate of 5% per annum which is suggested by the EC to discount benefits and costs and calculate ENPV and B/C ratio. ENPV and B/C ratio demonstrates whether CBM is desirable from a socio-economic perspective. Positive ENPV (ENPV>0) or B/C (B/C>1) indicate that the present value of the total socio-economic benefits (inflows) is greater than the present value of the total socio-economic costs (outflows). Thus, the society is better off with such CBMs.

The qualitative CBA followed a similar course as the quantitative one, with the difference being that the assessment was descriptive and did not involve quantitative indicators. In accordance with the specific case, we defined the baseline scenario and subsequently provided a descriptive assessment of the distinct benefits and costs that arise from the implementation of the given CBM.

In total 5 quantitative and 7 qualitative socio-economic cost-benefit analyses were carried out. One case, following the requests of the representatives of the case, has been excluded from the comparative analysis.

- **General conclusions on the socio-economic costs and benefits of CBMs**

Circularity of bioresources in the analysed case studies of circular business models in AFA sectors involves effective use of by-products, waste reduction (or even prevention), and the integration of biological processes to create more environmentally friendly systems. Closed-loop systems are usually formed either within agriculture or in interaction with the agricultural sector, as bioresources return to circulation either through crop production (as fertiliser) or livestock production (as feed). On the other hand, in the case considered within the wood processing industry (*Fibenol*), through the process of biorefining, wood processing by-products transform from being a mere energy source into valuable raw materials, specifically lignin, cellulosic sugars and microcrystalline cellulose, for other industries. This creates the possibility to decrease the need for crude oil as a primary source of these materials. Such a transition holds particular significance in the Baltic region as it offers the potential to lower the reliance on imported fossil resources.

The introduction of new technologies in the circularity process, as well as the involvement of the so-called bridge sectors in the bioresource flow, enables to expand the scale of operations, to utilise the potential of bioresources in a more comprehensive way, and to increase the socio-economic benefits generated by the CBM compared to the traditional circulation of bioresources in agriculture.

For instance, instead of diverting livestock production by-products like manure directly to fertilise fields, but into biogas production, companies create an additional source of renewable energy (biogas). This kind of CBM not only generates energy but also provides various utilisation avenues, including

electricity and thermal energy production. Furthermore, the purified biogas (biomethane) can be used in internal combustion engines. Importantly, it maintains a direct link with agriculture, as the digestate, a by-product of biogas production, is valuated as being a more suitable fertiliser for plants, providing enhanced nutrient uptake compared to animal manure.

It is worth noting that as technology advances, energy production from by-products is not necessarily considered to be an optimal solution for maximising added value within the bioresource circulation, as demonstrated in the case studies of *Fibenol*, *Insectum,* and *Invertapro*. Additionally, in cases where biogas is used for electricity generation, there still can be a place for more efficient solutions for utilising the heat generated in the process, that are worth exploring in the future.

Certainly, the incorporation of new technologies or additional processing procedures entails additional investments and operational costs, which, in turn, introduce supplementary business risks that must be carefully assessed before venturing into these areas. However, it is important to consider that, initially, a CBM might create significant socio-economic benefits, but, due to market distortions, regulatory framework or other barriers, these benefits might not be fully recognised or valued at this moment. As a result, from an individual financial point of view, implementing such a CBM may even give a negative outcome. In cases like these, if it is appraised that the CBM provided high socio-economic benefits for improved wellbeing of the society in the future, public support (not always in the form of subsidies) would be appropriate to address these barriers and encourage entrepreneurs to take action.

The results of the CBA also demonstrate that there can be both positive and negative socio-economic performance of circular business models, when comparing the scenario of implementing circular practices to a counterfactual baseline scenario. In most cases the socio-economic benefits exceed the costs associated with their implementation. However, significant challenges may arise if a CBM involves considerable investments. Thus, if implementation of a CBM is feasible without significant investments to modernise or adapt infrastructure (e.g. *HKScan*), the net socio-economic benefits are highly likely to be positive.

Socio-economic **benefits** are most often associated with:

1) The valorisation of by-products or residues, transforming the nutrients contained in them, particularly proteins and fats, to a higher quality, and reintroducing back into the circulation as animal feed or fertiliser for soil improvement, thereby reducing the necessity of other protein and fat sources.
2) The replacement of fossil sources in the production of energy, fertilisers, or raw materials for chemical industry with renewable or natural sources.
3) The reduction of waste.

Additionally, in some cases it is possible that the implementation of circular practices may also have a positive influence on the conservation of biodiversity, for example, by reducing leeching of nutrients or serving as a possible substitute for ingredients in animal feed with high pressure on biodiversity.

On the other hand, the **costs** are primarily associated with:

1) Investments in research and development, new technologies, and processes.

