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Report on Good Practice Business Models and Example Small and Medium Scale Pilot Business Projects for Sustainable Bioenergy and Side Bio-products Production in the BSR

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BalticBiomass4Value

Preface

This report is the Output 2.3 of the implementation of Work Package 2 Group of Activities 2.3 "Preparation of good practice business models and example small and medium scale pilot business projects for sustainable bioenergy and side bio-products production in the BSR" as specified in the latest approved version of the Application Form of the BalticBiomass4Value project.

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Table of Contents

I. Introduction to the BalticBiomass4Value project and Output 2.3

The Baltic Sea Region (BSR) holds a great potential for circular bioeconomy development. Therefore, the project aims to enhance capacity of public and private actors within the BSR to produce bioenergy in more environmentally sustainable and economically viable way by utilizing new biomass sources (mainly, biological waste) for energy production, as well as possibilities to use bioenergy side streams for higher value bio-products. Biomass from different sources (agriculture, food and feed industry, forestry, wood industry, municipal waste and sewage sludge, fishery, algae), its logistics, various biomass conversion technologies and value chains were mapped to identify good practices of bioenergy generation and the potential of more efficient and sustainable deployment of biomass in the BSR. Seventeen partners from Lithuania, Latvia, Estonia, Germany, Poland, Sweden, Norway and the Russian Federation represent the producers of biomass and bio-based products, as well as relevant public authorities and policy stakeholders, and research organisations.

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Project partners:

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- Forest and Land Owners Association of Lithuania (Lithuania)
- Lithuanian Biotechnology Association (Lithuania)
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For more information, please visit project website: www.balticbiomass4value.eu

The transition towards more circular economy that maximizes value of products, materials and resources and minimizes waste generation calls for a systemic change and rethinking of production, consumption and waste use (European Commission, 2015). The change requires not only new technologies, processes, but also new business models (BMs) that change the way the enterprises conduct their business. The aim of the activities in Work Package 2 was to collect information and share the knowledge and experience on the good practices that facilitate the development of circular BMs in the BSR. The present analysis in Output 2.3 adopted FAO’s (2013) definition that good practices are those practices that have been successfully proven to work and produce good results, and thus could be recommended as models for the adoption by others. The present report summarizes the results of three sets of activities:

- analysis of good practice BMs;
- description of good practice business cases (BCs) of small and medium-sized enterprises (SME);
- development of business planning tool for identified BMs.

The present report builds on the two previous outputs of Work Package 2 – Output 2.1. "Report on Market Outlook and Future Viability of Different Bioenergy Products and Value Chains in the Baltic Sea Region Energy System for the BalticBiomass4Value Project" (Trømborg and Jåstad, 2019), and Output 2.2. "Report on mapping of biomass value chains for improved sustainable energy use in the Baltic Sea Region countries" (Stolarski et al., 2020). Both of those outputs studied the biomass availability, bioeconomy development trends, drivers and value chains at the macro-regional level in the BSR. This report illustrates how the trends described in those two outputs manifest at the micro, i.e. business enterprise level.

In the following sections, theoretical background on BMs and business model canvas (BMC) is shortly introduced. The methodology section describes the selection of cases and development of taxonomy of good practice BMs. Third section provides the description of identified good practice BMs using BMC. Good practice BM are summarized into archetypes in fourth section. Business planning tool is presented in the fifth section, followed by conclusions in the sixth section. The extended descriptions (narratives) of selected BCs are presented in the Appendix 2.

II. List of concepts and abbreviations

B2B	Business to business transactions
B2C	Business to consumers transactions
B2G	Business to government transactions
Baltic Sea Region (BSR)	Area of the Interreg Baltic Sea Region Programme, which includes eight EU Member States (i.e., Denmark, Estonia, Finland, Germany (the States (Länder) of Berlin, Brandenburg, Bremen, Hamburg, Mecklenburg-Vorpommern, Schleswig-Holstein and Niedersachsen (only NUTS II area Lüneburg region)), Latvia, Lithuania, Poland, Sweden) and two partner countries (i.e., Norway, Russia (St. Petersburg, Arkhangelsk Oblast, Vologda Oblast, Kaliningrad Oblast, Republic of Karelia, Komi Republic, Leningrad Oblast, Murmansk Oblast, Nenetsky Autonomous Okrug, Novgorod Oblast and Pskov Oblast)).
Bioeconomy	All sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services (European Commission, 2018).
Bioenergy	Energy created from renewable biomass.
Biomass	Biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste (European Parliament …, 2009).
Business case (BC)	Description of a real-life business and its context for the study of the particular phenomenon.
Business model (BM)	Simplified description on how an enterprise conducts its business.
Business model canvas (BMC)	A template for describing a business model and its elements.
Business model innovation (BMI)	Purposeful, novel and significant changes to one or more key elements of business model and their interlinkages.
Circular economy	Economy, where the value of products, materials and resources is maintained for as long as possible, while generation of waste minimized (European Commission, 2015).
CHP	Combined heat and power
CNG	Compressed natural gas
Cluster analysis (CA)	A multivariate statistical method for grouping data according to the similarities in observed values of the studied data objects.
ICT	Information and communication technologies
Value capture	Enterprise's ability to monetize its transactions with its customers and earn profit.
Value creation	A process in which the enterprise combines its resources and activities to create products and services to satisfy their customers' needs.
Value chain	An interconnected set of primary and support activities that are carried out in order to transform ideas into products and services for customers' end-use and beyond, starting from the conception and going through stages such as design, production, marketing, delivery, consumption, disposal/recycling.
Value network	Set of interconnected actors and the relationships between them through which value is created for the customers

III. List of figures

IV. List of tables

1. Business Models and Business Cases

1.1. Definition of Business Models

Business model (BM) is a topic that has risen to prominence in the last 25 years as a reaction to rapid development of ICT and digital technologies that have opened up new ways of doing business as well as with the integration of highly globalized and hypercompetitive markets (Nielsen et al., 2018). Growing body of research evidence indicates that BMs are seen as essential to company competitiveness, renewal, and growth (Chesbrough and Rosenbloom, 2002; Johnson, 2010; Teece, 2010; Lambert and Davidson, 2013; Campbell et al., 2013). Most of the research so far has been published since the 2000s and is heavily focused on ICT and on private businesses with limited attention to public organizations. BMs in bioeconomy have received considerably less attention (Bocken et al., 2014; D'Amato et al., 2020). In order to utilize the potential of bioeconomy in the EU and the BSR, and build competitive bioeconomy sector, however, innovation in technologies and resource use are not sufficient without addressing how enterprises can create and capture value from bioeconomy.

BM can be defined as a simplified description and representation (Nielsen et al., 2018) of how the organization conducts its business and how it functions (Osterwalder et al., 2005). However, there is no uniform definition for BM as different researchers and practitioners have utilized different approaches, definitions and frameworks for studying them (Zott et al., 2011; Nielsen, et al., 2018). Typically, the common emphasis is that BM describes the *business logic, the way value is created and captured for customers as well as for the enterprises involved* (Heikkilä et al., 2016, p. 339). BM provides a systematic and holistic approach on how the focal enterprise conducts its business (Zott et al., 2011; Tell et al., 2016). It is used to convey strategic choices, clarify how organizations develop, produce and capture value, and enable the identification of competitive sources by managing a dynamic network of interrelated activities (Lambert and Davidson, 2013; Zott et al., 2011). BMs are often viewed as tools used by managers to design, implement, manage, modify, and control their enterprises (Johnson, 2010; Wirtz et al., 2010).

Osterwalder et al. (2005, p. 3) define BM as *a conceptual tool containing a set of objects, concepts and their relationships with the objective to express the business logic of a specific firm.* The tool seeks to identify the elements, concepts and relationships of the business in order to develop a simplified model representing value creation, delivery and capture by the business.

BMs provide organizational blueprints (Baden-Fuller and Morgan, 2010). A good BM should clearly identify who are enterprise's customers, what is the enterprise's unique value proposition for them and how does the enterprise differ from others, how the value proposition is implemented, and revenues, expenses and risks managed, etc. (Sandberg, 2002). Generic descriptions of BM contain components such as customers, competitors, offering, activities and organization, resources (human, physical and organizational), and supply of factor and production inputs (Hedman and Kalling, 2003, pp. 52–53). In more detailed models, elements such as the strategic choices (customers, value proposition, capabilities, revenues, competitors, strategy, differentiation, offering, mission, branding), value creation (resources, processes), value capture (costs, profit, finances) and value network (suppliers, relationships, information, product flows) are described (Shafer et al., 2005). Some BM concepts emphasize the concise description of the interrelated activities of the process and their content, as well as the various interrelated decision variables (e.g., strategy, architecture, and economics) to establish a sustainable competitive advantage for the organization (Magretta, 2002; Morris et al., 2005; Zott and Amit, 2010).

1.2. Functions of Business Models

BM is a useful tool in global business landscape characterized by uncertainty, increasing complexity and appearance of wide range of BMs and new stakeholders (Osterwalder, 2004). A BM helps various stakeholders to understand and articulate how the business is conducted and the relationships between the different elements. More specifically the general functions of the BM are to (Chesbrough, Rosenbloom, 2002, pp. 533–534):

- explain the value proposition for the customers;
- identify the market segment: who are the clients to whom the offering is useful and why, and what is the revenue generation mechanism;
- specify the structure of value chain within the organization required to create and distribute value;
- estimate costs and profits;
- describe the position of organization within the value networks of suppliers, customers, etc., and identify potential complementors and competitors;
- formulate competitive strategy by which the organization can gain advantages.

As a conceptual tool, BM provides a simplified representation of its different elements, relationships and interconnection between them. Osterwalder et al. (2005, pp. 11–17) outline following roles of BM as a conceptual tool:

- Understanding and sharing: a BM provides a simplified and shared concept for describing the business to different stakeholders, helps to visualize and to understand different elements and their relationships in the model, and to communicate the business logic of the enterprise.
- Analyzing: BM concept helps to analyze the business logic of the enterprise by providing a structured approach for identifying suitable indicators for different elements, measuring the changes and for comparing the data, incl. comparisons with competitors.
- Managing: BM contributes to the management of the business logic by helping to design and improve the elements of BM, and by facilitating the planning, changes and implementation on different elements of the business logic. Better understanding and mapping of different elements improve the decision making and results in quicker and more appropriate reactions to external changes.
- Prospects: the concept helps to understand the future prospects of the enterprise. Better understanding of different elements fosters innovation and readiness for change, incl. creation of new strategies and BMs for the future and creating simulation and testing for those.
- Patenting: BM concept can help to develop models that can be patented and commercialized.

Approaches to BM concept and its functions can be divided into static and dynamic ones. In the static approach, focus is on the BM as a description of business logic (Spieth and Schneider, 2016). In this, BM functions as a template that allows description and classification of how the enterprise functions and generates revenues (Demil and Lecocq, 2010). The dynamic function of a BM is to facilitate identification and utilization of new opportunities and commercialization (Spieth and Schneider, 2016). The dynamic view aims to understand how the BM evolves over time in response to new opportunities and environmental changes. In dynamic approach, the focus is on the transformational aspects of BM, thus it functions as a tool for creating changes and innovation in the organization or in the BM (Demil and Lecocq, 2010).

1.3. Archetypes and Typologies

As there is no common definition or concept of BMs in research literature, Osterwalder et al. (2005) proposed a concept hierarchy to help to clarify the BM concept (Table 1).

Table 1. Business Model Concept Hierarchy (adopted from Osterwalder et al., 2005, p. 5, with changes)

<table>
<tr><td rowspan="2">1</td><td rowspan="4">Conceptual levels</td><td colspan="3" rowspan="2">Business model concept</td><td>Definition: what is a business model?</td></tr>
<tr><td>Meta-model: what elements belong to the business model?</td></tr>
<tr><td rowspan="2">2</td><td colspan="2" rowspan="2">Business Model Type A</td><td rowspan="2">Business Model Type B</td><td>Archetypes/taxonomy of types: which business models resemble each other?</td></tr>
<tr><td>Sub(meta)models: what are common characteristics?</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Instance levels</td><td>Business Model of Company A</td><td rowspan="2">Business Model of Company B</td><td rowspan="2">Business Model of Company C</td><td>Instances (view of company)</td></tr>
<tr><td>Modelled instance</td></tr>
<tr><td>Company A</td><td>Company B</td><td>Company C</td><td>Real word company</td></tr>
</table>

Osterwalder et al. (2005, pp. 5–6) point out that in literature, different authors talk about different things (e.g., concept, types of BM, parts of BM, real world instances of BMs) while using the expression BM, and they suggest a hierarchical classification for clarification. On the first level, BM is approached as an abstract overarching concept that defines what a BM is and what elements belong to the different BMs (metamodels). Below those, the second level consists of abstract descriptions of different types of BMs with similar features. That includes categorization of different types into taxonomies and subclasses for metamodels. Third category of approaches refers the instance level in which the descriptions, representations and conceptualizations of real-world BMs are studied.

The BalticBiomass4Value project studies the different types of good practice BMs in the BSR and the archetypes of bioeconomy BMs with the main focus on bioenergy as one of the main points of interest. The conceptual approach on what is a BM and what are its components are based on Osterwalder and Pigneur (2010) and Osterwalder et al. (2005). In order to develop BM taxonomy, the project partners collected information about real-world bioenergy and bioeconomy enterprises (BCs) in BSR, that were analyzed to create archetypes.

BM archetypes refer to categorization of different BMs into typologies for benchmarking, research and for facilitating BM innovation (Nielsen et al., 2018). Archetypes are groupings of BMs based on comparison of their similarities and differences (Bocken et al., 2014). The objective of creating BM archetypes is *identifying and describing BMs with similar features, dynamics or behaviors to make them comparable, easy to understand and applicable*. Archetypes provide practical frameworks of ready-to-use templates that can be fully or partially copied by other enterprises (Nielsen et al., 2018).

Archetypes can be created by categorization, i.e., process of dividing the studied entities into groups on the basis of their resemblance to each other in the given context and the aggregation of the groups into categories (Jacob, 2004). Groupings of different types can be created in several ways. Baden-Fuller and Morgan (2010), and Nielsen et al. (2018) differentiate between creation of typologies and taxonomies:

- taxonomy – kinds/taxa of enterprises, empirically based on bottom-up approach through observation;
- typology – types of enterprises, created top-down conceptually and theoretically.

Different authors have used different criteria for creating archetypes. Thus, in research literature, archetypes can refer to typologies or taxonomies of full BMs of specific enterprises, generic basic models or models based of specific element or aspect of BM (e.g., revenue model) (Fielt, 2014).

1.4. Sustainable business models

Bioeconomy BMs have received less attention. Some examples of research on archetypes include sustainable BMs (Bocken et al., 2014; D'Amato et al., 2020), which are relevant also in the context of present project. Bocken et al. (2014) used systematic review of literature to categorize sustainable BMs into eight basic archetypes (Table 2) that are grouped by their type of business model innovation (BMI) (technological, social, organizational).

Research on BM archetypes tends to be more specific and empirical, but it helps to improve understanding on the BM definition and more abstract conceptual frameworks as well as the relationships between the elements of BM (Fielt, 2014).

Table 2. Sustainable business model archetypes (based on Bocken et al., 2014, pp. 48–54)

Business model innovation	Archetype of business model	Value proposition	Value creation and delivery	Value capture
Technological	Maximization of material and energy efficiency	Products and services using fewer resources to reduce waste, emissions and pollution	More efficient production processes using less resources and reducing waste	Cost reduction from optimized use of resources, reduction of waste and environmental impact
	Creation of value from waste	Eliminating waste by turning waste into input for other production	Recycling of waste and closing of resource loops and making use of under-utilized capacities	Cost reductions from reuse of materials, reduction of waste and virgin material use
	Substitution with renewables and natural processes	Products based on renewables resources and natural processes	Innovative production processes based on renewable resources and energy and natural systems	Revenues from new products, reduction of environmental impact of use of non-renewable resources
Social	Delivery of functionality, rather than ownership	Shift from selling physical products to consumers to providing services for users	Redesign and delivery product/service offerings based on reuse, reparability and upgradability	Revenue for provision of services and increased access for consumers
	Adoption of stewardship role	Products and services for ensuring stakeholders long term well-being	Production and supply systems that deliver the environmental and social benefits	Revenues from the stewardship and benefits from the well-being of the stakeholders
	Encouragement of sufficiency	Product and services aiming to reduce consumption and production	Promotion of less consumption and less waste and more durable products	Revenues from durable products and environmental and social benefits from reuse and less consumption
Organizational	Re-purpose of the business for society/environment	Prioritization of social and environmental benefits over economic profit	Development of products and services with participation and integration with local communities and stakeholders	Environmental and social benefits from locally embedded enterprise
	Development of scale-up solutions	Large scale delivery of sustainable solutions	Development of channels and partnerships for scale-up solutions	Revenues for scaling up (e.g., franchising, licensing fees) and benefits from partnerships

1.5. Business Model Canvas

A BM is represented *by an interrelated set of elements that address the customer, value proposition, organizational architecture and economics dimensions* (Fielt, 2014, p. 96). Different authors have presented different framework for studying the BM, but in the present analysis BM canvas developed by Osterwalder and Pigneur (2010) is used. Osterwalder (2004) focused on identifying basic constructs of BMs and developed an ontology that would explain the relationships between those in a structured format, as well as elaborated the BM canvas further in Osterwalder et al. (2005); Osterwalder and Pigneur (2010). Osterwalder and Pigneur's (2010) business model canvas (BMC) consists of nine components (Table 3).

Table 3. Components of Osterwalder & Pigneur's (2010) business model canvas and their explanation

<table>
<tr><td rowspan="2">Key partners
The network the organization uses to operate its business model</td><td>Key activities
The main activities required for making the business work</td><td rowspan="2">Value proposition
Value offered to customers in mix of products and services</td><td>Customer relationships
Type of relationships the organisation has with customers</td><td rowspan="2">Customer segments
Specific groups of customers the organisation aims to reach and serve</td></tr>
<tr><td>Key resources
Most important tangible and intangible assets required for the business model</td><td>Customer channels
How organization reaches its customers</td></tr>
<tr><td colspan="3">Cost structure
Most significant costs for operating the business model</td><td colspan="2">Revenue streams
What kind of cash flows different customers create for the organization</td></tr>
</table>

The nine blocks can be divided into four main areas:

- Value proposition refers to products and services and complementary services provided by the enterprise to its customers to satisfy their needs and solve their problems (Osterwalder, 2004). Value proposition is the reason why customers choose to do business with the enterprise over another business. The products and services provided to the customers may be in form of new or innovative offerings or similar to existing products and services, but they offer the specific customer segments value in terms of pricing, design, customization, functionality, brand, cost or risk reduction, convenience, etc. (Osterwalder and Pigneur, 2010).
- The infrastructure domain on the canvas contains the key partnerships, activities and resources the enterprise needs to create value for its customers. Key partners include enterprises' suppliers, manufacturers and variety of other enterprises, governmental and non-governmental organizations, who help the enterprise to acquire resources, reduce risks, and who directly impact how the enterprises conducts its activities. Key activities refer to the most important activities the enterprise carries out to make its BM work (Osterwalder and Pigneur, 2010). For example, those may include production, design, marketing, customer management, network/platform developments, etc. Key resources are physical, intellectual, and financial and human resources the enterprise owns or acquires through partners in order to create and distribute its products and services, develop the customer relationships and earn revenue.
- Customer interface contains description of customer segments and relationships, and distribution channels. Customer segments are the groups of customers the enterprise aims to reach. Enterprises divide customers into segments on the basis of common characteristics, needs, and behaviors. Customer relationships refer to links the enterprise establishes with

different groups in order to acquire and retain customers (Osterwalder, 2004). For example, personal assistance, automated services, self-service, co-creation or community-based relationships. Distribution channels describe how the enterprise reaches its target customers, incl. how it communicates with customers and helps them evaluate the product and services, in which way the products and services are purchased, delivered and supported post-purchase. The channels may be direct or indirect, owned by enterprise or its partners (Osterwalder and Pigneur, 2010).

- Financial viability of a BM is determined by enterprise cost structure and revenue models. Cost structure refers to all the costs incurred by the enterprise in connection with acquiring resources, assets, carrying out its activities, developing and maintaining partner network and customer relationships (Osterwalder, 2004). Revenue model describes how the enterprise generates revenues (e.g., markup, rent/lease, licensing, subscription fees, assets sales, etc.) and pricing mechanisms (fixed/dynamic, price level, changes over time).

1.6. Business Model Innovation

Business model innovation (BMI) can be defined as *designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements* (Foss and Saebi, 2017, p. 216). BMI can occur by adding novel activities, linking existing activities in new ways, by changing the parties that perform the activities (Amit and Zott, 2012). Previous research has examined the importance of BMI "as a result". However, less is known about BMI "as a process". More specifically, even though some early research distinguished between, for example, radical and incremental BMI (Brink and Holmén, 2009), a major shortcoming of the literature is that it does not systematically analyze the processes. According to Klang et al. (2014) most practitioners use Osterwalder and Pigneur's (2010) BMC when they attempt to innovate their BMs. A firm's change in one or more building blocks in the BMC is defined as BMI (Björkdahl and Holmén, 2013).

BMI provides an opportunity to change the way the enterprise does business by re-conceptualizing and rethinking the enterprise's purpose, value creation and delivery (Bocken et al., 2014). Based on insights from the process models in the innovation management literature, Frankenberger et al. (2013) state that the process of BMI consists of several phases which is similar compared to other innovation processes.

Research on BMI has so far mostly concentrated on the large companies and high technology. Micro and small businesses, such as farms with low tech industrial products (e.g., wheat, rice, milk, and potatoes) have received very limited attention (Tell et al., 2016).

Johnson and Suskewicz (2009) explain that BMI is shifting the emphasis from creating individual technologies to developing new systems. Sommer (2012) points out that the BMI not only focuses on the company but also involves a broader range of stakeholders, requiring a broader value-added network perspective to innovate and transform the BM.

Research on BMI has flourished the last decade, and a great number of studies have contributed to our understanding of the BMI phenomenon (Foss and Saebi, 2017). The multitude of studies has provided empirical evidence on barriers preventing firms from mastering the challenge of BMI (Chesbrough, 2010; Doz and Kosonen, 2010). Prior research also shows that there are different BMI processes and that these situations need to be dealt with in different ways.

1.7. Case Studies in Business Research

Business cases (BC) are often used both in teaching and research, however, in different fashion. BCs used in teaching are typically descriptions of real-life businesses, projects or activities that students

interpret by applying their theoretical knowledge and to recommend practices (Farguhar, 2012). In academic research case study refers to *a particular design of research, where the focus is on an in-depth study of one or a limited number of cases* (Tight, 2017). In this project, case study research is used to study the phenomenon of BMs, more specifically in the cases of bioenergy and biomass companies within the BSR.

Case studies aim to capture both the real-life event and its natural setting, especially when the boundaries between those are not readily separable (Yin, 2009). Case studies differ from experiments and surveys as they are not conducted in a controlled environment and the generalizability of results is limited (David and Sutton, 2011). Typically, the cases for the study are selected non-randomly on the basis of theoretical considerations or of particular interest (Ridder, 2017).

Case study research is *particularly suitable for description, explanation and exploratory research* **(**Farguhar, 2012, p. 7). Explanatory case studies, on one side, aim to explain the case that is investigated, but also at the same time try to explain the larger class of cases, and thus, to provide a larger context to the study (Gerring, 2017). Exploratory and descriptive case studies that seek to explore and describe the phenomenon have usually more inductive and qualitative approaches than explanatory studies that tend to be more focused on quantitative and deductive approaches (David and Sutton, 2011). The strengths of case study research lie in exploration of actual practice by which it contributes to knowledge building and theory development, it allows to address the complexity of why and how certain phenomena occurs, and it provides useful insights in early exploratory studies of phenomenon that are not well understood (Benbasat et al., 1987).

A case is *spatially and temporarily delimited phenomenon of theoretical significance* that is being described or explained (Gerring, 2017, p. 27). Cases can be individuals, organizations, social groups, communities, events, states, etc. They can be observed in a single point in time or over certain period of time, and each case may provide a single or several observations.

Case studies may be based on a single case or multiple case designs. The rationale for selecting a single case includes interest in a critical case for testing a theory, finding a rare, unique case of a new and rare phenomenon; studying a representative and typical case to represent a common event; finding a revelatory case to study previously inaccessible phenomena; and longitudinal cases for studying changes over time (Yin, 2009). Multiple case studies provide opportunities to study replication by focusing on similar or contrasting results, as well as provide more data for analytic conclusions, but also are more time consuming and expensive (Yin, 2009).

Case studies typically utilize variety of different methods, such as participant and non-participant observations, interviews, focus groups, analysis of documentation artefacts (David, Sutton, 2011). The use of multiple sources of data and different data collection methods within each case allows data triangulation that provides support for the research findings (Benbasat et al., 1987).

2. Data and Methodology for Creating Business Model Taxonomy and Description of Cases

2.1. Conceptual Approach

Good practices refer to successful experiences that have been tested and proven, could be replicated, and deserve to be recommended as models to be adopted and improved by others (FAO, 2013). There are also opportunities for evolvement and improvement of the practices, and thus "good practices" can be differentiated from the term "best practices" that can be associated with the proven best approach that does not need further improvement. The focus of the activities 2.3. of Work Package 2 was to collect data on successful BMs of biomass enterprises from the BSR and share this knowledge so that those BMs could be replicated and improved around the BSR.