2) The requirement for additional energy or labour to transform and enhance the quality of nutrients in bioresources, facilitating their return to circulation.
3) The collection and transportation of by-products or residues of bio-resources for recovery.

5. CONCLUSIONS

Deliverable 3.2 discusses the results of 12 case studies conducted in the CIRCLE project. Each case study is both a circular business initiative (CBI) engaging with bioresources and a closed loop of the bioresources the CBI is part of. The results discussed in this report capture the circular use of bioresources in the Nordic-Baltic region. While it is highly likely, that somewhat similar observations could be made in any other Europe region, the particular geographical focus of the study needs to be considered when the results are interpreted.

The case studies illustrate a set of contextual factors affecting effective engagement with circular business models. The report structures these factors into five dimensions named by the STEEP model: social, technological, economic, environmental, and political. There are two major **social factors** listed by most case study reports. Firstly, the reports point to a possible mismatch between the available technology and the human capital to benefit from recent advances, especially in more peripheral regions. Secondly, reports claim that while there is consumer demand for sustainably produced products, acceptance of circular and sustainable products is uneven. Furthermore, it is also important to stress that consumers are not always aware of what circularity entails. The use and adoption of certain products may hinge on broader cultural shifts.

While looking at **technological factors**, case studies agree that digital transformation has raised the overall level of technological sophistication and development across various industries and serves as the foundation for complex solutions that are specific to CBIs. Case studies also suggest that there are vulnerabilities and risks associated with strong interdependencies between different technological processes. Circularity is a heterogeneous playing field with technologically advanced and novel solutions and more mundane and incremental innovations existing side by side. Technological innovation and shifts towards sustainability can be regarded as a response to hybrid challenges encountered by businesses. However, there is often insufficient research and data to assess the environmental impact of specific solutions beforehand.

Environmental factors play a crucial role in relation to CBIs. Climate crisis provides the necessary impetus for innovation and thus it facilitates the availability and variety of environmentally friendly solutions. Case study reports also present several **economic factors** relevant to CBIs. Circularity can be seen as a way for businesses to diversify their activities and reduce costs and expenditures. An important challenge for CBIs is the lack of certification for circular products. While organic products can be certified, circular products cannot be easily distinguished from linear alternatives. Finally, there is a perception that CBIs are characterised by high risk, and it is difficult to attract investments and access loans, though our respondents note a growing willingness to invest in “green” solutions.

The **legal** and political environment for CBIs is shaped by broader European policy developments, but we must also consider the role of local governments - the support (or lack thereof) from line ministries and municipal governments. However, there is a key difference between rhetoric and concrete measures to support circularity.

The case studies illustrate, that the motivation of enterprises engaged with circular resource use differs. Only a few of these enterprises had strong sustainability-focused motivation. Instead, most of the enterprises saw circularity as a business opportunity. These entrepreneurs were motivated by the possibility of:

- creating new products;
- reducing costs;
- optimising the use of resources;
- engaging regulations.

The case studies illustrate, that there are commonalities in the ways enterprises capture the value of circular resource use. Upscaling is seen as a solution to make CBIs more profitable. However, there are risks linked to upscaling of closed loops. The case studies also illustrate that the circular use of bioresources cannot be achieved by just adopting new technologies and technological solutions. Often the solutions described in case studies demand broader changes all across the supply chain. Unfortunately, the infrastructure to support the circular use of bioresources is poorly developed. This pushes CBI to engage bioresource circularity in ways that are comparatively better advanced. As a result, the solutions are not always the most sustainable or the best for the particular location.

Engaging in the circular use of bioresources requires rethinking links the enterprise has both upstream and downstream of the supply chain. Because of this, collaboration is essential for enterprises working with bioresource byproducts. Across the case studies four types of structural arrangements characterising forms of collaboration can be identified: 1) horizontal, 2) vertical, 3) public, and 4) informal arrangements. Collaboration is also essential to ensure a constant flow of bioresource byproducts needed by the initiative. Ensuring that there is constant access to these resources in the needed amount has been a challenging task for many of the cases.

Bioresource loops can be closed both by using highly innovative and traditional solutions. The cases relying on complex technologies require substantial investments as well as demand expertise and skilled labour. All of the mentioned can be difficult to obtain. Furthermore, despite the various strategies the enterprises have chosen to manage their business, the circular use of bioresources is still relatively expensive and enterprises struggle to remain profitable. Because of this, many of the considered cases have focused simultaneously on multiple income sources.

6. Appendix

Appendix 1. Table used by researchers to present data on contextual factors.

	Factors and trends characterising the market	Factors and trends shaping the CBI	Factors and trends serving as barriers
Social			
Technological			
Environmental			
Economic			
Political			