Present analysis utilized multiple case study approach and in descriptive and explanatory in its nature. The underlying idea behind the methodology was a bottom-up approach to create a taxonomy of BMs in bioeconomy and provide in-depth analysis of cases representing each BM (Figure 1).

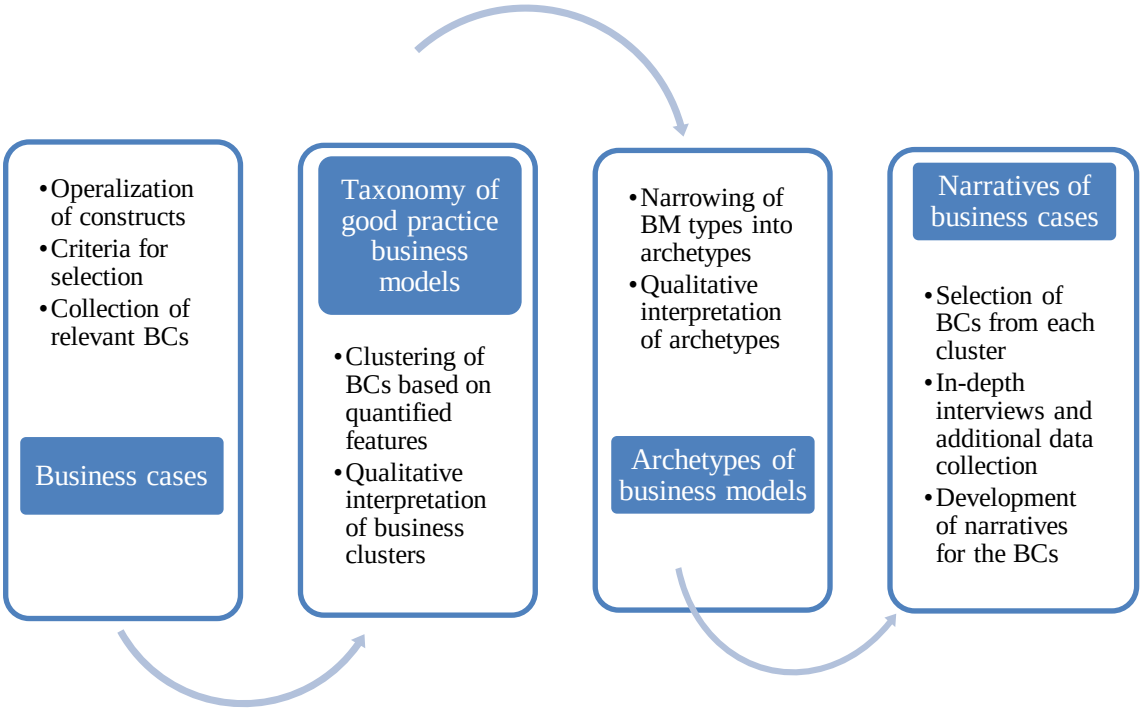


Figure 1. Research process

The procedures for conducting case studies suggested by Eisenhardt (1989) and Yin (2009) were adapted for methodological approach. The research utilized the Osterwalder et al.'s (2005) conceptual model of BM (Table 1). The process started at conceptual level with specification of what is a BM and what are its elements drawing on Osterwalder and Pigneur's (2010) approach. After setting criteria for the selection of BC, the analysis proceeded from bottom-up at the instance level: description of BC of real-life company → models of the BC → clustering of BCs into a taxonomy of good practice BMs → summarization of the good practice taxonomy into four archetypes.

The criteria for selection of business cases were:

- inputs and outputs (e.g., source of biomass and products or other outputs);
- type of enterprise (processing, service provision, distribution, cooperative, etc.);
- sustainability (environmental, economic and social aspects);
- feasibility from policy perspective (regulation and subsidy dependence);
- transferability to SMEs in the BSR.

Analysis of those features allow to summarize the main elements as well as the functioning of a BM (Chesbrough and Rosenbloom, 2002, pp. 533–534) as described earlier.

The similarities and differences between BC were examined, and translated into a taxonomy of a good practice BMs using cluster analysis (CA). The taxonomy is used to separate related BCs and the resulting clusters were analysed using BMC. The resulting BMs are also interpreted in terms of archetypes, e.g., similar to approach used by Bocken et al. (2014). The research process can thus be summarized as generalizing initially individual BCs into coherent BMs. An additional step was the development of narratives for SME BCs representing identified good practice BM.

2.2. Data and methodology

The method for creating archetypes of business models can be summarized with following steps:

1. selection of BCs and collection of their data;
2. quantification of characteristics of BCs using keyword (“hashtag”) ratings;
3. dimensionality reduction of the keywords via principal component analysis;
4. CA of BCs according to principal components to create the taxonomy of BMs;
5. manual rearrangement of some BCs in clusters;
6. qualitative interpretation of the BMs of the clusters (taxonomy)
7. summarization the clusters into four archetypes

Data for the analysis was collected by project partners from seven countries participating in the project, i.e., from Norway, Sweden, Estonia, Latvia, Lithuania, Poland and Germany. The list of potential cases was formed by using desk research, partner and outside expert feedback.

The criteria of selection of BCs were set taking into account the objective of the project and FAO (2013) recommendations for selecting good practices, incl. transferability, feasibility, economic, social and environmental sustainability. As the focus of the project is on utilization of biomass, preferably biological waste, first criterion was the source of biomass from either agriculture and food industry, municipal waste and sewage, fisheries and algae or wood. The end output of the BC had to be either energy or various bio-based products. Thus, the envisioned types of BCs can be illustrated as a matrix where each row is a particular source of biomass and columns characterize types of production using these sources (Figure 2).

	Type of production		
Source of biomass	Energy production	Circular bioeconomy development	Production of non-energy high value added products
Agriculture and food industry			
Municipal waste and sewage			
Fishery and algae			
Wood			

Figure 2. Initially envisioned types of BCs by source of biomass and types of production

Information on the type of enterprise was collected, but whether the business activity was production or provision of services related to biomass was not relevant for final selection. BCs had to demonstrate economic, environmental or social benefits. Selected cases had to be feasible and transferable to other countries of the BSR. While it was imperative that the BMs would be applicable to SMEs, some BCs included were larger enterprises with some specific novel approach to biomass utilization.

The final number of included business cases was 59. Important aspect was to draw on the cases from different countries to better understand what kind of similarities the good practice BCs share and how this experience could be replicated elsewhere in the region. Each country from which the cases were collected was represented by 6–12 cases.

After the initial selection of cases, data on the enterprises and their activities was collected on each case by partners using desk research and interviews. The data was analysed and coded using initial selection criteria as categories for keywords and further specifying those so that more detailed categories could be developed (Table 4). Previously, Kuehl et al. (2015) and Engel et al. (2016) have used features from BMC (see section 1.5.) to quantify the characteristics of BCs. Our approach to quantifying BCs was more flexible and not strictly limited to the BMC framework. The codes/keywords were called “hashtags”. A total of 60 hashtags were divided into categories presented in Table 4.

For each case, ratings were given to all hashtags to describe how well this certain aspect characterizes particular BC. Thus, for each BC and each hashtag partners had to answer the following question: “To what degree the following hashtags (keywords) characterise this BC?”. Ratings were given on a 5-point scale (0-not at all, 1-to a little extent … 5-to a great extent). After this process, the ratings assigned by different experts were revised by a group of researchers and analysts in meetings to achieve better consistency of the ratings. The ratings were used in CA for creating the taxonomy of BCs. Some additional data on each business was collected that was not used for creation of the taxonomy, but was analysed later during qualitative interpretation of the BMs. This included data of BMs for the further analysis using BMC, as well as specifying technology readiness level, enabling policies and economic factors.

Table 4. Categories and keywords

1. Source of biomass	**2. Outputs/products**	**3. Environmental benefits**
# WoodyForestryBiomass # CultivatedPlantBasedBiomass # AnimalBasedBiomass # AgricultureResidues # Manure # AquaticBiomass # FoodResidues # MunicipalWaste # SewageWastewater	# DistrictHeating # HeatForIndustry # Electricity # LiquidFuelOrFuelGas # SolidFuel # Feed # FoodAndDrinks # Cosmetics # IngredientsForFarmaceuticals # IngredientsForNutraceuticals # BioChemicals # BioBasedTextiles # OtherBioBasedProducts # BiobasedFertilizer # Services	# Environment # SubstitutionOfFossil BasedResources # Biodiversity # CleanWater # PurificationCleaning # ReductionOfAirPollution # CarbonSequestration # SoilQuality # PlasticSubstitution # WasteReduction # LandscapePreservation
4. Type of enterprise	**5. Social and regional aspects**	**6. Policy aspects**
# CooperativeOrPartnership # SocialEnterprise # PrimaryProducer # Distributor # ProcessingCompany # ServiceCompany # InnovationKnowledgeCompany	# HumanHealth # Collaboration # SociallyAcceptable # SustainableJobs # BioenergyVillage # BeneficialForLocalEconomy # BeneficialForLocalCommunity	# RegulationDependence # InvestmentSubsidyDependence # OperationalSubsidyDependence
7. Aim of business	**8.Transferability**	**9. Novelty**
# DiversifiedBusinessModel # GoalIsProfit # GoalIsSustainability	# TransferabilityToSMESInBSR	# CircularBioeconomy # Novelty # HighValueAdded # IncreasedEnergyEfficiency

Due to the high number of hashtags relative to the number of BCs, reducing dimensions prior to clustering was deemed necessary. This was accomplished by a principal component analysis that reduced the hashtags into seven factors. The aim of the following CA was to measure the differences between each of the BCs in order to construct a taxonomy of these. To achieve this, agglomerative hierarchical clustering was implemented. This involved first measuring Euclidean distances between BCs where the dimensions were defined by the principal components calculated in the previous step. Then BCs were agglomeratively linked according to these distances using Ward's method of clustering. No weighting was applied to hashtags; thus, each keyword had an equal role in determining the distances between BCs. This resulted in a dendrogram (Figure 3) of BCs that can also be understood as a taxonomy. This dendrogram was then divided so that 12 clusters emerged. Thus, the average number of BCs in a cluster was five and each cluster included three to nine BCs.

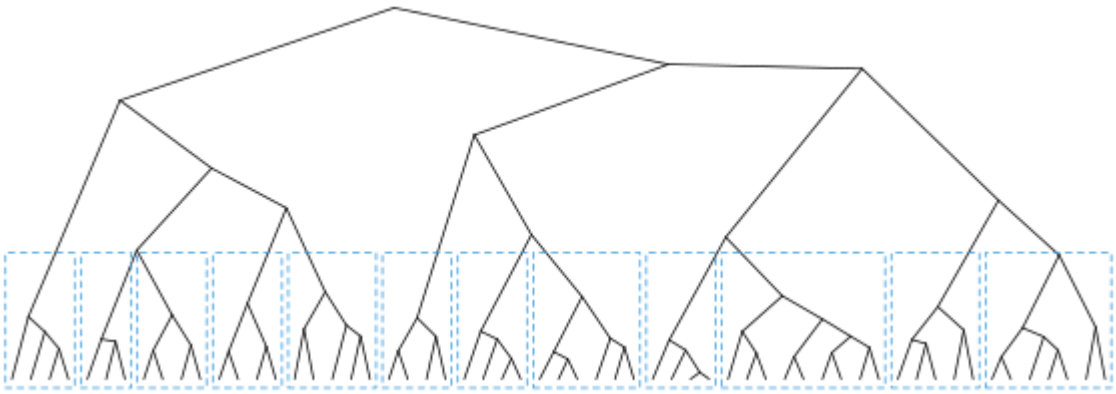


Figure 3. Dendrogram of the cluster analysis

A similar approach to assigning business cases to clusters has previously been adopted by Kuehl et al. (2015) with the exception of applying k-means clustering algorithm. Due to the arguably poor performance of their method, Engel et al. (2016) attempted to avoid conventional clustering methods. Instead of traditional hierarchical or k-means clustering, they calculated the differences between each case using the Jaccard coefficient for a binary measure of similarity. This could be interpreted as "matching score". Engel et al. (2016) defined a match of less than 89% between two business cases for them to be considered different and belonging to different clusters. This is comparable to the Euclidean distances calculated in our approach, with the exception that we used the number of desired clusters (12) to find a suitable threshold for distinguishing clusters. Unlike the two other described approaches, hierarchical clustering allows to visualise the formation of clusters as a dendrogram (Figure 3), thus providing a better understanding of how BCs and clusters are related.

The clusters were studied and compared and some BCs were manually reassigned into more fitting clusters according to suggestions by partners. This also resulted in the replacement of one cluster. The clusters were presented to partners during two consortium meetings: in November 2019 in Soltau and in March 2020 in Rostock. In Soltau meeting the methodology and ratings for hashtags were specified and tested. The feedback was used for the final clustering and the types were validated in the Rostock consortium meeting.

In the next step, clusters were examined in order to develop them into meaningful BMs. This was done by scrutinizing the arithmetic mean ratings for each hashtag in each cluster and comparing them. Because some hashtags had high or low ratings in all or most of the clusters, the mean ratings in each cluster were also compared to overall average rating of the hashtag. For example, one of the clusters had an average value of 5 for the keyword "Processing company" and 4.5 for the keyword "Innovation/knowledge company". This suggests that all or most of the cases in that cluster were involved with knowledge-based processing. Furthermore, the cluster had relatively high average ratings for the hashtags "cosmetics", "ingredients for pharmaceuticals" and "ingredients for nutraceuticals". While the overall average values for these hashtags were just 0.4, 0.3 and 0.9 respectively, in this cluster the average value for all these hashtags was 3.8. As a result, this cluster was defined as a BM representing "High-value Products from Knowledge-based Processing".

Following the logic explained in the example above, we were able to provide an interpretation to each of the 12 clusters so that a distinct and meaningful BM emerged from each cluster. This is in contrast to Kuehl et al. (2015) who attempted clustering a comparable number of BCs but could not achieve a "semantically sensible outcome" if more than two clusters were obtained from the clustering process.

After the creation of taxonomy of good practice BMs, the additional data collected on cases was studied and placed on BMC for each cluster. Data from individual cases was summarized and interpreted to emphasize the main elements of BM. The description of BMs is presented in the next section. These

taxonomy was presented during the aforementioned meetings in Soltau and Rostock. The presentations were followed by discussions where opinions and suggestions were collected. Thus, the good practice BMs were also validated by project partners. On the basis of the main value propositions and goals related to circular bioeconomy adoption, the 12 BM types were narrowed into four archetypes.

After the analysis of taxonomy of BMs, cases were selected from each type for a more detailed narrative of the business case. 20 cases were selected to represent different countries as well as BM types. Additional interviews were conducted with the enterprises. As the project aims to make use of already existing knowledge and create synergy with other ongoing EU projects, the project team contacted and coordinated their data collection with presently ongoing Horizon 2020 project RUBIZMO (2020)[1] that works on identifying BMs with high potential for empowering rural communities. Project team integrated the questions studied in RUBIZMO project to the interviews used for the narratives of business case. The narratives on business cases are presented in the Appendix 2. The narratives presented here summarize the background and development of the enterprise, their main activities related to bioeconomy, market and their innovative aspects.

[1] https://rubizmo.eu/

3. Taxonomy of Good Practices Business Models

The BM describes the logic of a business in a strategic view – what is offered to whom and how. The BMC of Osterwalder and Pigneur (2010) was used as a framework to compare the types formed in the CA. At first, data from each BC for particular type of good practice BM was used to fill the BMC. In the following steps, the data was examined, grouped and main features of particular BMC block were identified and interpreted in the abstraction process. The 12 types forming the taxonomy and their biomass inputs and outputs are presented in Table 5.

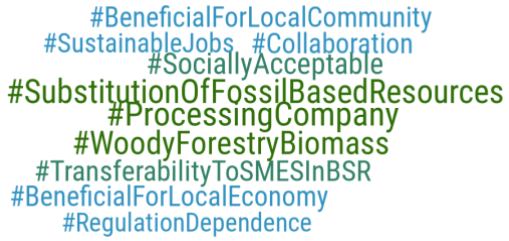
Table 5. Taxonomy of BM by the Source of Biomass and Type of Production

	Source of biomass				Type of production		
	Agriculture and food industry	Municipal waste and sewage	Fishery and algae	Wood	Energy production	Circular bioeconomy development	Production of non-energy high value-added products
1. Heat and Fuel from Woody Biomass	x			x	x		
2. Fuel and Electricity from Biogas	x				x	x	
3. District Heating and Electricity from Various Biomass Sources	x				x	x	
4. Specialized Heat and Electricity Production and Services		x		x	x		
5. Innovation in Novel Fuels and Bio-chemicals	x			x	x		x
6. Circular Bioeconomy in Agricultural Production	x				x	x	
7. Bio-based Fertilizer for Increased Soil Quality	x	x		x		x	x
8. Sustainable Bio-based Products from Plant-based Biomass	x			x	x	x	x
9. Sustainable and Novel Bio-based Products from Food waste and Biomass	x		x			x	x
10. High-value Products from Knowledge-based Processing	x		x				x
11. High-value Products from Circular Bioeconomy	x		x	x		x	x
12. Utilization of Municipal Waste and Sewage		x			x	x	

The names of BM types aimed to capture their main value proposition. Besides the BMC, the analysis of BMs presented below includes visualisation of ratings given to each BC in the BM type to illustrate how particular hashtags relate to the BM type and differentiate it from others. Additionally, word clouds are presented to quickly summarize the most distinctive traits of particular BM type. Socio-economic and novelty aspects of particular type briefly summarize the ratings presented in the more detailed charts according to the categories studied in Appendixes 1.1.–1.8.

3.1. Heat and Fuel from Woody Biomass

This BM type was formed by processing companies using woody biomass aiming to substitute fossil-based energy resources. More specifically, it represented two types of enterprises: companies that produce solid fuels from herbaceous biomass from forests and fields and/or companies that produce heat and fuel from this biomass with some of those involved in both activities of producing pellets and using those in their heating plants.



Value Proposition

The main **value proposition** is the replacement of fossil fuels in heat and thermal energy production with environmentally friendly biomass (wood, wood waste, sawdust, straw, dry grass, hay, reed) (Table 6). The fuel (wood chips, pales, pellets) is completely natural and sustainable, and in some cases, e.g., heat production from hay and reed, it is also cheaper compared to using fossil fuels. Biomass is collected from local fields and forests and used for local heating.

Infrastructure

The key partnerships are with biomass suppliers (farmers and local forest owners, wood industry). Cooperation with public authorities, such as the municipal owners of the heating infrastructure as well as end user of heating and fuel in municipal buildings, is required.. Policy-makers setting renewable energy targets and influencing access to investment supports have considerably affected the development of this field. Technology partners (suppliers of parts for the operation and maintenance of equipment), financial providers (e.g., banks, investors, environmental subsidies etc.) were mentioned as crucial relationships for running those companies.

Key activities for solid fuel and heat producers are somewhat different. The main activities of fuel producers are collection of biomass (two companies) and/or searching for places/companies for biomass acquisition, incl. participation in tenders for the purchase of biomass, storage, quality control and processing, organization of logistics of deliveries to final recipients. The main activities of heat producers are procurement and storage of heating material, energy conversion, and distribution. Some companies produce the fuel themselves and in the next step use it for their heating plants.

The necessary **key resources** are biomass (wood, wood waste, sawdust, straw, dry grass, hay, reed, wood chips, pales, pellets), equipment and technology for biomass production (incl. for logistics processing and packaging the product), heating plants and storage facilities (biomass warehouses and yards), distribution network (functioning district heating network). A competent staff are essential. Intangible resources are necessary know-how for production and on local markets.

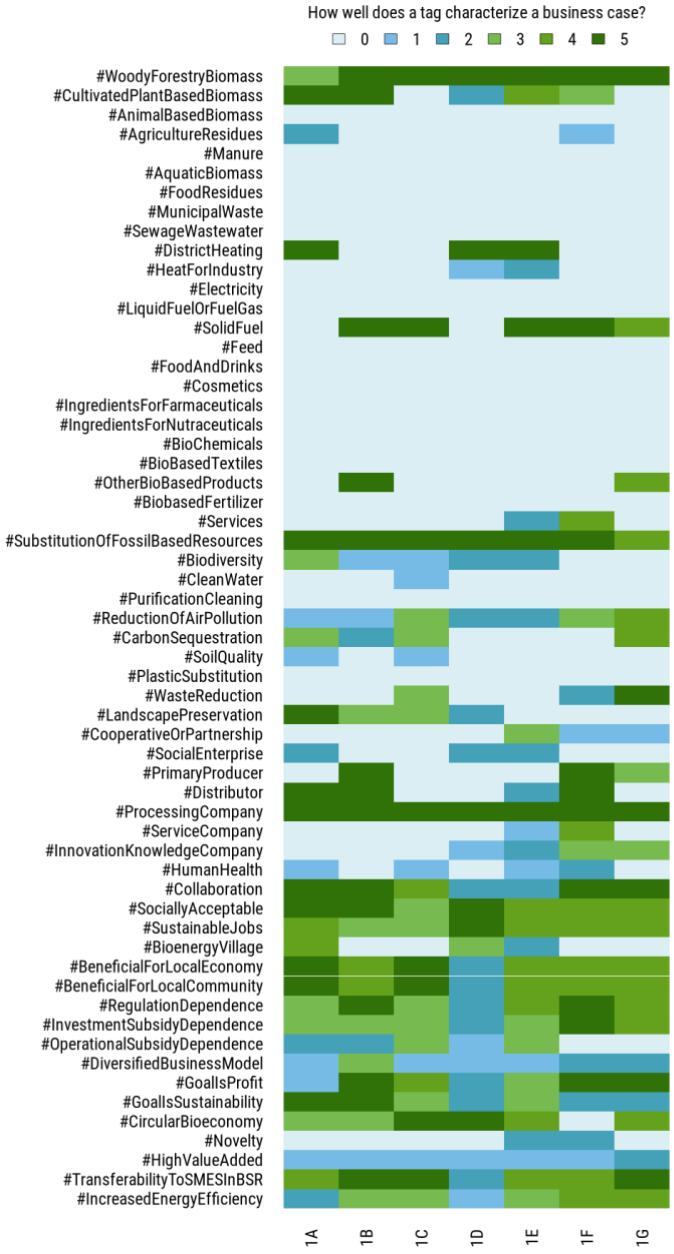


Figure 4. Keyword ratings for enterprises in the BM type of Heat and Fuel from Woody Biomass

Customer interface

Entrepreneurs have established close **customer relationships** through personal direct sales in internet and physical store as well as sales via intermediaries (particularly for pellets). Both short and a long-term contracts for the supply of biomass with energy producers and offer of spot (non-contractual) purchase of biomass were mentioned. The district heating network provides heat and thermal energy to the local community, close relationship with a limited and local group of consumers.

Customers include the central heating and thermal energy end users, including various public institutions and residential buildings, other businesses and private users of wood pellets and other products.

Customer segments of biomass fuel products are heat producers. Most of the pellets, wood chips, dry grass, hay and reed as well as wood residues for heating are used in combustion plants in schools, nursing homes, business buildings, hotels, district/local heating systems, large energy companies, municipal heat energy companies, local heating plants, individual homes. The pellets are also used in small boilers and pellet stoves. The niche market is by-products from the production (pellets and litter) that can be used for pet care and cooking (barbeque). Customers of heat producers are end users as well as potential new users of heating.

Customer channels include enterprise's own sales force, intermediaries in wholesale and retail networks and are different for different products. The fuel producers reach customers through participation in tenders and public procurement; through direct marketing both online and in physical stores or using intermediaries for selling pellets. Physical delivery takes place by road and rail transport. Heat sales depends on the access to local networks. District/local heating systems and municipal heat energy companies use local networks (hot-water pipes networks).

Table 6. BMC for Heat and Fuel from Woody Biomass BM type

<table>
<tr>
<td rowspan="2">Key partnerships
Forest owners
Farmers
Wood industry
Technology suppliers
Policy makers
Municipal authorities
Financial capital and services providers</td>
<td>Key activities
Collection of biomass
Procurement of biomass
Storage
Production of pellets
Heat production
Distribution
Marketing and sales</td>
<td rowspan="2">Value proposition
Replacement of fossil fuel-based heating and fuels with wood and biomass (wood, wood waste, sawdust, straw, dry grass, hay, reed) based products (pellets, wood chips, bales)</td>
<td>Customer relationships
Personal direct sales
Automated online sales
Long term supply contracts
Short term contracts</td>
<td rowspan="2">Customer segments
B2G, B2B, B2C
Municipal byers for municipal buildings (schools, nurseries etc.)
Large energy companies
Industry
Other business customers
Private persons</td>
</tr>
<tr>
<td>Key resources
Raw material (wood chips, low value wood, hay, straw)
Storage and production facilities
Equipment and technology
Heat distribution network
Logistics and transportation network
Staff
Know-how</td>
<td>Channels
Sales force
Online selling
Wholesale network
Retail network
Participation in supply tenders and public procurement
Delivery channels
Delivery by trucks and rail
Delivery through local heating and water infrastructure</td>
</tr>
<tr>
<td colspan="3">Cost structure
Raw material costs
Investment into the heating plants
Equipment and technology costs
Maintenance costs
Production costs
Distribution costs
Labour costs
Penalties for failing supply contracts</td>
<td colspan="3">Revenue streams
Sales of heat
Sales of pellets
Sales of by-products such as sawn wood products, bark, wood chips
Sales of services (logistics, distribution network, processing)</td>
</tr>
</table>

Financial viability

Costs are related to collection and purchase of raw/fuel material, processing the fuel from hay, reed and other raw materials, investments into the plants, their operating and maintenance, labour costs, transport

of biomass to the recipient, access to and the maintenance of heating distribution networks. Additional potential costs can be contractual penalties for failing in biomass supplies and amounts.

Revenue comes mainly from sales of heat or sales of pellets, wood ships and some cash-flow from selling by-products. In the cases of commercial power engineering and large heating plants, the value of the contract depends on the quality of biomass, most often expressed in the biomass energy value. For smaller installations, the contract value is the amount of biomass and the unit price. In addition, revenue stream includes services provided with own equipment. The revenue of district/local heating systems and municipal heat energy comes mainly from heat sales, but also from a connecting fee and a rental fee for hot-water pipes. Some of the companies provided logistics services for other biomass processors.

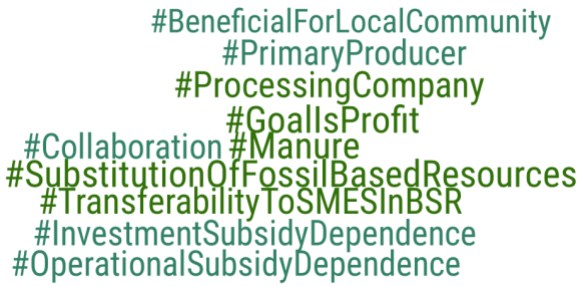
Socio-economic aspects and novelty

As described in the Output 2.2. of the project, pellet production is particularly important in the region as the countries of BSR include the largest pellets producers in the EU, and for three Baltic States and Poland, pellets are important export items (Stolarski et al., 2020).

The companies representing the BM valorise local knowledge and resources, thus serve local communities. The companies provide economic and regional benefits to the local population by providing stable employment. The use of biomass from local sources, incl. private forests and farms, supports regional economies more broadly. The companies in this type are typically specialised to one (e.g., pellet, wood chip production) or two activities (e.g., pellet production and heating). The policy dependency lies in access to investment supports that have been used for establishing the plants. The EU renewable energy targets have considerably facilitated the expansion of pellet production in the BSR in the last two decades.

The BM is easily transferable. The novelty of this BM and of companies is relatively low. There are examples of incremental product innovations, e.g., the case of Ecopellet presented in Appendix 2. The company has broadened the production from heating pellets to grilling pellets and bio-pellets for pets. The other BC presented is of Quercus Sp, a wood chip producer from Poland.

3.2. Fuel and Electricity from Biogas



The type is formed by processing companies aiming to replace fossil energy, but what sets it apart from the previous type that used woody biomass for solid fuels, is different biomass inputs and output of gaseous fuels as this type was formed on the basis of companies producing biogas from agricultural wastes such as slurry, manure and silage and using it for electricity, heat and selling compressed natural gas (CNG) for industrial and private customers. Three out of four companies in this type were established during the period from 2007 to 2016, illustrating more than threefold increase in the production of biomass based biogas in the BSR (Trømborg and Jåstad, 2019).

Value proportion

The main **value proposition** is to produce biogas for fuel and electricity from slurry, manure and silage collected from farms. The biomass is sustainable and renewable, production helps to address slurry and manure management in farms and provide consumers with lower priced energy. Digestate leftovers from fuel, heat and electricity production replace mineral fertilizers in agriculture.

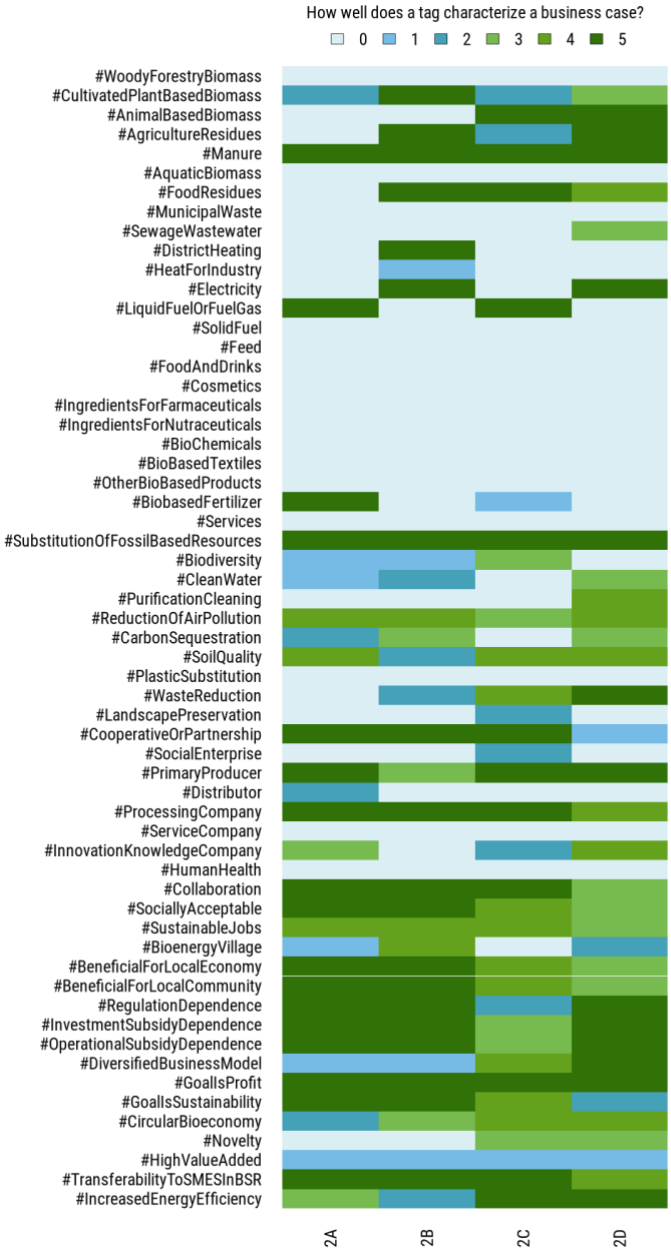


Figure 5. Keyword ratings for enterprises in the BM type of Fuel and Electricity from Biogas

Infrastructure

The upstream **key partnerships** include cooperation with farmers who are main biomass providers. In several cases, the farms providing the biomass were related companies. Relationships with operators of gas stations, owners of electricity infrastructure and district heating providers is required. Other partners include substrate and technology suppliers, financial capital providers. Municipal authorities setting requirements for construction of facilities, biogas use have considerable impact on the planning, infrastructure development and access.

Key activities are processing activities, starting with acquisition of cattle manure and maize silage from own production and other farmers, supply and storage of own and purchased/collected substrates, and preparation of slurry, silage and manure, production of biogas, heat and electricity. Main activities also

include distributing heat and electricity, cleaning raw biogas into biomethane and compression of biomethane and transportation to gas stations and industrial consumers.

The tangible **key resources** are raw material (slurry, silage and manure), biogas and biomethane production plants, equipment and technology, incl. collection container, compressing technology, cleaning device, fermenter, gas storage, combined heat and power (CHP) production equipment, digestate storage, equipment and vehicles for storage and transportation. Intangible key resources include staff and the technical and innovation know-how.

Table 7. BMC for Fuel and Electricity from Biogas BM type

<table>
<tr>
<td rowspan="2">Key partners
Farmers
Gas filling stations
Electric grid owners
Technology suppliers
Municipal authorities
Financial capital and services providers</td>
<td>Key activities
Collection and preparation of slurry, silage and manure Procurement of biomass
Production of biogas
Distribution
Marketing and sales of biogas</td>
<td rowspan="2">Value propositions
Biogas from agricultural wastes for fuel and electricity
Digestate as biofertilizer for farming</td>
<td>Customer relationships
Automated self-service stations
Personal direct sales</td>
<td rowspan="2">Customer segments
B2B, B2C
Biogas
Industry
Regional public transportation companies
Electricity and heating companies
Users of CNG vehicles
Local residents using heating and electricity

Digestate
Farmers</td>
</tr>
<tr>
<td>Key resources
Raw material (slurry, manure, silage)
Biogas production plant
Distribution network
Equipment and technology
Staff
Know-how</td>
<td>Channels
Own filling stations
CNG filling stations of other intermediaries
Natural gas pipelines
Local heating infrastructure
Local electricity infrastructure</td>
</tr>
<tr>
<td colspan="3">Cost structure
Investment into biogas plant
Equipment and technology costs
Production costs
Maintenance costs
Distribution costs
Labour costs
Environmental taxes</td>
<td colspan="2">Revenue streams
Biomethane sales
Government subsidies
Sales of digestate as biofertilizer
Cost reduction from waste utilization</td>
</tr>
</table>

Customer interface

The enterprises established their **customer relationships** via operators of gas stations, electricity energy suppliers and industrial consumers. Gas stations are automated self-service stations. Personal direct sales are used for certain industrial customers and for selling digestate.

The customer segments included electricity and heating companies that provide respective infrastructure and energy suppliers. Other customers include industry and transportation companies. The end users of the products are persons using biogas powered vehicles, local residents buying directly their electricity and heating in some cases, industrial consumers that use biomethane to replace natural gas, and agricultural producers using digestate.

The distribution channels depend on connection with existing electricity grid, heating network and fuel stations. Enterprises use their own filling stations and sell through channels owned by other actors.

Financial viability

The cost structure included investment in to equipment and technology and construction of biogas plant, biogas and other production costs, maintenance costs of the CHP equipment, transportation costs, personnel costs, and certain activities were also subject to environmental taxation in some countries.

The revenue stream comes from the sale of products (gas, electricity and heat), subsidies for renewable energy production, sales of the digestate and cost reduction on fertilisers used in own farm, income from better utilisation of waste and raw materials.

Socio-economic aspects and novelty

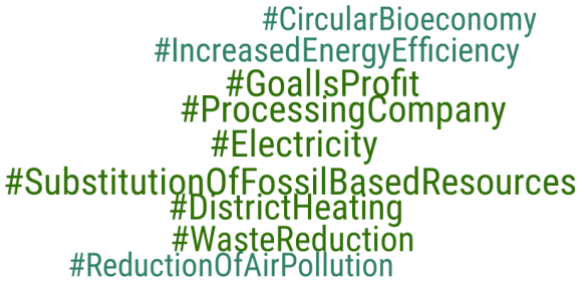
A notable environmental and social aspect of these businesses is the reduction of odour pollution in the local community. Digestate or high-quality fertilizer, a by-product of biogas production, is used to fertilize arable land instead of raw manure, thus supporting development of more circular production. The environmental benefits also include waste reduction, use of renewable biomass, increased energy efficiency.

The positive economic impacts for the local communities include employment, facilitation of local entrepreneurship, regionally more balanced development that utilizes local resources and cooperation with local actors (farmers as biomass providers). However, the BMs of those companies are very policy dependent, as energy policies and their bioenergy targets and related measures on investment subsidies for biogas plants have affected the investments into biogas plants and related gas distribution infrastructure. The companies in this type were mostly specialised to biogas production, although in some cases the slurry provider was a sister company in the same corporate group.

Novelty of BM is relatively low and BM is easily transferable but dependent on regulations and investment policies.

3.3. District Heating and Electricity from Various Biomass Sources

The BM type is based on five enterprise that use waste and other various sources of biomass for production of heat and electricity and bioethanol (one company). It is set apart from other BMs as it includes the enterprises that establish their own biomass plantations, but also enterprises that buy a wider variety of the biomass and biowaste for processing and their output is heating and electricity for local districts.



Value proposition

The main **value proposition** is use of various sources of biowaste and biomass (from slaughterhouses, slurry, manure, silage, maize, beet, etc.) to produce heat, electricity, biogas, digestate and fertilizers for local districts. The enterprises reuse nutrient rich waste, contribute to significant biomass yield improvement on marginal lands and to production of renewable biomass energy at a competitive price.

Infrastructure

The upstream **key partnerships** include the raw material suppliers (farmers, landowners, and bioethanol plant), technology suppliers. Municipal authorities impact the planning and regulations for the production, and district heat and electric grid owners impact the access to the infrastructure the companies need for the BM to work.

Key activities are connected with establishing the plantations, collection or purchasing the biomass and biowaste, processing activities, selling the electricity and heat. Digestate is separated during processing by screw presses and dried.

The tangible **key resources** are land for biomass, raw material (biowaste, cattle slurry, whole plants silage, maize, sugar beets, etc.), equipment and technology for production. Staff and intangible key resources such as the technical competence and knowledge are required.

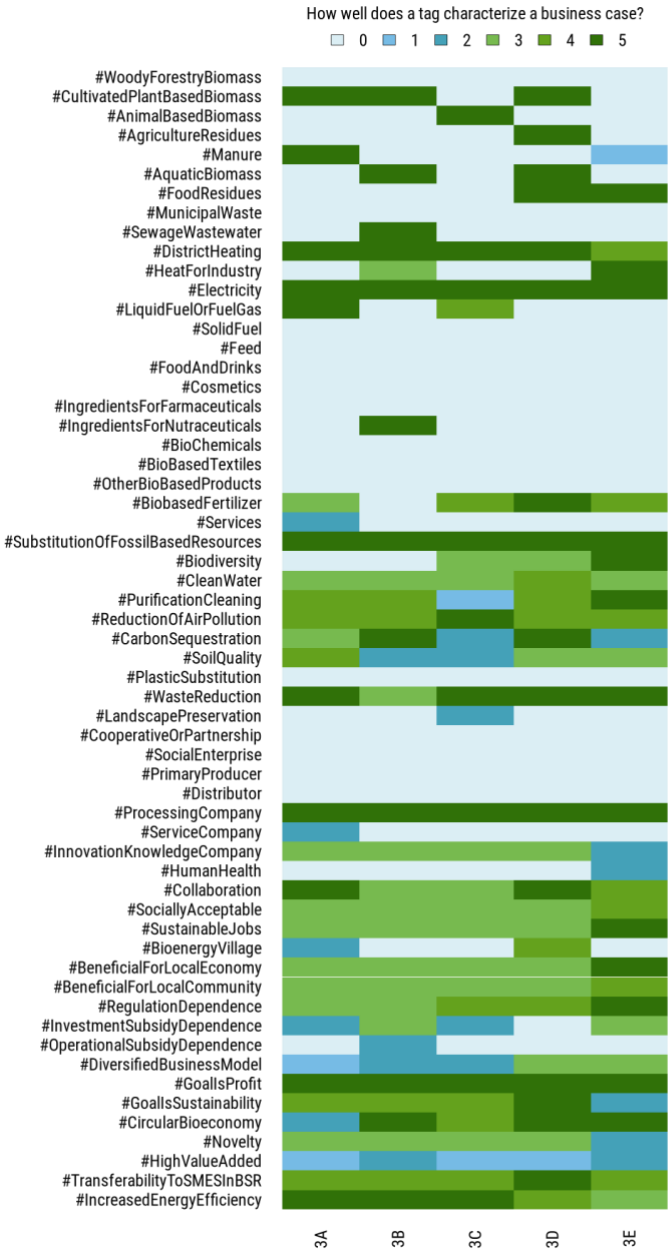


Figure 6. Keyword ratings for enterprises in the BM type of District Heating and Electricity from Various Biomass Sources

Customer interface

The enterprises establish their **customer relationships** by direct contacts, by sales force establishing mostly long-term contractual B2B relationships.

The **customer segments** included local settlements (heat and electricity for local districts), farms and national electricity distribution network. Farmers are customers for the digestate from the biogas production.

For **customer channels**, the national distribution grid is used for selling electricity, while heat is sold to the customers by local heat distribution piping. Digestates and fertilizers are delivered by mobile transport. Contacts with customers are created by enterprises' sales force as well as by intermediaries.

Financial viability

The cost included investment in land, harvesting and processing the biomass, raw materials costs, establishment of biogas plant, technology and equipment, maintenance and transportation costs as well as costs related to dealing with sludge, digestate and biomass ashes, and labour costs.

The revenue stream comes from the sale of products (electricity, heat, digestates and fertilizers).

Table 8. BMC for District Heating and Electricity from Various Biomass Sources BM type

<table>
<tr>
<td rowspan="2">Key partners
Landowners
Farmers
Biogas and wastewater treatment plants
Technology suppliers
Municipal authorities
Electric and heat grid owners</td>
<td>Key activities
Establishment of biomass plantations
Collection of biomass
Procurement of biowaste and biomass
Production of heat, electricity, biogas
Sales of heat and electricity
Sales of digestate</td>
<td rowspan="2">Value propositions
Heat, electricity and biofuels for local area from various sources of biowaste and biomass with utilization of marginal lands
Digestate and biofertilizers for local farming</td>
<td>Customer relationships
Personal direct sales</td>
<td rowspan="2">Customer segments
B2B, B2C
Heat and electricity
Electricity and heating companies
Local residents

Bioethanol
Industry

Digestate
Farmers</td>
</tr>
<tr>
<td>Key resources
Marginal or infertile land for biomass plantation
Raw material (variety of biomass and biowaste)
Biogas production plant
Equipment and technology
Staff
Know-how</td>
<td>Channels
Sales force
Intermediaries
Delivery
District heating grid
National electric grid</td>
</tr>
<tr>
<td colspan="3">Cost structure
Land costs
Biomass plantation establishment costs
Raw material costs
Equipment and technology costs
Harvesting costs
Production costs
Maintenance costs
Distribution costs
Costs of spreading sludge, digestate and biomass ashes
Labour costs</td>
<td colspan="2">Revenue streams
Sales of heat
Sales of electricity
Sales of bioethanol
Sales of digestate
Cost reduction from waste management</td>
</tr>
</table>

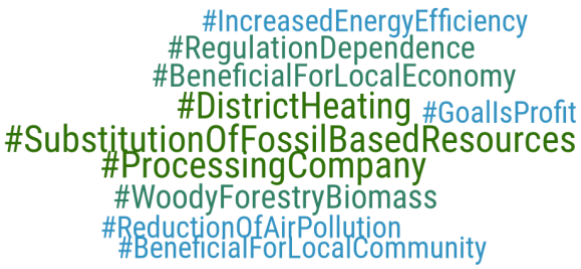
Socio-economic aspects and novelty

The social benefits of those companies include creation of new jobs in rural areas and development of regional supply chains for heat and electricity, and strengthening rural areas by promoting decentralized bioenergy production plants. The environmental benefits relate to reduction of air and water pollution and waste reduction, development of circular production. The BM itself is transferable. The regulation dependence lies in the local and national regulation and policies for heat and electricity grid access, prices and bioenergy targets.

The novelty of companies is at an average level. The novelty lies in incremental changes in production technology and processes. This is illustrated by the BC described in Appendix 2. The BC of UAB Kurana demonstrates a company that was the first company inside EU to connect manufacturing of bioethanol, electricity and thermal energy from renewable energy sources into one closed technological loop. This technological loop produces zero waste plus valuable organic fertilizers that are becoming more and more popular in contemporary farming. The BC of 3B Bioenergie represents biogas producer utilizing novel technological solution for processing digestate.

3.4. Specialized Heat and Electricity Production and Services

This type was formed by seven enterprises specializing in district heating. This type is set apart from the others as it is formed by larger heat and electricity service providers partially operating the grids and being major distributors. The companies also buy biomass based solid fuels for inputs from other types.



Value proposition

The main **value proposition** is providing residents with high quality and low-cost network bioenergy (thermal energy) in the form of hot water or steam. The sustainable biomass-based energy production replaces fossil fuel-based energy production. Ash from bioenergy production is used as a soil improver (amendment).

Infrastructure

The upstream **key partnerships** include companies involved in the production and supply of biomass for energy (wood industry). Important aspect is long-term contracts with woodchip suppliers to provide a stable supply for production inputs. Other key partnerships are formed with wood and biomass logistics companies, technological partners - suppliers of components for the construction and operation of technical elements of the heating system and heating nodes, financial providers (e.g., investors, national funds specializing in environmental protection and water management projects, subsidy providers etc.) and municipal authorities regulating the field and tariffs.

Key activities are purchase of biomass (wood chips, waste and residues), biomass supply, storage and handling for heat and/or biogas production, selling/distribution of electricity and heat, heat network arrangement and selling the digestates and fertilizer, attracting new customers for heat and other products.

The tangible **key resources** are raw material (biomass, waste and residues), equipment (for heat production, CHP and condensing economizer), and infrastructure (storage area for biomass, distribution network), the plants. Intangible resources are staff, their technical know-how on operating the plant, experience and know how on the biomass market and knowledge of their customers and arrangements on the tariff for power production.

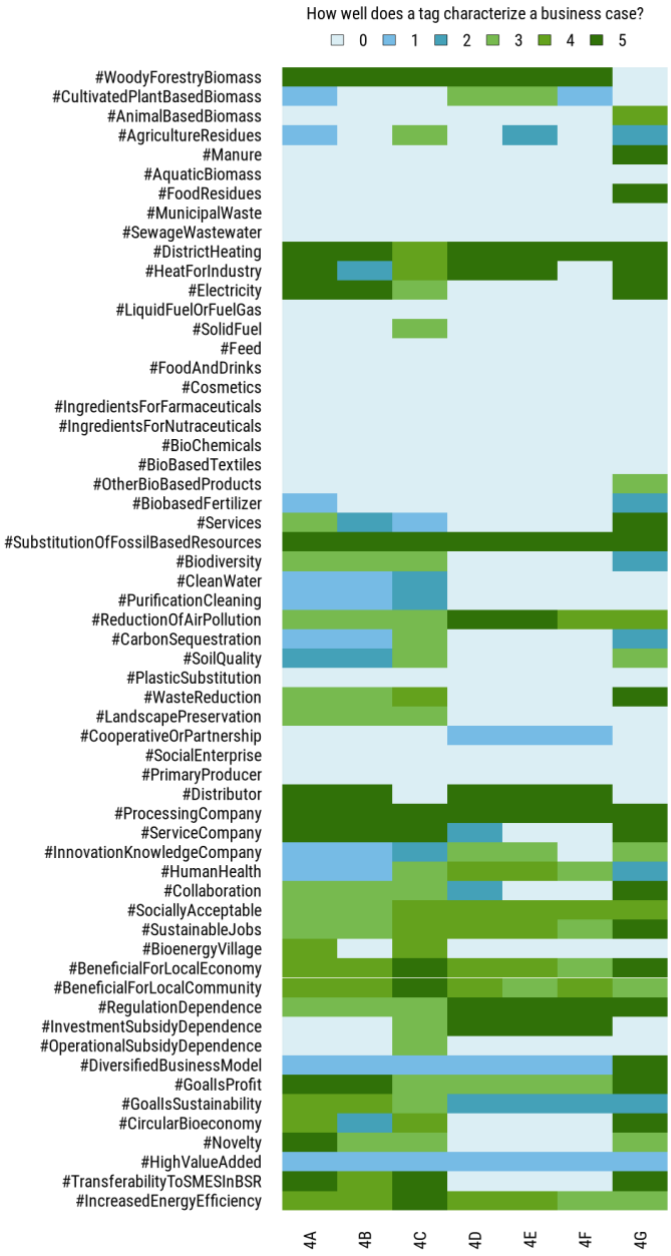


Figure 7. Keyword ratings for enterprises in the BM type of Specialized Heat and Electricity Production and Services

Customer interface

The enterprises establish their **customer relationships** through personal direct sales in online or physical locations and contracts with customers are multiannual agreements.

The **customer segments** are very wide: local private customers (B2C), but also public bodies (incl. B2G) in the area. Municipal and private housing sector (housing associations, multi-family buildings, single-family houses), public institutions e.g., (hospitals, colleges, schools) and private organization

(commercial buildings, shops, etc.). The distribution network typically belongs to the state (electricity distribution network) or local government (district heating network).

The distribution channels include the national distribution grid for electricity. Heat is sold to the customers by local heat distribution pipelines and nodes, digestate is distributed by mobile transport.

Table 9. BMC for Specialized Heat and Electricity Production and Services BM type

<table>
<tr>
<td rowspan="2">Key partners
Wood industry
Technology suppliers
Logistics companies
Municipal authorities
Electric and heat grid owners
Financial capital and services providers</td>
<td>Key activities
Procurement of biomass
Production of heat and electricity
Maintenance of distribution network
Sales of heat and electricity
Sales of digestates and fertilizers</td>
<td rowspan="2">Value propositions
High quality network heat from renewable biomass for local residents and businesses.
Ash for soil improvement</td>
<td>Customer relationships
Personal direct sales
Long-term contracts for heat supply</td>
<td rowspan="2">Customer segments
B2C, B2B, B2G
Heat and electricity
Municipal byers for municipal buildings (schools, hospitals, nurseries etc.)
Other business customers
Local residents using heating and electricity

Fertilizers
Farmers</td>
</tr>
<tr>
<td>Key resources
Raw materials (biomass, waste and residues)
Energy and heating plants
Distribution infrastructure
Equipment and technology
Staff
Know-how</td>
<td>Channels
Sales force
Delivery
National electric grid
District heating grid</td>
</tr>
<tr>
<td colspan="3">Cost structure
Raw material costs
Investment into the plant
Production costs
Maintenance costs
Distribution costs
Waste (ash) disposal costs
Labour costs
Environmental taxes</td>
<td colspan="2">Revenue streams
Sales of heat
Sales of electricity
Sales of fertilizers
Revenues from green energy projects</td>
</tr>
</table>

Financial viability

The cost structure included biomass costs (purchase and storage), investment costs, maintenance costs of equipment, piping and nodes, transportation costs (ash disposal), personnel costs, environmental taxes.

The revenue stream comes mainly from the sale of heat and electricity; while smaller revenues come from selling digestates and fertilizers, and in some enterprises also from planning and organizing green energy projects, their development, investments and constant maintenance. District heating revenues are subject to local regulation and tariff approval by national or local authorities.

Socio-economic aspects and novelty

The main economic benefits are the creation of local jobs and supporting of regional economy through use of local biomass, provision of heat and electricity services for local population and industry.

Environmental benefits are connected with the reduction of air pollution, more efficient use of energy and waste. Companies uphold local values by using existing knowledge and resources while serving local communities. The BM is transferable, but it also depends on the characteristics of the particular location and its grid infrastructure. The BM is heavily policy and regulation dependent. This type includes large and specialised district heating providers and those companies are the main subjects of the EU and national bioenergy policy targets requiring adjusting their BMs. This is demonstrated with the BC of Przedsiębiorstwo Energetyki Cieplnej, a Polish company shifting its production form coal use towards biomass use.

The novelty of companies is low and lies mainly in shifting from fossil fuel-based energy production towards renewable biomass-based energy production and in increasing the automation and efficiency of production.

3.5. Innovation in Novel Fuels and Bio-chemicals

The type is formed by three enterprises that are in the process of developing novel fuels and biochemical products from wood industry residues, wood and plant biomass. The type is set apart by high R&D intensity. The enterprises in this type include those working with plant protein for food industry for vegetarian and vegan foods and for application in the cosmetics industry, where the raw material can be used for development of new natural emulsions and creams. Other enterprises included into this type work on developing variety of biochemical products (biodiesel, bioplastics, resin, heating oil, turpentine).

Value proposition

The main **value proposition** is innovative and sustainable biomass based (plant parts and other green plant material that is not currently used but remains in the fields after the harvest, by-products in the forest industry) fuel and bio-chemical products (biodiesel, bioplastics, resin, heating oil, turpentine, plant protein products).

Infrastructure

Because of the high R&D intensity, the **key partnerships** are formed with universities and other R&D institutions, technology providers and fuel and wood industry actors in order to develop the innovative products. Besides those, cooperation with different funding organisations as well as biomass providers is required.

Key activities are R&D and technology development as well as processing (the technical and chemical process of refining rest products into biodiesel, the process of making bio-oil, processing plant proteins, and sales of those products. For some of those enterprise, crucial aspect is to scale up the business and creating profitability as well as demonstrating the business potential of R&D outcomes and BM to other stakeholders and investors to achieve strong growth and market diffusion.

The most important **resources** are intangible: specific technical and chemical process knowledge and the know-how regarding the refining process and the divided ownership.

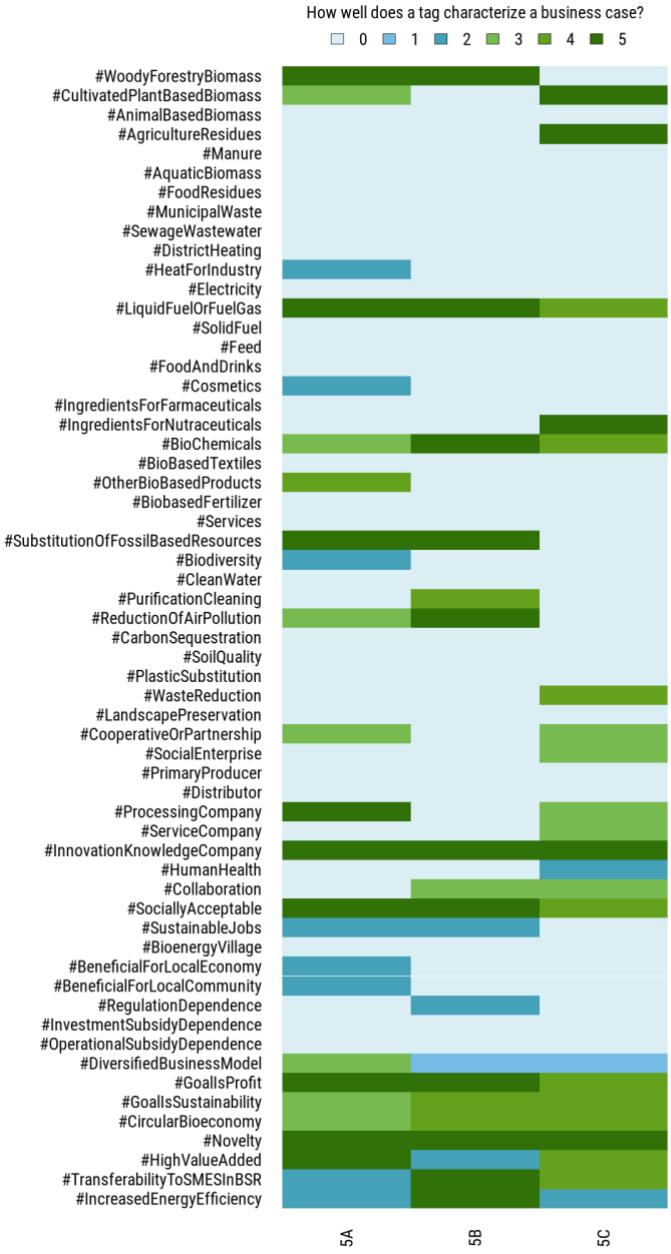


Figure 8. Keyword ratings for enterprises in the BM type of Innovation in Novel Fuels and Bio-chemicals

Customer interface

At present, the **customer relationships** are based on direct personal contact, but product development also is based on co-creation as the R&D process requires cooperation from wood and fuel industry and other actors.

The main focus was on B2B sales and **customer segments** included variety of customers on the world market (from biodiesel to perfume): fuel companies, food industry, and cosmetic industry.

For **customer channels**, enterprises use their own sales force to create contacts with variety of food, fuel and other industry actors, who will be the intermediaries for the end consumers (private persons).

Table 10. BMC for Innovation in Novel Fuels and Bio-chemicals BM type

<table>
<tr>
<td rowspan="2">Key partners
Wood industry
Other biomass suppliers
R&D organisations
Fuel industry
Technology providers
Financial capital and services providers</td>
<td>Key activities
R&D
Scaling up
Technology development
Production
Marketing and sales</td>
<td rowspan="2">Value propositions
Wood and plant biomass based novel fuel and biochemical products for fuel, food and cosmetic industry</td>
<td>Customer relationships
Personal direct sales
Co-creation</td>
<td rowspan="2">Customer segments
B2B
Fuel industry
Food industry
Cosmetics industry</td>
</tr>
<tr>
<td>Key resources
Research knowledge
Technical know-how
Market knowledge</td>
<td>Channels
Sales force
Intermediaries</td>
</tr>
<tr>
<td colspan="3">Cost structure
R&D cost
Equipment and technology costs
Investment in the processing plant
Production costs
Maintenance costs
Labour costs</td>
<td colspan="2">Revenue streams
Sales of products
R&D grants</td>
</tr>
</table>

Financial viability

The costs are related to the development of innovative production process and technology, building plants and production and labour costs. For some of those enterprises, in the current phase the main difficulty is achieving profitability and demonstrating the business potential and scalability of the BM.

Revenue will come from the sales of the products, but also from R&D grants from variety of sources that help to cover the cost of product development.

Socio-economic aspects and novelty

The regional and community impact of the companies is relatively small. The companies employ relatively small number of highly-paid knowledge workers for high-value added product development. The transferability of BM will depend on the access to knowledge resources and labour as the competitive advantage of the companies lies in the combination of specific in-house knowledge and external knowledge and capital network relations that may be hard to replicate. The regulation dependence is low in comparison with other types. The renewable energy policies encourage the R&D, but typically companies in this type are not subject to investment or operation subsidies, although companies benefit from public research funding opportunities.

The novelty of the companies in the cluster is very high with high potential for creating radical product and process innovations. The BC of SunPine, a Swedish bio-refinery, represents this BM type in Appendix 2.

3.6. Circular Bioeconomy in Agricultural Production

The type is formed by seven agricultural producers that apply principles of circular production in their resource and waste use in their own production facilities. Enterprises in this group are primary producers themselves and this sets this type apart from other types in case of which enterprises used the biomass as inputs, but did not produce it themselves.

#BeneficialForLocalCommunity
#SociallyAcceptable
#Manure
#TransferabilityToSMESInBSR
#PrimaryProducer
#GoalIsProfit
#SoilQuality
#AgricultureResidues
#SubstitutionOfFossilBasedResources

Value proposition

The main **value proposition** is producing food, fertiliser and energy by circular bioeconomy methods/approaches in agricultural production. It means sustainably and environmentally friendly produced agricultural and food products, fertilizer and bioenergy (biogas, heat and electricity). Enterprises in this group produce milk, meat, grain, fish, and feedstuff sustainably and are reusing their waste and biomass for bioenergy and fertiliser production.

Infrastructure

The key partnerships the enterprises depend on are companies involved in the production and supply of machinery and means of production and financial providers (e.g., banks, subsidies). Cooperation with knowledge organisations such as universities and their extension services for development of projects and changing the BM by adding the side activities for circular production was also mentioned. For those selling their bioenergy, the access to electric and local heating grid is required.

Key activities are quite different and depends on the profile of the enterprise and area in which the circular economy is developed. The enterprises are characterised by diversified activities in order to develop a circular economy. Those includes plant and animal husbandry, production of food products, production of biogas from manure or silage, production of heat and electricity from biogas, distributing and biofuel, utilizing the digestate by producing organic fertilizer. For those activities, production from harvesting, storage, transport, and marketing and delivery activities are carried out. Several companies integrated their production with services, incl. agricultural services and non-agricultural services (tourism, catering, and shops).

The tangible **key resources** are agricultural land, raw material (own produced manure, silage), farm buildings, equipment and machinery for agricultural production, reception of waste, biogas plants and storage facilities for the product in various stages of production. Intangible key resources include the technical and innovation competence and knowledge and educated staff with leadership qualities to manage this kind of operations and side activities.

Customer interface

The enterprise established **their customer relationships** through direct sales in internet and physical store as well as sales via intermediary stores. As the enterprises produced different produce, processing some onsite, very different relationships and marketing and sales activities were mixed (direct selling some of products, raw material inputs for others).

The main focus was on B2B and B2C sales in both local area and outside, and **customer segments** included private individuals, wholesalers and retailers (farmers, florists, and nurseries), truck and other logistic companies as biogas customers, food and cosmetics industries for raw materials, electricity and gas industry. B2G sales were mentioned in connection with selling energy to municipal buyers.

The channels through which customers are reached are mixed as both direct and enterprise owned channels (direct personal sales, farm shops, online selling) were mixed with distribution through partner

owned retail and wholesale networks, food companies (milk, meat, fish products), local government (electricity production) and through filling station.

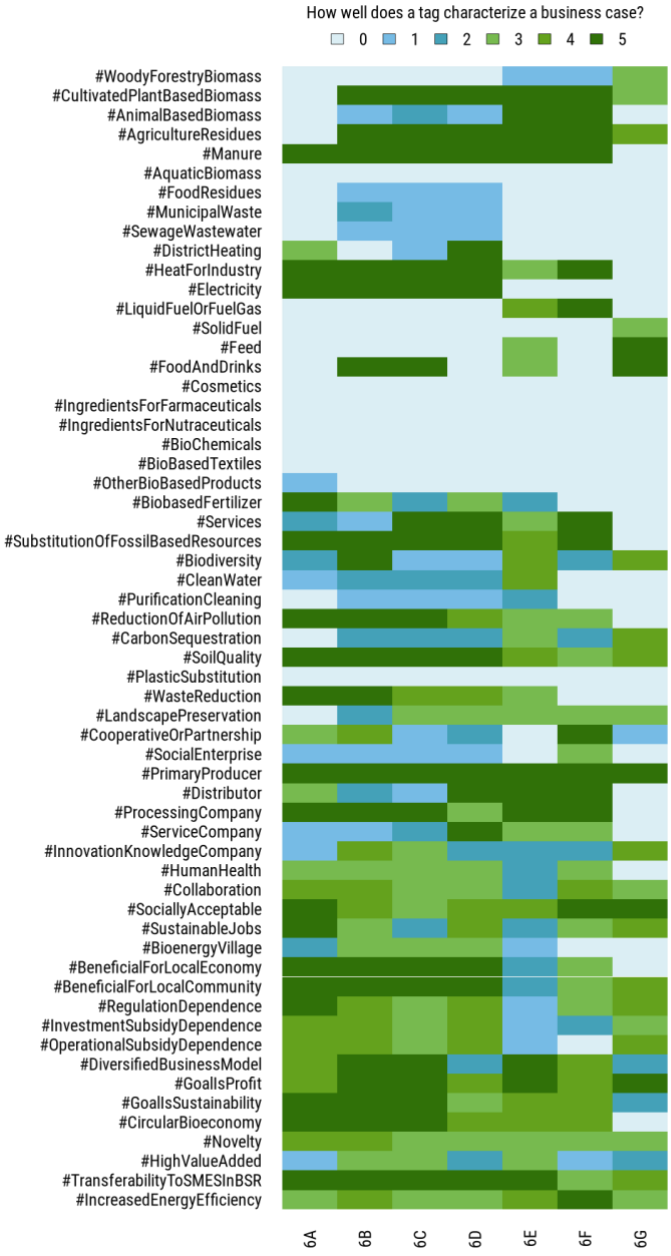


Figure 9. Keyword ratings for enterprises in the BM type of Circular Bioeconomy in Agricultural Production

Financial viability

The cost structure is divided between several different activities which reduces the overall cost. The costs include land costs, production costs of crops and animal husbandry, production costs for biofuel (biogas, electricity), investments in the biogas plants and operating it, costs of servicing of the machinery and equipment, costs of personnel, transportation costs.

The revenue stream is diversified and comes from the sale of products (biomass, electricity, heat and fertilisers, food products), from different services and state guaranteed payment for electricity produced, reduction of waste management costs.

Table 11. BMC for Circular Bioeconomy in Agricultural Production BM type

<table>
<tr>
<td rowspan="2">Key partners
Technology providers
Financial capital and service providers
R&D organisations
Electric and heat grid owners</td>
<td>Key activities
Production of diversified crop and animal produce
Production of heat, electricity, biogas
Sales of animal and crop produce
Sales of digestate
Sales of heat, electricity, biogas
Distribution</td>
<td rowspan="2">Value propositions
High quality food, fertiliser and energy products by circular production in agriculture</td>
<td>Customer relationships
Personal direct sales
Automated online sales</td>
<td rowspan="2">Customer segments
B2B, B2C, B2G
Produce
Private persons
Wholesalers
Retailers
Food industry
Cosmetics industry
Biofuels
Logistic companies
Biogas
Municipal byers for municipal buildings
Electricity and gas companies
Fertilizers
Farmers</td>
</tr>
<tr>
<td>Key resources
Agricultural land
Raw material
Biogas plants
Storage and production facilities
Equipment and machinery
Technical know-how
Staff</td>
<td>Channels
Sales force
Online selling
Intermediaries
Wholesale network
Retail network</td>
</tr>
<tr>
<td colspan="3">Cost structure
Land costs
Investment into the biogas plants
Equipment and technology costs
Harvesting costs
Maintenance costs
Production costs
Distribution costs
Labor costs</td>
<td colspan="2">Revenue streams
Sales of agricultural produce
Sales of biomass
Sales of biogas
Sales of fertilizer
Sales of electricity
Sales of variety of services
Reduced costs for waste management</td>
</tr>
</table>

Socio-economic aspects and novelty

The companies provide variety of social and economic benefits for both the local community and the local economy. The companies directly create variety of different jobs with their diverse activities in local area, facilitate local economy by purchasing local biomass, producing and selling produce, energy and services. The shift from primary production of raw materials towards processing of higher value-added products and sales provides opportunities to capture more value from the production. The environmental benefits include highly circular production minimising waste, use of renewable biomass to replace fossil- fuels based inputs in production process. The BM is transferable. The business activities are highly diversified. As the companies are agricultural producers, the companies receive agricultural subsidies, thus are dependent on subsidies and related regulation and investment opportunities.

The novelty of companies is at an average level and lies in combining different activities and products in new ways that maximise the utility of each. Self-produced and locally sourced biomass is recycled. Biomass is converted into products that are used again in the company as a production input for other

activities. The BC presented in Appendix 2 include Energifabriken, a biofuel processor that operates the value chain from fossil-fuel free production of raw material at farm to processing and sales of the biofuels. BC of Ziedi JP demonstrates integration of agricultural production with biogas and fish production in order to utilize each activity and minimize waste. The BC of Wapnö Farm provides an example of diversified sustainable BM that integrates dairy and crop production, forestry, processing, sales and marketing activities while focusing on sustainable production, animal welfare, openness to consumers and reduction of energy consumption.

3.7. Bio-based Fertilizer for Increased Soil Quality

This cluster is based on four enterprises that specialize in producing compost, biofertilizers, soil improvement products from waste as well as providing know-how, technology and infrastructure for this production.

Value proposition

The **value** offered to customers is biodegradable waste and fertilizers for improving soil quality and according to the requirements of the customers. Enterprises offer a mix of products (compost, fertilisers, and soil and crop care products) and related services in form of consultations, training, and technology. Products and services help to deliver more efficient, environmentally friendly and profitable ways for using bio-waste.

Infrastructure

The key partnerships are from private sector (raw material suppliers, waste collectors, farmers). Public sector regulates the waste use. Technology providers and international and local industrial partners as well as universities and research centres impact the product development and distribution. These partners, both from industry and academia are global players within recycling, waste processing, forestry and agriculture. Products are developed and evaluated in cooperation with research organisations.

Key activities are producing and selling products (composts and fertilisers) and offering services (garden and park green mass waste collection, waste transport, landfill diversion, mobile brush chipping), consultancy and training. Knowledge development and network for sourcing and distribution are important also.

The tangible **key resources** are raw material, equipment and technology for waste collection and production and skilled staff. Intangible key resources include the patents, market, and technical and innovation know-how, networks for biomass collection, R&D and marketing.

Customer interface

The enterprises established their **customer relationships** mostly through personal direct (contractual) sales. Production of products has to meet the needs of specific customers. Customers using the collection service might also use the products. The main focus was on B2C and B2B sales and **customer segments** included farmers, gardeners, florists, garden centres and public entities. **The channels** through which customers are reached were enterprise owned channels – sales force using both physical store as well as online sales.

Financial viability

The cost structure includes operating costs of the machinery, production costs, maintenance of infrastructure and distribution, personnel costs and R&D.

The revenue stream comes from selling the different products to the various market segments – organic fertilizers, soil additives, as well as biorefinery packages etc., and waste utilization services and consultancy and training fees.

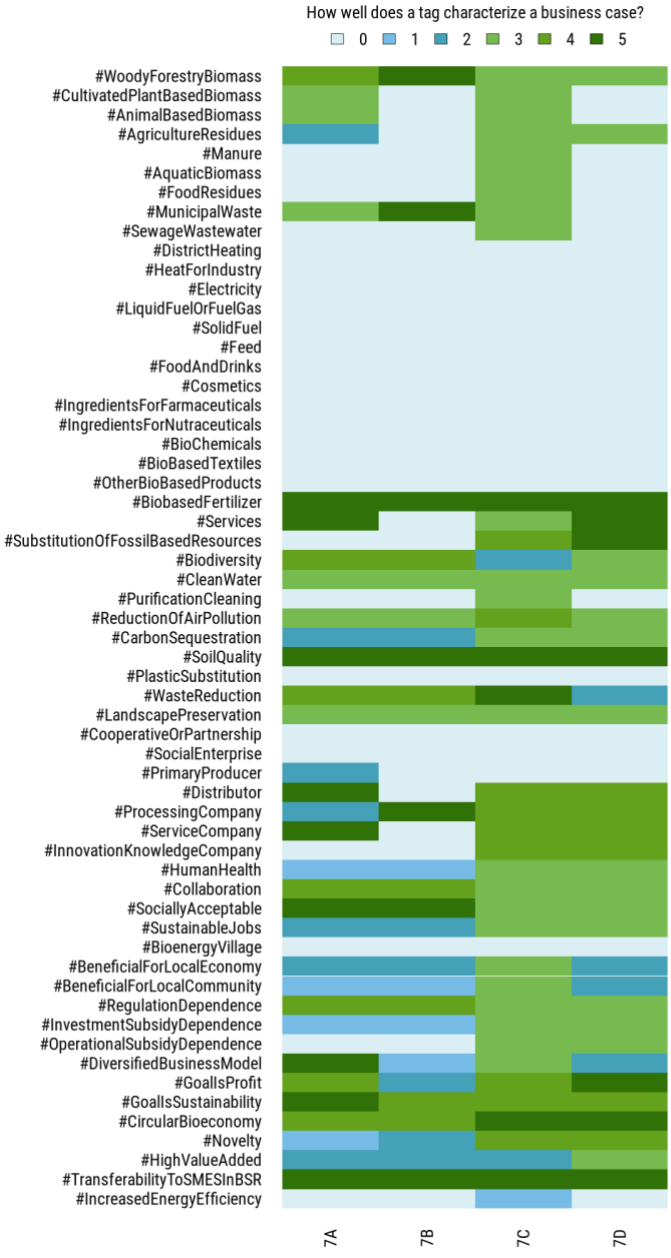


Figure 10. Keyword ratings for enterprises in the BM type of Bio-based Fertilizer for Increased Soil Quality

Table 12. BMC for Bio-based Fertilizer for Increased Soil Quality BM type

<table>
<tr>
<td rowspan="2">Key partners
Farmers
Waste collectors
Technology providers
Industry
R&D organizations
Regulatory authorities</td>
<td>Key activities
Production of composts, fertilizers and other products
Waste collection and transportation
Consultancy and training activities
R&D
Distribution
Sales of compost, fertilizers and other soil products</td>
<td rowspan="2">Value propositions
Provision of biodegradable waste and fertilizers from bio-waste</td>
<td>Customer relationships
Personal direct sales</td>
<td rowspan="2">Customer segments
B2C, B2B
Farmers
Tree nurseries
Gardeners
Florists
Garden centers</td>
</tr>
<tr>
<td>Key resources
Raw material
Equipment and technology
Technical know-how
Patents
Networks
Staff</td>
<td>Channels
Sales force
Online selling
Wholesale network
Retail network</td>
</tr>
<tr>
<td colspan="3">Cost structure
Production costs
Equipment and technology costs
Maintenance costs
Distribution costs
R&D costs
Labor costs</td>
<td colspan="2">Revenue streams
Sales of compost and fertilizers
Sales of services (biomass collection, etc.),
Training, consultancy fees</td>
</tr>
</table>

Socio-economic aspects and novelty

The activities of companies meet the demands of society for reducing waste and more environmentally friendly production. Utilization of biodegradable waste from landscaping and plant growing as a valuable local resource provides sustainable jobs for local community, additional income streams and cost savings from waste handling for local producers. Waste is collected from customers, who do not have the opportunity to recycle it themselves. Replacing mineral fertilizers with organic fertilizers has a positive effect on environment and health. Besides waste reduction, the environmental benefits include soil quality improvement, reduction of air and water pollution, higher biodiversity. The BM is transferable, but requires specific technical knowledge for replication.

The novelty of companies is at an average level as this type included both companies that were research intensive actively developing new waste management and processing approaches and variety of soil amendment products as well as smaller companies focusing mainly on using waste for compost.

3.8. Sustainable Bio-based Products from Plant-based Biomass

This cluster formed on the basis of five enterprises using cultivated plant based and wood biomass for variety of other bioproducts, incl. food products (vegan, gluten free food, starch, baking products, ingredients for organic food products), animal feed, animal beddings, paper and cardboard, and bioenergy and fertiliser side streams. Thus, the products of this type are more varied than in the previous one that specialised on plastic replacement.

Value proposition

The **value** offered to customers is a mix novel, sustainable, natural and organic products or ingredients for food and packaging based of plant and woody biomass. Different high value-added products from side streams include biogas and fertilisers.

Infrastructure

The key partnerships are forest owners and wood industry, other suppliers for biomass raw material. Universities and other research institutions provide opportunities for concept development for materials, processes, products, verification and prototyping and design. The role of business and industrial associations was especially emphasized for network, export and product development. Cooperation with regulatory authorities is required for meeting the environmental and other requirements for ingredients for food and feed industry were important for some companies. . Some of companies were selling bioenergy to municipal byers.

Key activities include procurement of biomass, production (food ingredients, pellets, organic mulch, magazine paper, and bioenergy production), distribution and marketing and sales network development, incl. sales channels. In some cases, the enterprise collected their own biomass. Other enterprises bought the biomass from various industries and also outsourced the processing. Other important activities included constant product development (e.g. new products based on ash from bioenergy production). Some of the enterprises offered various additional agriculture related services as side activities.

The tangible **key resources** are raw material (straw, hay, high starch crops, manure, and wood), machines and equipment, vehicles for transportation and water, energy, processing and packaging infrastructure, technology for new product development based on residuals. Intangible key resources include human resources, the technical, market and innovation know-how, networking with research organisations for the development of products and technologies, also global trademarks.

Customer interface

The enterprises established their **customer relationships** through direct personal sales, long-term relationships and distribution networks. The main focus was on B2B sales (incl. private labels in B2B chains, B2B with other producers that use products as ingredients for their products). **Customer segments** included gardeners, livestock farmers, consumers of pellet and wood heating, producers of organic food products using potato starch or brown peas starch (bakeries, confectioners), dry blends, as well as vegan products, gluten free products, companies using paper and hardboard and packaging; municipal buyers for heating.

The channels depended on the product. Mostly enterprise's own sales force selling directly (B2B and B2C) and enterprise owned online channels (online shops, website, and social media) and partner owned retail networks were used. Intermediaries were also used, especially for export and distribution. Marketing channels included direct marketing and trade fairs.

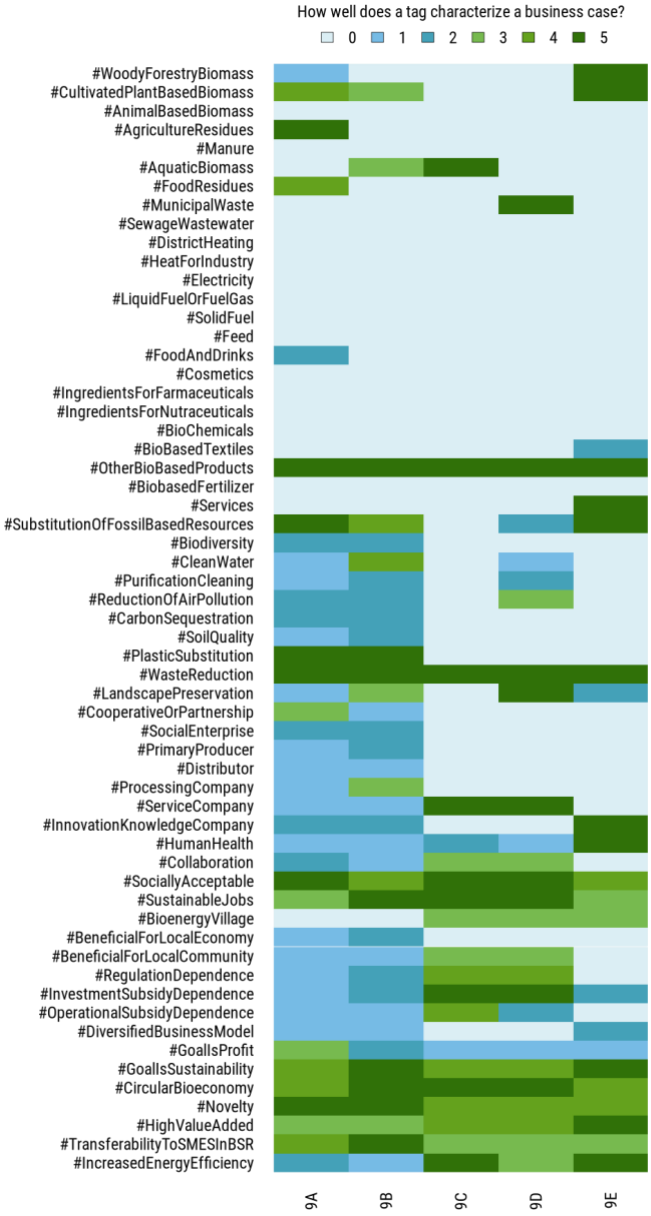


Figure 11. Keyword ratings for enterprises in the BM type of Sustainable Bio-based Products from Plant-based Biomass

Financial viability

The cost structure is that of manufacturing company with main costs being costs for raw material, production (energy costs), personnel costs (also for manual work in some cases where the product was manually prepared), R&D costs for new products and marketing, operating and service costs of equipment and fuel. Marketing costs were separately emphasised as the products were novel, costs such as for specialised export managers and specific marketing channels occurred, and in some cases separate certifications were required.

The revenue streams mainly come from the sale of products (selling the different products to the various market segments), bioenergy and to some enterprises also from provision of services.

Table13. BMC for Sustainable Bio-based Products from Plant-based Biomass BM type

<table>
<tr>
<td rowspan="2">Key partners
Forest owners
Wood industry
Other biomass suppliers
R&D organisations
Business and sectorial organisations
Municipal authorities
Regulatory authorities</td>
<td>Key activities
Collection of biomass
Procurement of biomass
Outsourcing of processing
Production
R&D
Distribution
Marketing and sales of bio-based products
Additional agricultural services
Sales of bioenergy</td>
<td rowspan="2">Value propositions
Plant and wood biomass based novel and natural products and ingredients for food and packaging
Bioenergy and fertiliser production from waste and residues</td>
<td>Customer relationships
Personal direct sales
Automated online sales</td>
<td rowspan="2">Customer segments
B2B B2C
Bio-based products
Farmers
Gardeners
Food industry
Packaging industry
Supermarkets
Heat
Municipal byers for heating</td>
</tr>
<tr>
<td>Key resources
Raw material
Equipment and technology
Processing plant
Staff
Technical know-how
Market knowledge
Networks
Global trademarks</td>
<td>Channels
Sales force
Online selling
Intermediaries
Retail network
Trade fairs</td>
</tr>
<tr>
<td colspan="3">Cost structure
Raw material costs
R&D costs
Investment in the processing plant
Equipment and technology costs
Production costs
Distribution costs
Marketing costs
Labour costs
Certification costs</td>
<td colspan="2">Revenue streams
Sales of bio-based products
Sales of bioenergy
Sales of agricultural services</td>
</tr>
</table>

Socio-economic aspects and novelty

The activities of the companies support the economic development of rural areas by creating employment opportunities, utilization of local resources for variety of products, and strengthening the diversity of economy. Some of the companies demonstrated integrating social goals to their economic and environmental activities by engaging in a local community support program. Consumer and health trends (ingredients for vegan, gluten free food) were important driver for R&D. The companies presented a mix of specialised and diversified enterprises.

The novelty of the companies in the cluster varies from company to company. Some enterprises represent the use of agricultural residues or wood for circular production and low value-added sustainable products (e.g., straw pellets). Some enterprises are working on high value-added product and processing innovations, e.g., offering in the market organic plant-based products for industrial application, development of new protein products for customers.

The BCs presented in Appendix 2 include a Latvian company Aloja Starkelsen, a company producing a mix of plant-based products for food and industrial application. Another BC involves company Lilli Agro that uses agricultural residues to produce straw pellets in Estonia.

3.9. Sustainable and Novel Bio-based Products from Food Waste and Biomass for Replacing Plastic

The type was formed on the basis of five enterprises that use food waste, grass and aquatic biomass for developing and producing products for replacing plastic-based straws, cutlery and kitchen ware.

Value proportion

The main **value proposition** is sustainable biomass-based products that replaces plastic based products. The products included both reusable and for one-time use, incl. edible products. Additional value proposition lies in utilising and reducing food and biomass waste and in the development of circular bioeconomy.

Infrastructure

The upstream **key partnerships** include the raw material suppliers, e.g. grass, forestry and aquatic biomass harvesters, and the food industry partners that supply the food waste and side streams for processing. As some of the enterprises do not own the production facilities, but outsource the production, food industry partners are not only the source of inputs, but crucial network partners for processing also. The enterprises in this type are developing the novel products, thus cooperation with universities for R&D and mentors for business development were emphasized. As the use of food waste and biomass and the use of plastic products are subject to different regulations, work with different public regulatory authorities is required.

Key activities are manufacturing activities, starting with the purchase of raw material (aquatic, grass, forestry and food waste biomass), processing it or outsourcing the processing (selection, cleaning, and cutting of certain biomass) and production of the end products. The products are novel, thus R&D development activities, incl. invention, product, machine and tool design, verification of process concepts and/or products, prototype development either in-house or in cooperation with external key partners (universities), are important. The enterprises carried out their marketing and sales activities.

The tangible **key resources** are raw material (reed or straw, aquatic biomass), organic residue, and food waste, the production facilities and technology, and the staff. Intangible key resources include the technical and innovation competence and knowledge.

Customer interface

The enterprises established their **customer relationships** through direct personal sales (personal face-to-face meetings or online through e-mail, social media) as well as through automated online shops.

The main focus was on B2B sales and **customer segments** included wholesalers and retailers, but also specifically the restaurants, cafeterias and other food establishments for whom the specific products (cutlery, kitchen wares) are intended. B2C direct sales were less important, but there were options for private individuals to buy through online shops.

The channels through which customers are reached are mixed as both direct and enterprise owned channels (direct personal sales, online web shops) were mixed with distribution through partner owned retail and wholesale networks. Exhibitions for reaching out to business customers were separately mentioned as marketing channel.

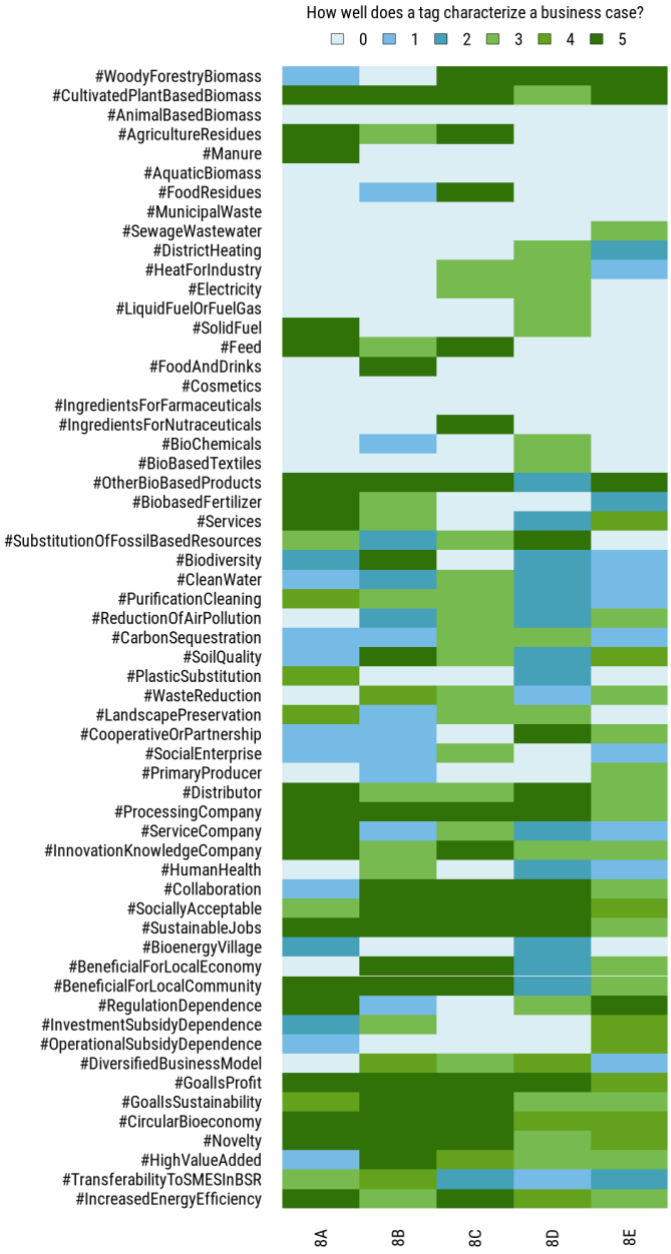


Figure 12. Keyword ratings for enterprises in the BM type of Sustainable and Novel Bio-based Products from Waste and Biomass for Replacing Plastic

Financial viability

The cost structure is that of manufacturing company with main costs such as costs for raw material, production, personnel costs (also for manual work). As the enterprises were developing novel products, R&D costs also occurred.

The revenue stream comes mostly from the sales of products.

Table 14. BMC for Sustainable and Novel Bio-based Products from Waste and Biomass for Replacing Plastic BM type

<table>
<tr>
<td rowspan="2">Key partners
Biomass suppliers
Processing industry
R&D organisations
Business mentors</td>
<td>Key activities
R&D
Production
Outsourcing of processing
Marketing and sales</td>
<td rowspan="2">Value proposition
Sustainable biomass (food waste, seaweed, reed, etc.) based products to substitute plastic

Repurposing of food and biomass waste for circular production</td>
<td>Customer relationships
Personal sales
Automated online sales</td>
<td rowspan="2">Customer segments
B2B, B2C
Wholesalers
Retailers
Restaurants, cafeterias
Private persons</td>
</tr>
<tr>
<td>Key resources
Raw material
Equipment and technology
Technical know-how
Staff</td>
<td>Customer channels
Sales force
Online selling
Wholesale network
Retail network
Exhibitions</td>
</tr>
<tr>
<td colspan="3">Cost structure
Raw material costs
R&D costs
Equipment and technology costs
Production costs
Labour costs</td>
<td colspan="2">Revenue streams
Sale of products</td>
</tr>
</table>

Socio-economic aspects and novelty

The activities of the companies are socially recognized and acknowledged for addressing consumer needs and trends (e.g. suitable for vegan), policy objectives such as reduction of single use plastics in daily lives, fair trade practices and social entrepreneurship principles and community involvement. The BC of Kaffeeform (Appendix 2), a coffee cup producer from Germany demonstrates integration of a social mission with environmental goals such as recycling food waste, reduction of the use of fossil fuel-based plastics and sustainable processing.

Companies in this type were highly specialised in their activities with some of them outsourcing specific processing activities to partner companies. The policies, particularly the EU level ban on single use plastics, has been major factor for discovering this kind of entrepreneurship opportunities, but in comparison with other types, those SMEs are less dependent on other regulations and policies, although some of companies have opportunities to apply for investment subsidies. The novelty of the companies is high with the focus on material technology and its development. The transferability of BM depends on the access to knowledge resources and highly skilled labour that are critical for this type of R&D intensive companies. The other BC presented in the Appendix 2 is Spoontainable, a German company using food waste for edible ice cream spoons, and demonstrates development of unique product in response to consumer and environmental policy drivers.

3.10. High-value Products from Knowledge-based Processing

The type is based on four enterprises specialising in using novel biomass and developing different new products specifically for pharmaceutical, nutraceutical, cosmetics, food and feed industries.

Value proportion

The main **value proposition** lies in processing novel and natural biomass for new and innovative products and ingredients for cosmetics, pharmaceutical, nutraceutical products, food and animal nutrition industries.

Infrastructure

The key partnerships are biomass (seaweed, crops such as hemp) collectors or producers, universities and other research institutes for R&D of the novel products. With pharmaceutical, food and feed industries as customers, the enterprises are subject of variety of regulations and cooperation with public regulatory bodies is required.

The key activities are collecting the raw materials, production starting from primary processing of raw materials (washing, extracting and filtering, drying and milling), followed by quality control, packaging, storage; R&D, marketing and sales. One of the enterprises also offers biochemical analysis and related services.

The tangible **key resources** are biomass (i.e. the algae, seaweed, hemp and other plant-based biomass), processing facilities, production infrastructure, equipment and machinery for washing, filtering, drying, milling the raw material, intermediate and final products, and equipment for packaging and conducting biochemical analysis. As enterprises work with novel products, intangible resources such as patented know-how (product formulations) and technical knowledge, trademarks and skilled staff are especially important.

Customer interface

The enterprises established their **customer relationships** through personal direct and automated online sales via webshop.

The main focus is on B2B sales and main **customer segments** are producers of various processed foods, feed, cosmetics and pharmaceuticals. To a certain extent sale to private persons as end users takes place. Those customers include often high-income and health-conscious persons, who are end users of the cosmetics and pharmaceuticals products.

The enterprises reached their customers through following **channels**: their own sales forces and direct sales, but also through intermediaries, including foreign partnerships. Exhibitions for introducing novel products to business customers were mentioned.

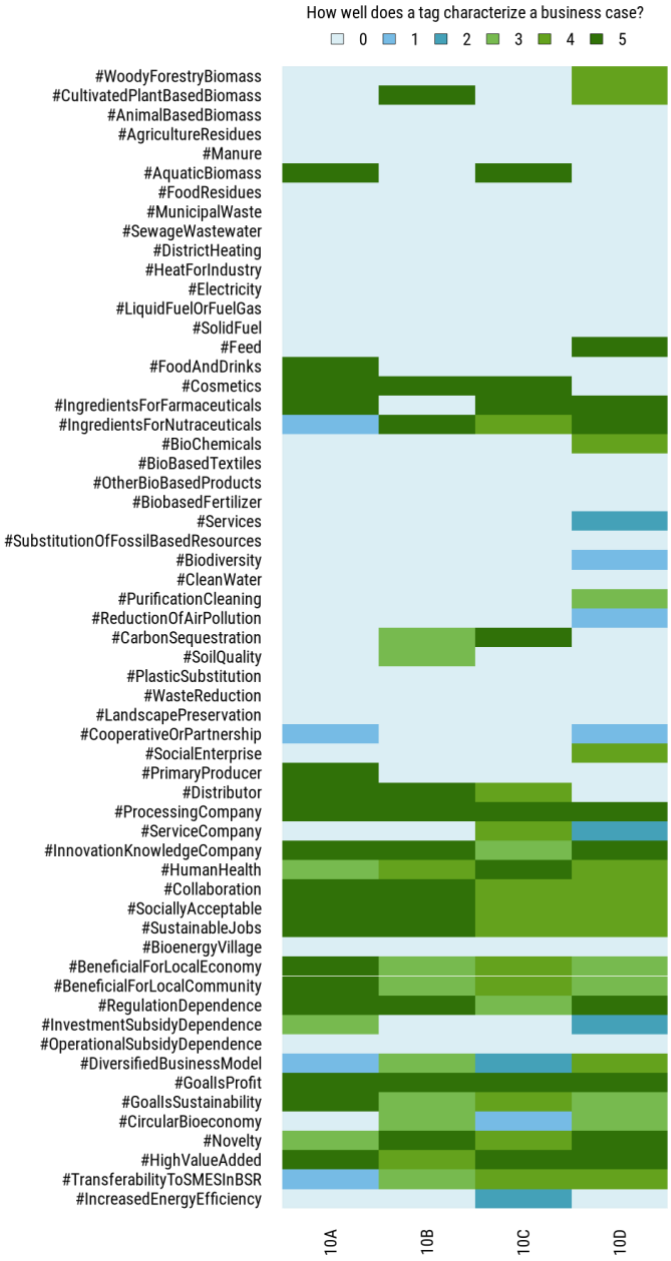


Figure 13. Keyword ratings for enterprises in the BM type of High-value Products from Knowledge-based Processing

Financial viability

Most significant **costs** for operating this business model are R&D and development of product formulations; patent applications, investment into processing facilities and biomass refinement to intermediate material; marketing, personnel and raw material costs. **The revenues** come from the sale of intermediate and final products, services offered and potential grants and subsidies for R&D.

Table 15. BMC for High-value Products from Knowledge-based Processing BM type

<table>
<tr>
<td rowspan="2">Key partners
Farmers
Aquatic biomass (seaweed, algae) suppliers
R&D organisations
Regulatory authorities</td>
<td>Key activities
Collecting biomass
Procurement of biomass
Production
R&D
Marketing and sales
Services for biochemical analysis</td>
<td rowspan="2">Value propositions
Processing of high-value novel and natural ingredients and products for cosmetics, pharmaceuticals, nutraceuticals, food and feed industry</td>
<td>Customer relationships
Personal sales
Automated online sales</td>
<td rowspan="2">Customer segments
B2C, B2B
Food industry
Pharmaceutical industry
Animal feed industry
Cosmetics industry
Private persons</td>
</tr>
<tr>
<td>Key resources
Raw material
Equipment and machinery
Processing plant
Staff
Technical know-how
Market knowledge
Patents
Trademarks</td>
<td>Channels
Sales force
Online selling
Intermediaries
Retail network
Exhibitions</td>
</tr>
<tr>
<td colspan="3">Cost structure
Raw material costs
R&D costs
Investment in the processing plant
Production costs
Patent applications
Labor costs
Marketing sales costs</td>
<td colspan="2">Revenue streams
Sales of bio-based products
Sales of intermediary products to industry
Sales of services for biochemical analysis
Grants and subsidies for R&D</td>
</tr>
</table>

Socio-economic aspects and novelty

The companies provide social and health benefits by developing new product for human well-being and by supporting production of healthy food and by exploring new uses of existing bioresources, e.g., aquatic resources. Companies stimulate local economies not only with employment, but with buying biomass from locals. The production can be the subject to specific regulations (e.g., volume of collection of aquatic biomass). In comparison with other types, the companies are less dependent policies, but also have more limited access to subsides in comparison with energy or agricultural producers.

The novelty of the activities of companies is high. Companies represent both product and processing innovation as they work on finding new ingredients for food, feed, cosmetics, new recipes for food industry or developing novel biomass based products for treatments in integrative medicine. The BM depends heavily on the investment into knowledge workers and resources and in some cases a specific local biomass, thus the transferability is limited.

The BC presented in the appendix include two cases – Est-Agar and oceanBASIS, which utilize algae and other aquatic biomass. The BC of SatiMed illustrates a Lithuanian biotechnology company developing hemp based products.

3.11. High-value Products from Circular Bioeconomy

This cluster is based on four very specialized enterprises working on highly innovative products, including aquaponic systems, biodegradable polymers, lignin-based products, fish sludge-based fertilizers and similar products. This type was formed by enterprises that did not fit to the more specific types specialising on plastic replacement, packaging, food and feed products. . Another element that sets it apart is the higher focus on invention and system design.

Value proposition

Value offered to customers is a mix of products. The **value proposition** is the invention and design of novel value-added products and solutions with practical application in different industries and markets. The products and services are different, ranging from individualized aquaponic systems as well as support in operating such systems, invention of biodegradable polymers, specific flakes and granules for food industry, proteins and fibres for waste water treatment-plants, the conditioned fish sludge, lignin-based products as binding and dispersing agents for a wide range of end-market applications (construction materials, agrochemicals, batteries, etc.).

Infrastructure

The upstream **key partnerships** include farmers and different biomass providers, wastewater treatment plants as variety of biomass is used for diverse purposes. As the enterprises specialise in developing products and designing systems for variety of industrial partners, the cooperation with those is essential. Financial capital and services providers and public agencies regulate as well as are potential source of R&D financing. High R&D intensity makes cooperation with universities and other R&D organisations vital.

Key activities that keep the business going are quite different: consultations, design and construction of industrial systems, high level R&D activities, combined with developing explorative business model and infrastructure solutions that are covering a large part of the value chain. In addition, the generic activities include the biomass processing and production, marketing and sales and other similar activities.

The tangible **key resources** are biomass and processing facilities and technology. The most vital resources are the intangible ones, such as extensive knowledge and know-how with highly competent personnel, networks in key private and public bodies in home country and abroad, also market knowledge.

Customer interface

The enterprise established their **customer relationships** through co-creation based on long term strategic relationships with various stakeholders and networks. Some enterprises use personal direct sales for specific customers. The main focus was on B2B sales and **customer segments** targeting specific niche markets, retailers and industries. The main **channels** for reaching customers are enterprises' own sales force, online presence and retailers. In some cases, the company was highly recognizable, and branding and visibility were facilitating creation of customer contacts.

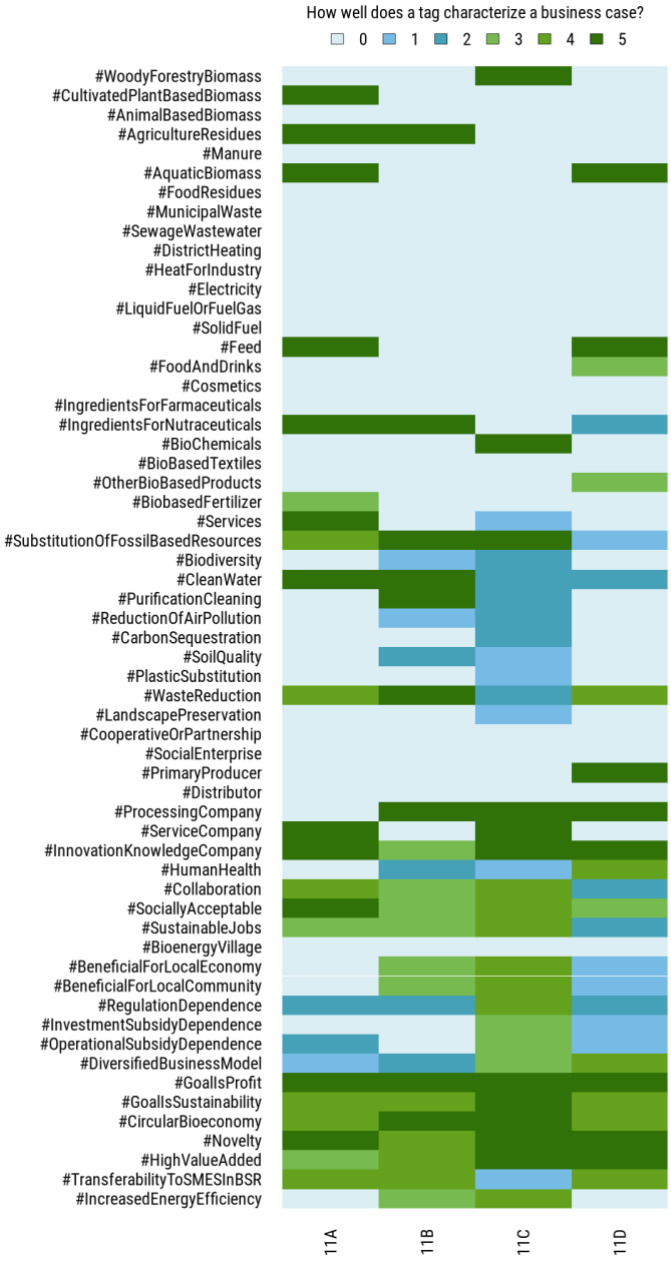


Figure 14. Keyword ratings for enterprises in the BM type of High-value Products from Circular Bioeconomy

Financial viability

Most significant **costs** are related to R&D that is expensive and a highly stochastic process with high endogenous sunk costs. Other costs include costs for biomass, processing costs, equipment maintenance, personnel costs, marketing and sales. The revenues are much diversified, depending on the specific market segment and industry.

The **revenue streams** come from the sale of products and services, grants for R&D.

Table16. BMC for High-value Products from Circular Bioeconomy BM type

<table>
<tr>
<td rowspan="2">Key partners
Farmers
Other biomass providers
Wastewater treatment plants
Industry
R&D organisations
Financial capital and services providers
Regulatory agencies</td>
<td>Key activities
Procurement of biomass
Production
R&D
Business model development
Consultations
System design
Marketing and sales</td>
<td rowspan="2">Value propositions
Invention and design of novel value-added products from wood, aquatic and plant biomass for solutions with practical application in different industries and markets</td>
<td>Customer relationships
Personal sales
Co-creation</td>
<td rowspan="2">Customer segments
B2B
Specific niche markets
Industrial customers
Retailers</td>
</tr>
<tr>
<td>Key resources
Biomass
Equipment and technology
Technical know-how
Market knowledge
Staff
Networks</td>
<td>Channels
Sales force
Online sales
Retail networks</td>
</tr>
<tr>
<td colspan="3">Cost structure
R&D costs
Raw material costs
Equipment and technology costs
Production costs
Labour costs
Marketing and sales costs</td>
<td colspan="2">Revenue streams
Sales of products
Sales of services
Grants and subsidies for R&D</td>
</tr>
</table>

Socio-economic aspects and novelty

The companies in this type include both small, relatively specialised R&D companies as well as large-scale biochemical and food processors that create substantial number of jobs and economic activity for biomass producers in their region. In several cases, the companies do not depend on the cooperation network only for purchasing of raw materials, but the external actors play significant part in R&D process by co-creating and testing systems design, providing financing and access to markets. The R&D is aimed towards providing more environmentally sustainable solutions by reducing water pollution, and waste and fossil fuels use.

The novelty of companies is high representing both product and process innovation. Companies in this type typically produce high value-added niche products or intermediates, technology and systems design for industrial customers. As this type is presented by very knowledge intensive companies, often with considerable processing capacity and networks that make them competitive, the BM is not easily transferable.

In the Appendix 2, this type is represented by the BCs of Borregaard, a large-scale biochemical producer from Norway, and Emsland Group from Germany that manufactures vegetable based products for food and other industries.

3.12. Utilization of Municipal Waste and Sewage

This type is based on four enterprises using municipal waste and wastewater for their bioenergy production. In comparison with the type of district heating and electricity from various biomass, enterprises in this type rely heavily on municipal waste and waste water, incl. using wastewater sediments, landfill gases for developing closed loop systems for biogas for transportation, heat and electricity, and using those for municipal heating or in greenhouses for agricultural production.

Value proportion

The main **value proposition** is provision of eco-services and environmentally friendly and relatively low-cost renewable energy (transportation fuel, etc.) from nutrient rich waste and wastewater.

The **key partnerships** include service providers for nutrient recycling, incl. large scale agreements with waste and wastewater treatment plants, land owners, public authorities and environmental monitoring institutions, different grid owners.

Key activities are production of biomethane from wastewater and purification the resulting gas to the necessary quality. Biomethane is delivered to customers via gas stations close to production plant or tank trucks. Some enterprises established their own biomass plantations, which can absorb nutrient rich waste (large area needed) and implement environmental monitoring.

The tangible **key resources** are biomass (wastewater), substances for the fermentation process, the production facilities and technology (equipment for reception of waste, biogas reactor and storage facilities for the product in various stages of production, equipment for cleaning) and marginal or non-fertile land for dedicated biomass plantation establishment. Staff with technical and innovation competence and knowledge is also required.

Customer interface

The enterprises' **customer relationships** with end users are mainly indirect as biogas is sold via gas, heating and electricity distributing companies. The relationships with the distributors are based on direct contacts.

This type is mostly characterised by B2B sales and collaboration with municipal public authorities. The **customer segments** included already operating gas companies with existing infrastructure and gas stations, municipal waste water treatment plants, biomass boilers/power plants, regional public transportation or final consumers in transportation sectors.

Distribution takes place via gas distributing companies or heat energy sold directly to district network or pump stations for regional public transportation. Intermediaries are used as the **channels** for reaching farmers, e.g., waste water treatment plants provide farmers with nutrient rich waste for re-usage through the intermediary, who provides service for environmental permits, consolidating farmers, arranging transportation services.

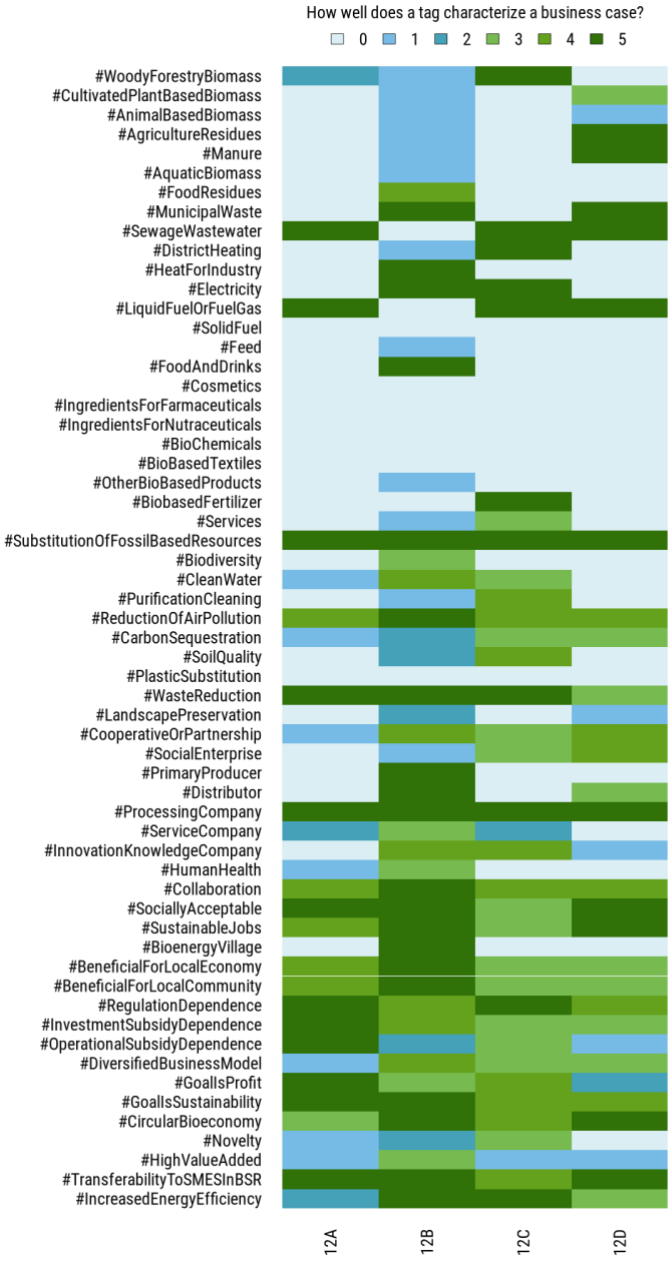


Figure 15. Keyword ratings for enterprises in the BM type of Utilization of Municipal Waste and Sewage

Financial viability

The costs related to biomass acquisition and biogas processing, technology and equipment maintenance costs. Costs may also include costs for land, establishment of woody biomass plantation (mainly seeding costs), biomass harvesting, investment into the biogas plant, transportation costs for sludge, digestate and pellets, cost for spreading (fertilization) of sludge digestate and biomass ashes, biomass harvesting, labour costs.

The revenue stream comes from the sale of products (biogas, heat energy, electricity) and reduced costs from waste management.

Table17. BMC for Utilization of Municipal Waste and Sewage BM type

<table>
<tr>
<td>Key partners
Landowners
Waste and wastewater processing plants
Technology suppliers
Municipal authorities
Electric and heat grid owners</td>
<td>Key activities
Establishment of biomass plantations
Collection of biomass
Procurement of biomass
Biogas production
Sales of heat and electricity
Sales of digestate
Environmental monitoring
Key resources
Marginal or non-fertile land for biomass plantation
Raw material (biowaste and wastewater)
Biogas plant
Equipment and technology
Technical know-how
Staff</td>
<td>Value propositions
Ecosystem services and renewable energy from nutrient rich municipal waste and waste water and utilization of marginal lands</td>
<td>Customer relationships
Personal direct sales with distributing enterprises
Indirect relationships with end consumers
Channels
Intermediaries</td>
<td>Customer segments
B2B, B2G
Biogas
Gas companies
Transportation enterprises
Industrial enterprises
Heat and electricity
Municipal byers
Electricity and heating companies
Digestate
Farmers</td>
</tr>
<tr>
<td colspan="3">Cost structure
Land costs
Biomass plantation establishment costs
Raw material costs
Investment into biogas plant
Equipment and technology costs
Harvesting costs
Production costs
Distribution costs
Costs of spreading sludge and digestate
Labour costs</td>
<td colspan="2">Revenue streams
Sales of biogas
Sales of heat
Sale of electricity
Sales of digestate
Reduced costs for waste management</td>
</tr>
</table>

Socio-economic aspects and novelty

The companies create value for local population by more efficient local biowaste management for local municipalities, use of biomass from local farmers and developing a circular and closed loop production for environmentally friendly energy for local transportation, heating and electricity. Additional environmental benefits include reduction of air and water pollution. The companies in this type were very regulation and policy dependent as waste management policies, environmental goals and municipal interests facilitated setting up the companies, but also provided public subsidies for investment and continuing operation. The BM is dependent on cooperation from network of different actors from providing biowaste to access to energy grids. This is well illustrated in the BC of Lithuanian UAB Pageldynių plantacija (Appendix 2) that integrates variety of activities and actors into closed loop circular model to process wastewater. Another BC is Greve Biogass that specialises on biogas production from municipal waste and sewage. The novelty of the companies is relatively low and the BM in easily transferable.

4. Archetypes of Business Models

The bottom-up approach to develop the taxonomy of good practice BMs was also followed to further narrow the types into four BM archetypes (Table 18). The 12 good practice BM types were categorized on the basis of their main value proposition in relation to circular bioeconomy development and BMI. The grouping is notional as the boundaries of types tend to overlap, because the BMs share similar features. For example, novel bio-fuel producers develop bio-chemicals and biomass processing for non-energy use, biomass production is diversified with bioenergy production from waste to create a more circular production or is integrated with biofuel production from various bioresources.

Table 18. BM Archetypes

Business model type in taxonomy	**Archetype**
1. Heat and Fuel from Woody Biomass 2. Fuel and Electricity from Biogas 3. District Heating and Electricity from Various Biomass Sources 4. Specialized Heat and Electricity Production and Services 5. Innovation in Novel Fuels and Bio-chemicals	Replacement of fossil fuels with bio-based fuels
7. Bio-based Fertilizer for Increased Soil Quality 9. Sustainable and Novel Bio-based Products from Food Waste and Biomass 12. Utilization of Municipal Waste and Sewage	Waste recycling
8. Sustainable Bio-based Products from Plant-based Biomass 10. High-value Products from Knowledge-based Processing 11. High-value Products from Circular Bioeconomy	Novel uses of bio-based materials for non-energy purposes
6. Circular Bioeconomy in Agricultural Production	Integration of complementary biomass production activities into circular production loop

Archetype of replacement of fossil fuels with bio-based fuels includes BMs focusing in substitution of fossil energy with solid, gaseous and liquid bio-fuels for energy production. This archetype was formed from five BM types that included BMs of producers of biofuels and energy companies using biofuels and BMs with various combination of those activities. Four of those types represent incremental innovations and easily transferable BMs. In case of converting fossil-fuel based energy production into bioresource based production, BMI lies in required changes in BM elements such as key relationships, key activities, and key resources in order to update their value proposition. Side streams of new activities require identification of new customer segments and channels for reaching them. The archetype also includes more complex knowledge intensive BMs focusing on innovation in bio-chemistry that have high potential for creating radical product and process innovations and new markets for their biomass use.

Waste recycling includes both, BMs of processing municipal and agricultural waste and residues into bioenergy as well as BMs based on utilizing the waste for new product offerings. The BMI innovation lies in finding new value offering from previously discarded waste and establishing new activities, finding new relationships, resources, markets, etc., for it. The model of recycling of waste into bioenergy is easily transferable. Reuse of waste extends the use of already collected bioresources, contributes to better waste management and reduction of environmental impacts, while offering new income streams and reducing costs.

Novel uses of bio-based materials archetype includes BMs developing innovative bio-mass based non-energy products and processing technologies for food, pharmaceutical, cosmetics, construction and other industries. The BMI in this archetype includes finding new ways to capture value from novel biomass, new uses of existing biomass or designing new processing systems, and related changes in other elements of the BM. The BMs in this archetype rely heavily on knowledge resources and their combination with networks, and thus are not so easily transferable.

Integration of biomass production activities into a circular loop archetype was formed by BM type based on the primary producers that aimed to maximize the resource use with diversification and integration of new activities and reuse of by-products in the same production unit into more efficient and circular production system. The archetype contains similar characteristics as waste recycling or fossil fuel replacement, but the distinctive element is that while companies in the other two archetypes typically are specialised and processing companies, the enterprises in this type are agricultural producers that diversify their value propositions and integrate a wide set of complementary activities and side streams into the production cycle starting from bioresource collection until product and service delivery for the customers. Besides the environmental benefits of reuse of production outputs for complementary activities, the companies had more control over their value chains. The diversification activities themselves are easily replicated, but the success of BM depends on combining and valorising the specific resources available for the enterprise.

5. Business Planning Tools for Bioeconomy Business Models

MS Excel-based tool was developed with modifiable parameters for business planning that allows to plan annual costs and revenues for seven years, and monthly costs and revenues for the first year of the project. The tool is submitted separately with this report. Figure 16 illustrates income and profitability assessment calculation using the tool.

2	The amount of the investment	1 000 000	€		Do not enter numbers in the yellow fields!		
3	The liquidation value of the investment at the end of the project	200000	€				
5	Projected income statement and project profitability assessment						
7	Year	2021	2022	2023	2024	2025	2026	2027
8	Quantity of product 1 sold, kg	200 000	500 000	500 000	500 000	500 000	500 000	500 000
9	Price of product 1	17,0	17,0	17,2	17,4	17,6	17,8	18,0
18	Income from sales	3 400 000	8 500 000	8 600 000	8 700 000	8 800 000	8 900 000	9 000 000
19	Other operating income, including grants							
20	Total earned income	3 400 000	8 500 000	8 600 000	8 700 000	8 800 000	8 900 000	9 000 000
21	Operating costs							
22	Goods							
23	Raw material	2 400 000	6 000 000	6 000 000	6 000 000	6 000 000	6 000 000	6 000 000
24	Material	18 000	50 000	55 000	60 000	65 000	70 000	75 000
25	Services, incl rental costs	40 000	50 000	52 500	55 000	57 500	60 000	62 500
26	Fuel	170 000	300 000	315 000	330 000	345 000	360 000	375 000
27	Energy	140 000	300 000	310 000	320 000	330 000	340 000	350 000
28	Wages and salaries	180 000	240 000	247 200	254 616	262 254	270 122	278 226
29	Labor taxes	59 400	79 200	81 576	84 023	86 544	89 140	91 815
30	Depreciation of fixed assets	75 000	100 000	100 000	100 000	100 000	100 000	100 000
31	Insurance	8 000	10 000	10 000	10 000	10 000	10 000	10 000
32	Administrative costs	5 000	6 000	6 500	7 000	7 500	8 000	9 000
33	Other costs	8 000	15 000	15 500	16 000	17 000	18 000	19 000
34	Total operating costs	3 103 400	7 150 200	7 193 276	7 236 639	7 280 798	7 325 262	7 370 540
35	Operating profit	**296 600**	**1 349 800**	**1 406 724**	**1 463 361**	**1 519 202**	**1 574 738**	**1 629 460**
36	Financial expenses							
37	Interest expenses	12 000	10 000	8 000	6 000	4 000	2 000	
38	Other financial expenses							
39	Total financial expenses	12 000	10 000	8 000	6 000	4 000	2 000	0
40	Profit on economic activities	284 600	1 339 800	1 398 724	1 457 361	1 515 202	1 572 738	1 629 460
41	Income tax							
42	Net profit	**284 600**	**1 339 800**	**1 398 724**	**1 457 361**	**1 515 202**	**1 572 738**	**1 629 460**
43	Net cash flow	**359 600**	**1 439 800**	**1 498 724**	**1 557 361**	**1 615 202**	**1 672 738**	**1 729 460**
44	Discount rate	9%	9%	9%	9%	9%	9%	9%
45	Discounted net cash flow	329 908	1 211 851	1 157 290	1 103 274	1 049 770	997 399	946 074
47	Business profitability	9%	16%	16%	17%	17%	18%	18%
49	Net present value (NPV)=	**5 995 565**	€	*The project should be undertaken if the NPV> 0.*				

Figure 16. Income statement and profitability assessment in the Business Planning Tool

The Business Planning Tool includes monthly cash flow projection for the first year (Figure 17).

2	**Project feasibility assessment based on start-up cash flows**											
3												
4	**Cash flow forecast**	**Month**										
5		1	2	3	4	5	6	7	8	9	10	11	12
6	**Opening balance**	**0**	**399 600**	**395 200**	**189 500**	**86 000**	**-72 490**	**-196 570**	**-355 140**	**-543 200**	**-636 750**	**-655 790**	**-549 870**
7	Receipts												
8	Capital contributions	**400 000**											
9	Long term loans												
10	Short term loans												
11	Proceeds from sales						**150 000**	**250 000**	**300 000**	**400 000**	**500 000**	**600 000**	**600 000**
12	Other receipts												
13	**TOTAL REVENUE**	**400 000**	**0**	**0**	**0**	**0**	**150 000**	**250 000**	**300 000**	**400 000**	**500 000**	**600 000**	**600 000**
14	Expenditure												
15	Purchase of fixed assets, construction												
16	Leasing payments			200 000	13 300	13 300	13 300	13 300	13 300	13 300	13 300	13 300	13 300
17	Goods												
18	Raw material				50 000	100 000	200 000	300 000	400 000	400 000	400 000	400 000	400 000
19	Material				500	1 000	1 000	1 500	2 000	2 500	3 000	3 000	3 000
20	Services and rents		4 000	4 000	4 000	4 000	4 000	4 000	4 000	4 000	4 000	4 000	4 000
21	Fuel				5 000	10 000	15 000	20 000	20 000	25 000	25 000	25 000	25 000
22	Energy			500	3 500	8 000	12 000	16 000	20 000	20 000	20 000	20 000	20 000
23	Wages and salaries					20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
24	Labor taxes						6 600	6 600	6 600	6 600	6 600	6 600	6 600
25	Insurance				25 000			25 000			25 000		
26	Administrative costs			800	800	800	800	800	800	800	800	800	800
27	Other costs	400	400	400	400	400	400	400	400	400	400	450	450
28	*VAT*												
29	Repaid short term loans												
30	Interest of short term loans												
31	Repaid long term loans												
32	Interest of long term loans (leasing)				1 000	990	980	970	960	950	940	930	920
33	**TOTAL EXPENDITURE**	**400**	**4 400**	**205 700**	**103 500**	**158 490**	**274 080**	**408 570**	**488 060**	**493 550**	**519 040**	**494 080**	**494 070**
34	**Closing balance**	**399 600**	**395 200**	**189 500**	**86 000**	**-72 490**	**-196 570**	**-355 140**	**-543 200**	**-636 750**	**-655 790**	**-549 870**	**-443 940**

Figure 17. Cash Flow Assessment in the Business Planning Tool

Based on the BM types and narratives of BCs, in the framework of project activity 4.1, an online library with filters will be developed that will simplify the search of information.

6. Conclusions

The analysis of BCs demonstrates the variety of enterprises making use of different biomass in the BSR. The BCs used for the development of BM types ranged from highly competitive global enterprises, some of which are the world leaders in their niche, to microenterprises smartly capitalizing on local market niches and utilizing local biomass. Analysis of the BMs and BCs provided an insight on the logic how bioeconomy enterprises in the BSR currently conduct their business and what kind of value is created from biomass. The enterprises analyzed in this report all use and process biomass and thus share common elements in their BMs. However, the use BMC and BC descriptions for the types provided an opportunity to create a more detailed overview of different bio-based business types. To summarize, the Appendix 1 provides also an overview on the BM types by the average scores given to the nine categories of keywords (source of biomass, outputs, environmental benefits, enterprise type, social benefits, policy aspects, business aim, transferability, novelty).

In the report, a bottom-up approach is used to classify 59 BCs into a taxonomy of 12 types of bio-based BMs that are in turn divided into four BM archetypes: replacement of fossil fuels with bio-based fuels, waste recycling, novel uses of bio-based materials, and integration of complementary biomass production activities into circular production loop. The heat and electricity production mostly from biogas was either the main or side activity of production in case of six BM types out of 12 and representing the archetypes of replacement of fossil fuels, waste recycling, and complementing the circular production loop. Different good practice BM types were formed from the producers: larger specialized heat and electricity, service providers mostly using woody biomass; wood and plant-based pellet producers and users; biogas producers combining manure, agricultural residues, plant biomass; circular agricultural producers with bioenergy production as a side-stream for primary production; plant and aquatic biomass users utilizing biowaste for energy production, and municipal sewage and waste users. Typical customers for heat and electricity for biogas are local municipal and residential byers, thus respective BM depends on regulation and access to different grids often operated by other parties. Products of enterprises in types such as heat and fuel from woody biomass, utilization of municipal waste and sewage tend to be high volume low value-added requiring substantial amount of biomass inputs. The BMs are generally easily transferable, but depend on easy availability of biomass in the region. This impacts also the BMs whose outputs are biogas and related heat and electricity that also require substantial amount of biomass from close proximity as well as access to different grids. Those BMs are transferable, but are highly dependent on specific national policies in the BSR and availability of investment subsidies. The analysis of BMs demonstrated that the bioenergy BMI is strongly network driven. The BMs of bioenergy providers are very dependent on the key relationships with a variety of stakeholders, who mediate access to bioresources, technologies and knowledge resources, grids and other infrastructures, investments.

In another six types, the main value creation lied in the development of novel and value-added products from biomass for specific purposes such as for novel fuels and biochemicals (replacement of fossil fuels archetype), biofertilizers and soil supplements (waste recycling archetype), substitution of plastic, ingredients for food and packaging that also created bioenergy production side stream in some cases, ingredients for cosmetics, pharmaceuticals and nutraceuticals, innovative system designs (archetype of novel uses of bio-based materials). All of those BMs are R&D intensive requiring cooperation with R&D institutions and knowledge workers. In comparison with other types, the BMs are not so easily transferred due to the intangible knowledge capital and value networks those enterprise have as their competitive advantage. The BCs representing knowledge intensive high value-added products included both very large enterprises in the BSR (mainly biochemical producers) as well as SMEs exploring very specific niches. Their BMs are affected by the regulation (e.g., on use of plastics, hemp, etc.) creating new opportunities, however, in comparison with bioenergy producers those BMs are less dependent on policies.

As the project focuses on biomass use, the BM archetypes presented here represent biomass processing enterprises whose BMI lies mostly in what Bocken et al. (2014) classifies under the technological innovation. Bocken et al. (2014) archetypes (i.e., maximization of material and energy efficiency, creation of value from waste, substitution with renewables archetypes) partially overlap with archetypes in present analysis. The most common environmental benefits characterizing the BM types were replacement of fossil fuels, reduction of waste and air pollution, improvement of soil quality (Appendix 1). The socioeconomic benefits lie mainly in the sustainable jobs, benefits for local area's economy and community.

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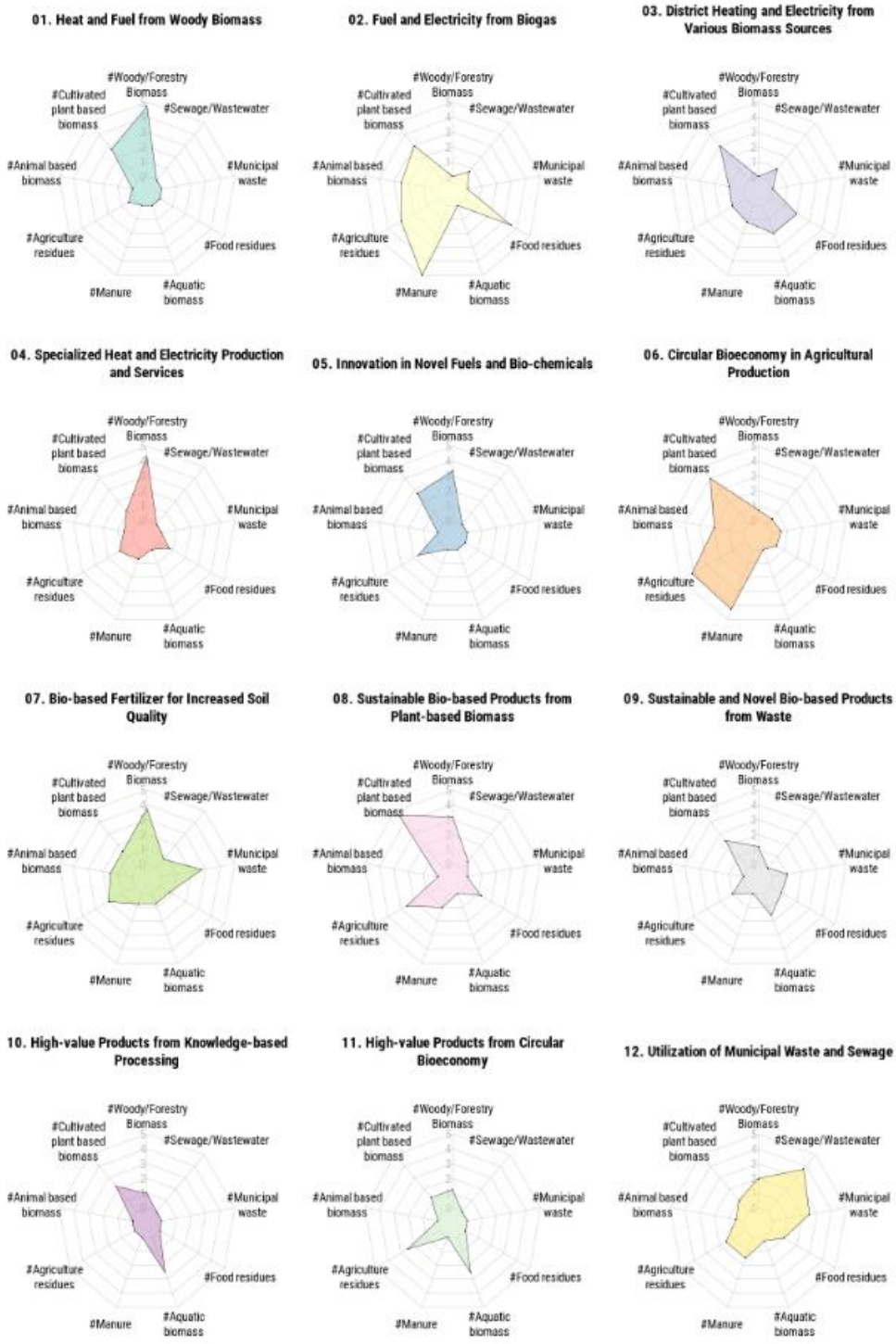
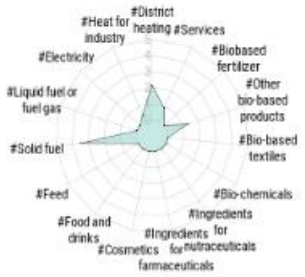
Appendix 1. Summary of types of good practice BMs by the nine categories used for selection criteria

Appendix 1.1. BM types by source of biomass

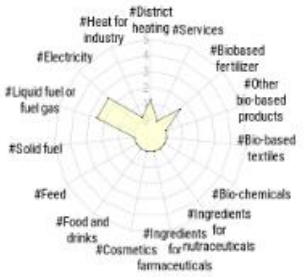


Appendix 1.2. BM types by outputs

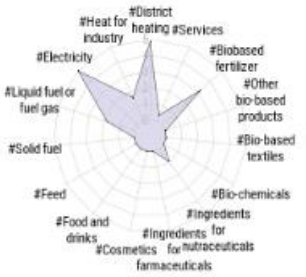
01. Heat and Fuel from Woody Biomass



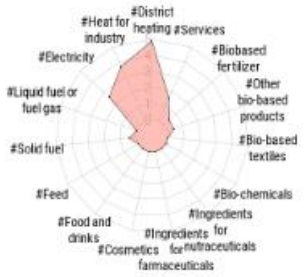
02. Fuel and Electricity from Biogas



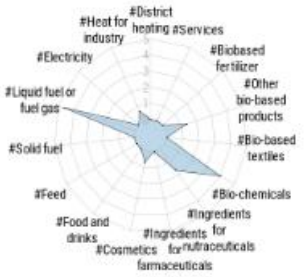
03. District Heating and Electricity from Various Biomass Sources



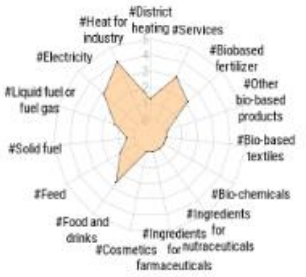
04. Specialized Heat and Electricity Production and Services



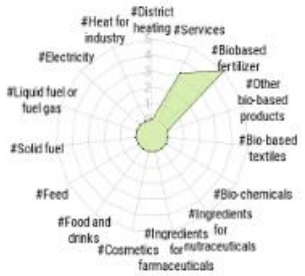
05. Innovation in Novel Fuels and Bio-chemicals



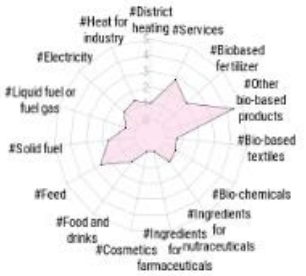
06. Circular Bioeconomy in Agricultural Production



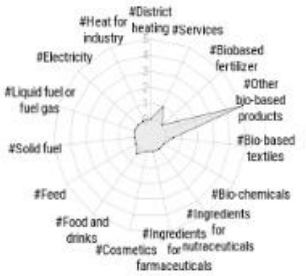
07. Bio-based Fertilizer for Increased Soil Quality



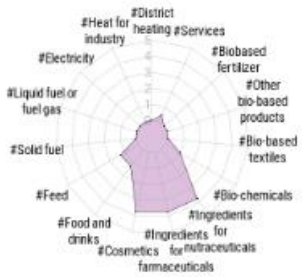
08. Sustainable Bio-based Products from Plant-based Biomass



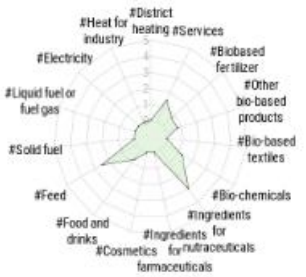
09. Sustainable and Novel Bio-based Products from Waste



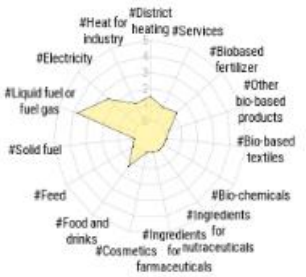
10. High-value Products from Knowledge-based Processing



11. High-value Products from Circular Bioeconomy

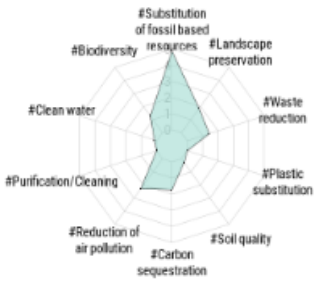


12. Utilization of Municipal Waste and Sewage

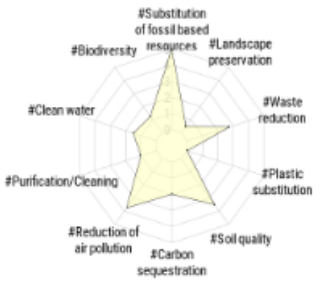


Appendix 1.3. BM types by environmental benefits

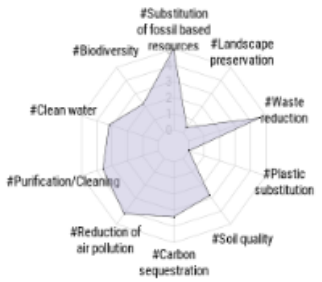
01. Heat and Fuel from Woody Biomass



02. Fuel and Electricity from Biogas

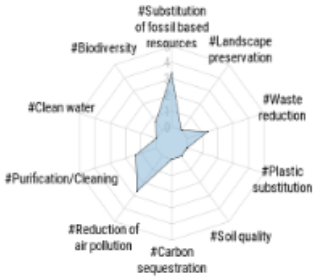


03. District Heating and Electricity from Various Biomass Sources

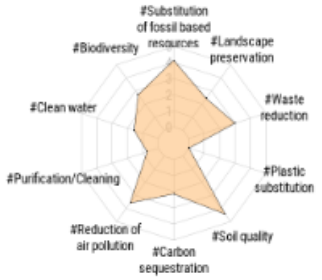


04. Specialized Heat and Electricity Production and Services

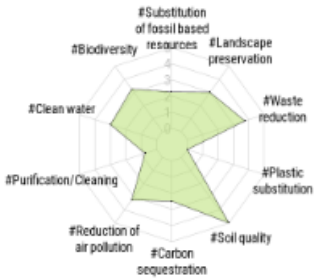
05. Innovation in Novel Fuels and Bio-chemicals



06. Circular Bioeconomy in Agricultural Production

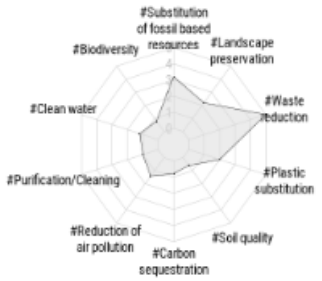


07. Bio-based Fertilizer for Increased Soil Quality

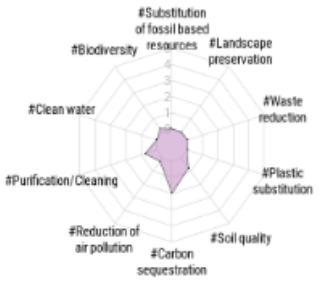


08. Sustainable Bio-based Products from Plant-based Biomass

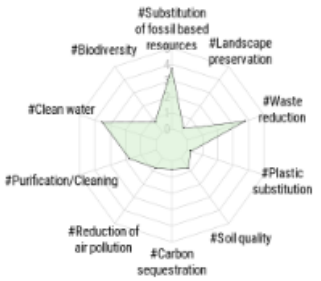
09. Sustainable and Novel Bio-based Products from Waste



10. High-value Products from Knowledge-based Processing



11. High-value Products from Circular Bioeconomy



12. Utilization of Municipal Waste and Sewage

Appendix 1.4. BM types by type of enterprise

01. Heat and Fuel from Woody Biomass

02. Fuel and Electricity from Biogas

03. District Heating and Electricity from Various Biomass Sources

04. Specialized Heat and Electricity Production and Services

05. Innovation in Novel Fuels and Bio-chemicals

06. Circular Bioeconomy in Agricultural Production

07. Bio-based Fertilizer for Increased Soil Quality

08. Sustainable Bio-based Products from Plant-based Biomass

09. Sustainable and Novel Bio-based Products from Waste

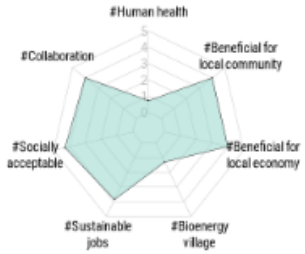
10. High-value Products from Knowledge-based Processing

11. High-value Products from Circular Bioeconomy

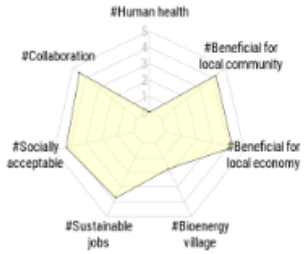
12. Utilization of Municipal Waste and Sewage

Appendix 1.5. BM types by social and regional benefits

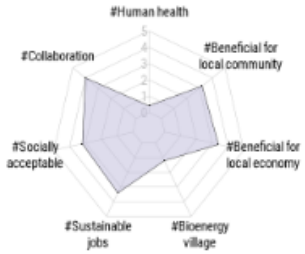
01. Heat and Fuel from Woody Biomass



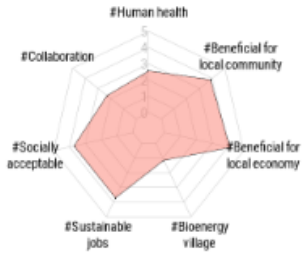
02. Fuel and Electricity from Biogas



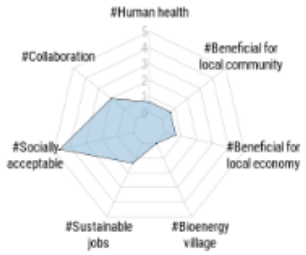
03. District Heating and Electricity from Various Biomass Sources



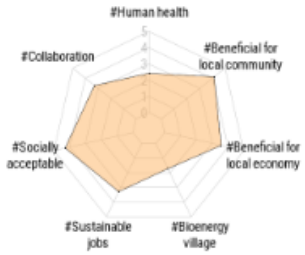
04. Specialized Heat and Electricity Production and Services



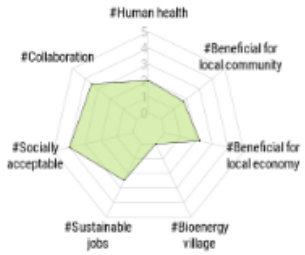
05. Innovation in Novel Fuels and Bio-chemicals



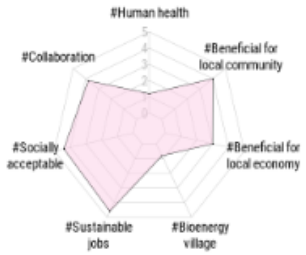
06. Circular Bioeconomy in Agricultural Production



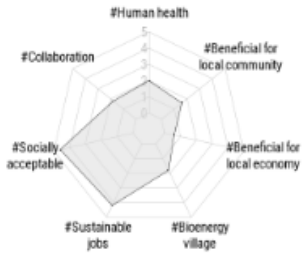
07. Bio-based Fertilizer for Increased Soil Quality



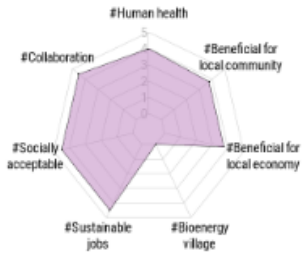
08. Sustainable Bio-based Products from Plant-based Biomass



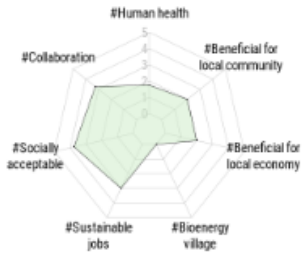
09. Sustainable and Novel Bio-based Products from Waste



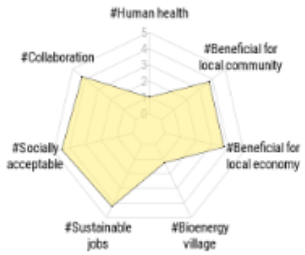
10. High-value Products from Knowledge-based Processing



11. High-value Products from Circular Bioeconomy

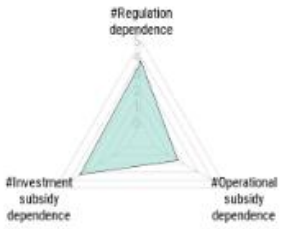


12. Utilization of Municipal Waste and Sewage

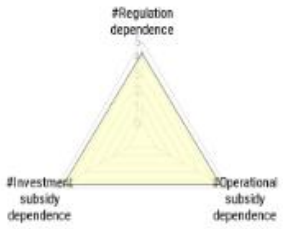


Appendix 1.6. BM types by policy aspects

01. Heat and Fuel from Woody Biomass



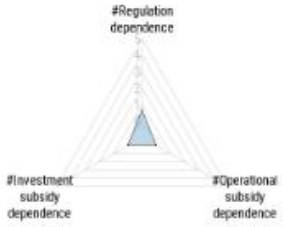
02. Fuel and Electricity from Biogas



03. District Heating and Electricity from Various Biomass Sources

04. Specialized Heat and Electricity Production and Services

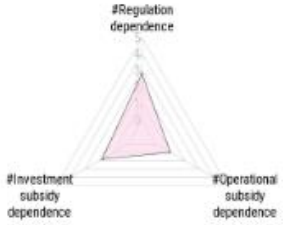
05. Innovation in Novel Fuels and Bio-chemicals



06. Circular Bioeconomy in Agricultural Production

07. Bio-based Fertilizer for Increased Soil Quality

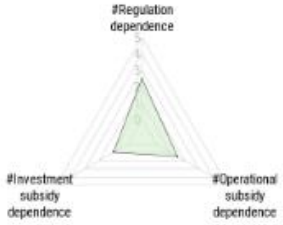
08. Sustainable Bio-based Products from Plant-based Biomass



09. Sustainable and Novel Bio-based Products from Waste

10. High-value Products from Knowledge-based Processing

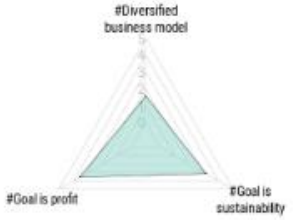
11. High-value Products from Circular Bioeconomy



12. Utilization of Municipal Waste and Sewage

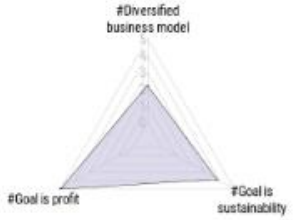
Appendix 1.7. BM types by business goals

01. Heat and Fuel from Woody Biomass

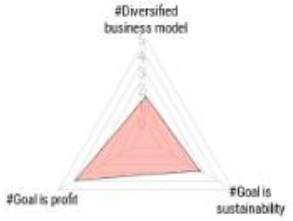


02. Fuel and Electricity from Biogas

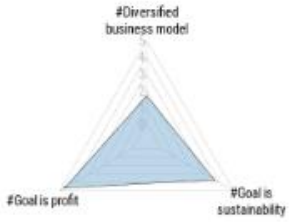
03. District Heating and Electricity from Various Biomass Sources



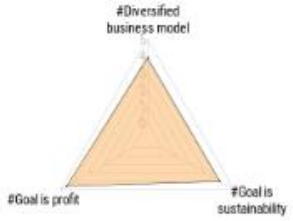
04. Specialized Heat and Electricity Production and Services



05. Innovation in Novel Fuels and Bio-chemicals



06. Circular Bioeconomy in Agricultural Production

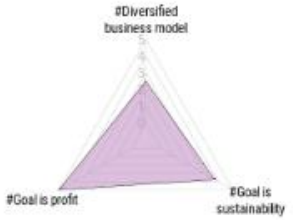


07. Bio-based Fertilizer for Increased Soil Quality

08. Sustainable Bio-based Products from Plant-based Biomass

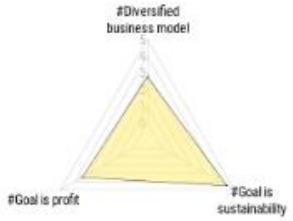
09. Sustainable and Novel Bio-based Products from Waste

10. High-value Products from Knowledge-based Processing



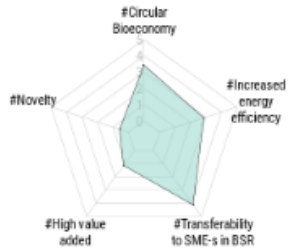
11. High-value Products from Circular Bioeconomy

12. Utilization of Municipal Waste and Sewage

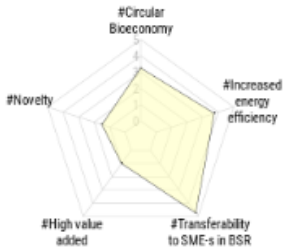


Appendix 1.8. BM types by transferability and novelty

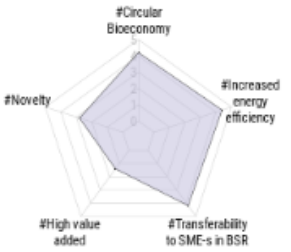
01. Heat and Fuel from Woody Biomass



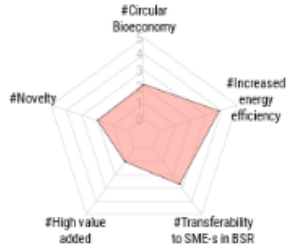
02. Fuel and Electricity from Biogas



03. District Heating and Electricity from Various Biomass Sources

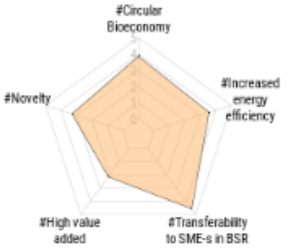


04. Specialized Heat and Electricity Production and Services



05. Innovation in Novel Fuels and Bio-chemicals

06. Circular Bioeconomy in Agricultural Production



07. Bio-based Fertilizer for Increased Soil Quality

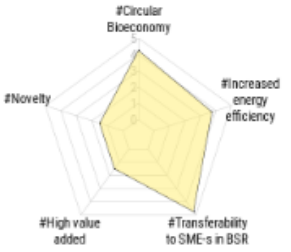
08. Sustainable Bio-based Products from Plant-based Biomass

09. Sustainable and Novel Bio-based Products from Waste

10. High-value Products from Knowledge-based Processing

11. High-value Products from Circular Bioeconomy

12. Utilization of Municipal Waste and Sewage



Appendix 2. Narratives of the business cases

The narratives below are presented using the same format as in the RUBIZMO project (2020)[2] database. The case description covers the background, main activities, market and main challenges of the enterprise, as well as its funding and innovativeness. The information collected and used in the analysis has been shorted here for clarity. In case of some types, the enterprises were not willing to have their information publicised, thus not all types are illustrated with a business case.

Heat and Fuel from Woody Biomass

Case: Ecopellet - environmentally friendly biofuels and pet products from sustainable raw materials

Name of the company: Ecopellet OÜ
Country: Estonia
Size of the business: 3 employees
Website: http://www.ecopellet.ee/en/, www.greenfull.eu

Background

The idea for the production of wood pellets came up 10 years ago, when local business partners investigated whether and where wood pellets are produced and sold, and whether there is interest in wood pellets in the local market. As it turned out that there was interest, financial and reliability study was performed together with cost-benefit analysis for production. The calculations gave a positive result, and half a year later, from the birth of the production idea, at the end of 2010, a small wood pellet production company Ecopellet was established in Western Estonia. However, not everything went as originally planned and the first profit was made in the fifth year of operation. Two business partners were involved in setting up the company. Later, a third business partner was added.

Main activities

The company's main and only activity is wood pellet production. Different types of wood pellets are produced: heating pellets, pet pellets and pellets for barbecue. Both coniferous and hardwood sawdust, planer chips, wood processing residues and chips made from debarked fine logs are used for the production of heating pellets. The main raw material for barbecue pellets is gray alder. Separately, bio granules are produced for cat litter, which consists of softwood sawdust and hay biomass. Compared to the early years of the company, the range of products has changed. In some years, straw pellets and hay pellets were also produced. As the market for straw and hay pellets gradually disappeared, the production of these pellets became uncompetitive and production ceased. The production of pet pellets and barbecue pellets replaced them. Heating pellets have remained the main product for many years. In the sector, the other pellet producers usually specialise on heating pellets, and 99% of their production is heating pellets. At Ecopellet, the share of heating pellets in production has decreased over the years. As of 2020, the share of heating pellets in production in different seasons is 35-45%. Despite its small size, Ecopellet has become the largest exporter of pet pellets in Estonia and the only producer of barbecue pellets in the Baltic region.

The size of the company has also changed over time. With the introduction of modern technology, i.e., the automation of production, the number of employees in production has decreased compared to the earlier years. Ecopellet is the only small pellet producer in Estonia that has a full production cycle (raw

[2] https://rubizmo.eu/

material preparation and crushing, drying line, production line, packaging line). The company has received the necessary permits for its operations.

Market

The main customers of heating and pet pellets are wholesalers and retailers in Estonia and Finland. The largest customers in Estonia are a local retail chain and specialized pet stores. The sales partners of barbecue pellets in Estonia are a large specialised retailer for barbecue supplies and other sellers of barbecue pellets. The company's products can also be found in the retail chains of neighbouring countries distributed through wholesalers.

Over the years, various marketing channels have been used to reach new customers: teleshopping, web marketing, participation in exhibitions, fairs, etc. There are two internet channels. The company has an internationally registered trademark Greenfull, which has a separate website, and the other is the website of Ecopellet, which is more aimed at the Estonian local market.

Using sales representatives in specific countries have proven to be the most effective marketing channel. In retail chains, the nomenclature of products is decided by the heads of particular product group, and once they have chosen their favourites, it can be quite difficult, if not impossible, to make changes in the selection of products. Thus, the relationships determine a lot in retail market access and further expansion plans.

Challenges and solutions

One of the biggest challenges in the near future is to increase the market share of grilling pellets in Europe. The use of grilling pellets is very common in the USA, but the barbecue pellets are a relatively new phenomenon in Europe, and 90% of barbecue pellets sold in Europe today come from the North America. It is estimated that the annual need for barbecue pellets in Europe is about 8-9 thousand tons. Ecopellet, as a niche manufacturer, would be able to cover about 10% of this need. To meet this challenge, Ecopellet has begun looking for a strategic partner to increase the market share of its products in Europe. Gaining trust in the market without a suitable partner is a very long and complicated process. The company is well positioned to increase the market share of barbeque pellets in Europe. The company improves the quality of products, develops the competence and experience of its employees in the production of barbecue pellets. In Estonia, there is sufficient amount of biomass for production of barbeque pellets and expansion of the market.

Funding

When establishing the company, public sector support was used, more precisely, the start-up capital was received from the Enterprise Estonia that is a national foundation for enterprise support. That start-up capital was vital for establishing the production until income was earned for starting to cover the running costs. The required start-up capital was calculated during the preparation of the business plan and included all costs, including investments. The start-up capital was supplemented by owners own capital investments and external loans and leases from different lenders. The minimum investment for starting a small-scale production of wood pellets is about 0.5 million euros. The objects of investment are primarily production technology, equipment and buildings.

What makes this case innovative?

Ecopellet is one of the few companies in Estonia that makes pellets from different types of wood and biomass. The wood species preferred by large producers are mainly spruce and pine, but Ecopellet also produces hardwood and hay pellets. The production of hardwood pellets requires more skills and technology adaptation than the production of softwood pellets.

In addition, bio granules are produced for litter cats and other small animals. Bio granules are a good substitute for cat litter made of clay, because the used bio granules can be composted in the garden. All Ecopellet granules are made without additives and are a pure natural product.

BalticBiomass4Value

Case: Quercus - production of solid biofuels for energy

Name of the company: Quercus Sp. z o.o.
Country: Poland
Size of the business: 86 employees
Website: https://quercus.org.pl/

Background

The Quercus company was founded in 1992 in Jedwabno, within the area of the Regional Directorate of State Forests in Olsztyn. At the beginning of its activity, it dealt with the production of wood chips for chipboard and fibreboard production. In 2005, on the initiative of the President of the Management Board the enterprise was transformed into a limited liability company, eventually adopting the name Quercus Sp. z o.o. (Quercus Ltd.). The driving force to start and develop the company's activity was the growing need to direct the domestic energy sector (heat and co-generation CHP plants) towards an increase in the share of renewable energy sources in the fuel structure. In addition, logging residues, which were burned at the place of harvest at that time, have gained the possibility of more effective use.

Main activities

The main source of revenue for Quercus Sp. z o.o. is the sale of solid woody biomass for energy purposes. In addition, the company provides chippers maintenance and repair services, varnishing services in own paint shop and transport services (including logistics of rail deliveries with the use of its own reloading terminal). This makes the company the largest producer of biomass in Poland with a well-functioning logistics network.

Compared to the early years, the company's main product (wood chips) is the same but is currently produced using the most modern machinery and equipment, making the production process itself more efficient. The main changes include the construction of transhipment terminals with their own railway sidings (two locations: Pasym and Spychowo), the creation of a paint shop and a technical department enabling the service of machine park and the introduction of bulk load transport service. All the above mentioned products and services have been introduced successively, along with the company's growth, to meet its own needs (e.g., machinery service) and to diversify operations to reduce risk.

Market

The clients of Quercus Sp. z o.o. are mainly large heating and co-generation plants, small local heating plants as well as pulp and chipboard industry companies. Due to the B2B relationship model, the acquisition of new customers is primarily based on participating in tenders for the supply of chips or other services. This in turn means that with the current model, the number of potential customers is limited and there are not so many feasible measures to increase customer availability. The present B2B relationship limits the need to use marketing channels, but the main forms of marketing are enterprise website, leaflets, participation in industry conferences and fairs, and a good market opinion ('word of mouth' marketing).

Challenges and solutions

The company plans to develop further the main area of its business activity, while developing ancillary activities that diversify the portfolio of revenue sources. However, currently, due to the lack of market stability, it is difficult to identify specific actions and investments.

The main limitation is the large share of biomass imported from outside Poland and the emergence of local competitors using an aggressive pricing policy. The main problems for business development have also been the instability of the renewable energy support system and policy in this area as it has caused fluctuations in demand for biomass for energy purposes.

Funding

The main sources of financing the company's operations are bank loans, leases, EU funds and retained (reinvested) profit. Profit was achieved within 2–3 years of commencing business operations. At present, the initial investment to start such a project would be over 0.9 mil EUR) due to very large entry barriers.

What makes this case innovative?

Quercus Sp. z o.o. has the goal of the constant development of the core business, which is the production of solid biomass of wood origin for energy purposes and to increase the diversification of operations in order to minimize the risk of negative impact of the potential reduction of the share of renewable energy sources in the national energy sector.

BalticBiomass4Value

District Heating and Electricity from Various Biomass Sources

Case: Kurana - production of bioethanol, electricity and heat from renewable resources in a closed technological loop

Name of the company: UAB Kurana
Country: Lithuania
Size of the business: 85 employees
Website: http://www.kurana.lt/en/

Background

The company started developing its bioethanol and biogas project in 2008. There were two main reasons for the investment. Firstly, in 2008 the energy was very expensive. Secondly, the construction of biogas power plants was encouraged by a feed-in tariff premium (formerly feed-in tariffs). Thus, the state support policy and market changes facilitated the investments into the biomass use.

Main activities

The enterprise produces bioethanol and biogas from grain. Biogas is converted to electricity and heat. Approximately 90% revenues come from bioethanol production and selling. Approximately 10% revenues come from energy and heating production and sales. The following changes have taken place in the production over the decade:

- Most bioethanol is produced from first-generation (grain) raw materials. However, the amount of second-generation bioethanol from starchy waste is increasing.
- The biomass after the biogas production process is concentrated and the treated water is fed back into production.
- The product mix was supplemented by disinfectant and industrial ethanol production.
- Production capacity is actually 40% higher than the designed capacity.

The main unique selling point is logistics as the enterprise's physical location is close to the main customer, thus the logistic costs for transmission are lower.

Market

The main customers are a major national refinery (for bioethanol), electric and gas utility company (for electricity) and major boiler and heating network managing company (for heating). When the biogas and bioethanol investment project started, at first no marketing and publicity activities were carried out. Only around 2–3 years ago the enterprise started to disseminate information on their technological loop, bioenergy production and environmental impacts.

Challenges and solutions

The enterprise plans to grow in the future, incl. investing into the plant with double production capacity of the current one and to focus on the biomass for the second-generation production and on supplying biomethane through a pipe. The main limit for expansion is the EU and national policy on bioenergy production.

Funding

The funding for the bioethanol and biogas investment had following financial model: 35% equity, 5% subsidies and 60% external capital. The initial investment to start such a project (the amount of total investment) was 30 million EUR. It took about 6–8 years before the company started making a profit.

What makes this case innovative?

UAB “Kurana is the first company inside the EU which connected manufacturing of bioethanol for biofuels, electricity and thermal energy from renewable energy sources (biogas produced by mesocphilic process) into one closed technological loop. This technological loop produces zero waste plus valuable organic fertilizers that are becoming more and more popular in contemporary farming. When building this factory, the company used the newest technologies and facilities bought from the EU countries (Germany, Denmark, Sweden and the Great Britain) and the USA.

BalticBiomass4Value

Case: 3B Bioenergie- energy production and special processing of digestate

Name of the company: 3B Bioenergie
Country: Germany
Size of the business: 9 employees

Background

The enterprise was originally engaged in dairy farming. In 1998, a small biogas plant was developed to complement agricultural activities. The aim was to process the farm's own slurry in a biogas plant and to produce digestate from manure to improve the nutrient supply of grasslands. The enterprise started with a small biogas plant as a dairy farmer, today they are primarily a biogas owner with a few cows.

Main activities

The main activities are energy production (electricity and heat) and fertilizer production. The side activity is agriculture. The outputs from the main activity are heat, electricity, ammonia-sulphate-solution and digestate (dried, solid, raw and liquid).

Market

The company is a big energy supplier for regional stakeholders (spa clinic, indoor tennis centre, public building, and indoor swimming pool). Farmers are the customers for the digestate. The main channels for reaching the clients are through direct communication or via the internet.

Challenges and solutions

The enterprise is interested in new fields like insects, algae and mushroom production. The challenge is in utilizing the insects or hydrogen for biological methanisation with feed. There is a potential in the expansion of organic fertilizer processing from fermentation residues and in the expansion of utilization of farm manure with the help of algae or fish. The limits are set by required nutrients that have to be transported and by the availability of substrates in the region and their costs. The biggest challenges are connected with the laws and the legal frameworks, as the requirements for the safe handling of nutrients are increasing and thus its costs are increasing, while the income from the activities has stayed the same. The ending of Germany's energy transformation policy *Energiewende* after 20 years is a big problem for the company. Partners are still being sought for the planned expansion.

Funding

The biogas plant, established in 1998, was developed and expanded with *Energiewende* funding and financing by banks. By selling electricity and heat for a fix price, the company was able to invest in new processes. Without these subsidies no further invest would be possible.

What makes this case innovative?

The 3B Bioenergie plant produces 1.7 mWh electric energy plus heat for local distance heating public houses (library, public bathhouse, etc.). The processing of the produced digestate is also of particular interest due to technological solution. The digestate gets separated by screw presses and dried. The liquid phase after the screw presses runs through a stripping and scrubbing process producing ammonium sulphate solution. The remaining phosphorus after this process is tried to get recovered by producing CAP and MAP (Struvite) precipitation.

Specialized Heat and Electricity Production and Services

Case: Przedsiębiorstwo Energetyki Cieplnej – energy efficient district heating system

Name of the company: Przedsiębiorstwo Energetyki Cieplnej Sp. z o.o.
Country: Poland
Size of the business: 266 employees
Website: http://www.pecpisz.pl/

Background

Miejskie Przedsiębiorstwo Energetyki Cieplnej (MPEC) is a heating plant and networks operator owned by Olsztyn Municipality. The company has a long history starting with the establishment of Olsztyńskie Przedsiębiorstwo Energetyki Cieplnej SP. z o.o. (OPEC) in 1968. Its statutory task was the coordination of all heating activities in the city of Olsztyn. At first, OPEC's main task was the development of technical documentation for the heating network supplied back then by a tyre factory. In 1973, the company was transformed into Wojewódzkie Przedsiębiorstwo Energetyki Cieplnej (WPEC) and started operating regionally as its operating range extended to the entire Olsztyn Voiovodship. The company took over heating plants in eight major cities, thus becoming part of the nationwide centralization trend. The first major investment of the new organisation was the transport and fuel base.

In 1975, a unit of Zakład Energetyki Cieplnej in Olsztyn was separated from the overall structure of WPEC. Due to the dynamic development of the city, the decision was made to establish new coal based heating plants and transition to a more centralised heating system with three central heating plants in place of 200 local boiler houses. A new heating plant and heat transmission networks were commissioned and finished by 1979 to cover the thermal needs of city of Olsztyn.

In 1987, regional authorities of the Olsztyn Voivode decided to put the WPEC into liquidation and power plants operating outside Olsztyn became independent entities. A year later in 1988, Miejskie Przedsiębiorstwo Energetyki Cieplnej (MPEC) was established. One of the company's tasks at the time was to take over about 200 local boiler houses from the military administration, health care and education, in order to cover the city of Olsztyn with one heating network.

In 1991, MPEC – the former property of the Treasury – became the municipal property of Olsztyn. The year 1997 brought the long-awaited transformation of the company into a sole proprietorship of the municipality with the city of Olsztyn holding 100% shares.

Recently, MPEC has completed the construction of the Kortowo BIO biomass heating plant. The newly built biomass boiler is part of the strategy for reconstructing the entire heat generation system in Olsztyn and shift from coal based system to more environmentally friendly systems. Before the decision was made to build a "BIO" heating plant based on renewable fuel (wood chips), a multi-variant concept was developed to specify the legal and technical possibilities of building such a facility. One of the main elements of the concept was to examine the availability of fuel. Determining the anticipated investment outlays and meeting the environmental conditions allowed MPEC to make the decision to start the investment.

The challenge for the next few years was taken on to obtain the status of an energy-efficient heating system referred to in the energy law. The qualifying requirement is the provision of non-conventional sources working for the needs of the municipal heating network. The lack of energy-efficient heating system status makes it virtually impossible to obtain financing for investments from EU funds.

Another reason for making this effort is the desire to improve the condition of the natural environment by reducing CO2 emissions by over 60,000 Mg / year. The scope of the investment planned was mainly influenced by two factors, i.e., the need to diversify the streams of fuels used in heat generation and minimizing the impact on the natural environment. The construction of renewable energy installations

is aimed at creating an environmentally friendly energy infrastructure, increasing the energy efficiency of the heating system and the energy security of heat supply to consumers. It is also a way to avoid the rising costs of CO2 emission allowances, which have an increasingly drastic impact on the price of heat.

Main activities

The main source of revenue is the sale of heat in the form of hot water, which is used in heat exchangers to heat utility water, water in central heating installations, and air in air conditioning centres. MPEC produces about 50% of the heat sold to its customers and owns the whole heating network that transports the heat. The company annually sells 1.9 million GJ of which its own production is 1.1 million GJ and its ordered thermal power capacity is 308 MW. Company operates 170 km of heating networks of which >120 km is a pre-insulated network, and has 1,573 heat distribution nodes (including five gas nodes).

Compared to the early years of the company, the following additional activities have been added to the company:

- Maintenance and repairs of water, sewer, gas, electric and central heating installations in residential buildings.
- Heat exchanger cleaning.
- Network emergency services and repairs.
- Diagnostics and assessment of heating networks technical condition.
- Technical consultancy in the field of energy optimization, including energy audits.

The purpose of additional activities are primarily to use the knowledge, skills and potential of our employees as well as the available hardware base. Thus, without incurring additional costs, there were opportunities to diversify the revenue portfolio and increase the value of the company's goodwill.

Market

Total net revenues from the sale of heat and electricity for the company was PLN 114.5 million. MPEC has two centralized sources of heat production and sells heat to approximately 1,500 customers in the city of Olsztyn and the area of the commune of Stawiguda. The main group of customers are residents of Olsztyn and SMEs, schools, administration etc.

Acquiring customers is carried out by informing the public about the company and its development plans in traditional and electronic media as well as during direct meetings. The company uses the following information activities and catching customers:

- Publications in traditional press and on websites: advertisement and introduction of operations and ongoing investments in local media outlets, in online media, incl. industry portals, economic and local government portals.
- Distribution of informational and promotional materials as MPEC annually posts printed promotional materials to its customers to provide information on new heat tariffs, promotional content and other relevant information related to the operations of the company (e.g., advertisement of non-licensed services such as exchanger cleaning). MPEC's key customers additionally receive printed company bulletins.
- Informational campaign on cable television Telewizja Olsztyn and its web portal introduce the activities of MPEC, provide environmental education, offer of services. E.g., the effectiveness and positive reception of these materials was reflected in the increased interest in chemical exchanger cleaning services, the annual orders of which tripled after TV and paper media campaign.
- Electronic media - websites, Facebook, Youtube, Google business card. MPEC runs two websites: www.mpec.olsztyn.pl and www.ec.olsztyn.pl (dedicated strictly to the project of a waste-to-energy plant), both with an 'ask a question' tab and analyses the visitor data. Internet engagement included such as collecting data on users' and local residents' comments and attitudes towards the company's activities.

- Organization of meetings, open days, eco-lectures and visits to MPEC facilities for the residents of Olsztyn that are annual popular events.
- The meetings with key clients, local authorities etc. are usually established by direct contacts and by individual meetings.

Challenges and solutions

Today, MPEC as a company managing heat sources and municipal heating network is facing many new challenges, while consistently aiming at the previously set goals. A few years ago, preparations began to transform the system, which until then had been based solely on coal, towards a wide diversification of fuels, with particular emphasis on renewable energy. Ultimately, the share of heat generated from coal is expected to fall below 40%, and it is planned to be completely eliminated after 2050. As a result of projects implemented currently and in the coming years, the majority of heat will be generated from biomass and waste.

The above-mentioned activities are related not only to the modernization of existing infrastructure but also to increasing the company's importance in the city economy.

In the coming years, works will be continued on further development of the automation of production processes, in particular the boiler's fuel supply system as well as the telemetry system. MPEC also plans to introduce new products - energy in the form of cold as well as the service of purchasing heat accumulated in buildings during the summer and released outside by air conditioning systems. Another great challenge is finding and testing a technology that captures CO2 in flue gases from coal combustion.

Their biggest challenge currently is the construction of a waste-to-energy plant with a gas/oil peak boiler. The facility will be built in two stages: the peak boiler – in the fourth quarter of 2021 and the CHP plant – by the end of 2022. The facility will fill the space in the production capacity after the tyre manufacturer Michelin ceases to deliver heat to the city network. The new plant will have a municipal waste-fuelled steam boiler and a turbine. It will generate about 30 MW of thermal power and 7.5 MW of electric power. Additionally, the peak gas/oil boiler will supply 70 MW.

The biggest problems in planning business development are the lack of legislative stability, not only on the national level but also, when it comes to environment protection legislation, also on the EU level. We take up further costly investment challenges, not being sure how long they will serve us. Every new idea appearing in directives and legal acts creates new challenges and additional costs.

Funding

The BIO heat plant project was financed from an EU subsidy and a preferential bank loan, in equal shares. The total gross value of the investment was 12 mil. EUR. The natural support for the project was the support of the Mayor of Olsztyn, as Olsztyn Municipality is the owner of the company.

What makes this case innovative?

The company is in the process of actively innovating its BM, particularly heat production inputs to shift from coal-based production towards more sustainable biomass-based production taking into account the local resource availability. The company is in the process of building new facilities and improving the efficiency of its production processes to better utilize the heating and cooling processes. The company has been active in engaging with local residents (internet, TV and print communication, open days).

Innovation in Novel Fuels and Bio-chemicals

Case: SunPine - an entrepreneurial bio-refinery

Name of the company: SunPine
Country: Sweden
Size of the business: 70 employees
Website: https://www.sunpine.se/en/

Background

The company was founded by innovator and serial entrepreneur Lars Stigsson, who had MSc degree in Chemical Engineering. The entrepreneur had an idea to use plant sterols in pine oil (tall oil) to produce cholesterol lowering food products and started a cooperation with Valeri Naydenov, a PhD student from Bulgaria specialising in analytical chemistry. The entrepreneurs started to cooperate in working on fatty acids and the separation process of plant sterols. The ongoing discussion in media and science regarding biodiesel at the time motivated the entrepreneurs to try to develop biodiesel and work on ideas on other products after biodiesel. Equity in the company SunPine was sold to three major industrial investors in order to build a full-scale plant in Piteå, Sweden, where the development climate was good, and there were possibilities to rent tanks in the area. Piteå has also a harbour with sufficient capacity. Additional part of the company was sold in 2014. The owner consortium of SunPine represent the entire processing chain from forest raw material to processing, marketing and distribution of renewable diesel fuel and resin.

History in summary:

- 2005 Concept development.
- 2006 Identification of location and tanks for storage.
- 2007 The first employees including appointed CEO.
- 2008 The environmental permit was approved.
- 2009 Construction of a new plant.
- 2010 Production of pine diesel began in May 2010.
- 2010 The first deliveries to Preem were made in October 2010.
- 2011 Improvement of the vacuum system. Problems in production, clogging and cleaning.
- 2012 Complementary improvement investments.
- 2013 During the years up until March 2013, efforts largely concerned the removal of bottlenecks and achieving a stable production. The plant reached its planned capacity in 2013, which was also the first year the company made a profit. In all, the initial investment amounted to around 35 MEUR.
- 2014 Stable production, increased feed and improved process. Handling sludge. The company Lawter, owned by Harima Chemicals in Japan, became a new shareholder and partner.
- 2014 The upgrade the plant for the manufacture of a new product – rosin that is an existing product on the global market, but is not dependent on political decisions.
- 2015 The new production plant became operational. The investment for upgrading the plant and to enable the manufacture of rosin totalled around 21 M EUR.
- 2016 First delivery of rosin, a start-up year for working on recurring production stoppages and a number of supplementary actions and succeeding in creating stable production with good reliability by the end of year.
- 2017 Achieving smooth and stable production, achievement of set goals and records in delivery and results.

- 2018 Continued stability and good production. The EU decides to open up for SunPine's pine diesel. Decision to invest 25 MEUR in a new factory. Production capacity will be raised by 50 %.
- 2019 In the fall of 2019, a new laboratory and a new office were inaugurated to make room for a new larger SunPine.
- 2020 Production started in new factory during the fall of 2020.
- 2021 Production in 2021 is estimated to be more than 150 000 m3 of raw tall diesel.

Main activities

SunPine seeks to extract renewable products through sustainable forestry by processing and seeking to make best use of a tree's essential components for the manufacture of renewable products. SunPine's bio-refinery supplies innovative and sustainable products that are based on pine oil, a residual product from Kraft pulp mills. The products reach the world market in everything from the Nordic Swan eco-labelled diesel to fragrant perfumes. The main products are:

- Pine diesel - SunPine produces over 100 million litres of pine diesel with plans to expand. In terms of positive climate impact, today's production reduces fossil CO2 emissions by 250 000 tonnes per year, or in simpler terms, equivalent to the emissions from 157 672 vehicles every year.
- Rosin is produced from pine oil and SunPine customers process it into adhesives, ink, tape, paint and road markings and other things. SunPine has an annual rosin production capacity of 24,000 tonnes.
- Heating Bio-oil - SunPine's bio-oil is certified sustainable by the Swedish Energy Agency – a green fuel oil.It is a good renewable alternative to fossil fuel oils for industry. Bio-oil has more potential development possibilities such as for petrol or lubricating oils, development of cholesterol reducing foodstuffs or medications. SunPine produces around 50 000 tonnes of fuel oil per year.
- Turpentine for customers in the perfume industry. SunPine produces around 2 000 tonnes of sulphate turpentine per year.
- Surplus heat used for district heating in the city of Piteå. SunPine supplies around 1 500 000 kWh of district heating annually.

Market

Pine oil is transported from pulp mills in Scandinavia to the factory in Piteå but also by boat from the USA. After processing mixed with diesel from ordinary crude oil, it is sold as the Swan-labeled Preem Evolution Diesel to consumers at tank stations all over Sweden. Rosin, heating bio-oil and turpentine are sold to mix of international and Swedish industrial clients. District heating market is the local area of the city of Piteå.

Challenges and solutions

Pine diesel only represents 2% of the total diesel consumption in Sweden. However, an important barrier to expansion is the supply of pine diesel. Several pulp mills in Scandinavia are expanding, meaning that the porudction volumes of pine oil will be increasing. Estimates on pine diesel indicate that pine diesel will constitute 5% of the diesel consumption in Sweden in the future. Research is going on concerning different processes for producing gasoline or diesel from other residues in the forest industry, e.g., converting lignin into fuel. SunPine collaborates with Luleå Technical University in technical research and development.

One important factor is the policy in Sweden and the EU. The industry is dependent on long-term regulation and cost-neutral energy politics. Companies are able and willing to invest if the rules are stable for many years, however, the political climate has been unstable with rules changing annually. Backing of national ambitious policies arguing for the importance of use of biomass for different purposes and taxation to increase the competitiveness of renewable fuels are required. The BM of

SunPine ought to be replicable on a general level in other regions of Europe. A combination of new applied technology and access to suitable forms of biomass could lead to new types of sustainable bio-fuels. Challenges are also related to finance and access to the specific value chain, both regarding supply and demand. SunPine has overcome these two challenges, by taking in new owners in the company. These owners have brought economic capital and access to the value chain from both supply and demand perspectives.

Funding

SunPine has not received any financial support or grants from public authorities. The initial development was financed by entrepreneur Lars Stigsson. Further financing was received from three investors each buying initially 20% share in company and each of them investing around 10 MEUR and later buying additional 5% share each. In 2014, the remaining 25% was sold told to the Dutch company Lawter, owned by Harima Chemicals in Japan.

The investors were particularly important as they represented actors along the value chain:

- Södra is Sweden's largest forest-owner association and a leading global producer of paper pulp.
- Sveaskog is Sweden's largest forest owner and a leading supplier of saw logs, pulpwood and biofuel.
- Preem is Sweden's largest fuel company, with over 600 fuel stations for private and commercial traffic. Preem has two refineries in Sweden: Preemraff Lysekil and Preemraff Göteborg.
- Lawter is a Dutch company owned by Harima Chemicals (Japan) with a strong position in terms of chemical products extracted from pine oil.

In 2018 SunPine decided to invest SEK 25 MEUR in a new production plant close to the old plant as the market for sustainable pine diesel fuel is growing and company wants to assume responsibility for the Swedish shift to renewable fuels. The production capacity will be raised by 50% and in the right conditions, SunPine could meet 14% of all renewable diesel requirements in Sweden by 2030.

What makes this case innovative?

Today it is a world-leading bio-refinery with 100 M EUR sales that continues to develop and invest in new technology and R&D.

BalticBiomass4Value

Circular Bioeconomy in Agricultural Production

Case: Energifabriken – fossil fuel free circular economy

Name of the company: Energifabriken
Country: Sweden
Size of the business: 12 employees
Website: https://energifabriken.se/

Background

The enterprise was established by three farm families, who were interested in replacing their fossil-based energy they used for heating the premises, drying the grain and for all the farm vehicles and machines with more sustainable options with the vision of becoming fossil-free and sustainable at their farms. The six partners have diversified previous work experience and educational backgrounds, incl. four partners with degrees in agricultural science. The three farms switched to Rapeseed Methyl Ester (RME) use instead of ordinary diesel and fuel-oil, and replaced the conventional electricity contracts with green, sustainably produced electricity contracts and started using transports based on fossil free fuel. The challenges related with reaching the goal of having fossil-free fuel on the farms, inspired the partners to use this experience, knowledge and networks for a potential business opportunity and answer the demand from other companies for fossil-free fuel. Private company was established with the plan to build a factory to produce biodiesel out of rapeseed oil. The enterprise received 300 000 EUR financial investment support from the Swedish Environmental Protection Agency through KLIMP, the Climate Investment Program, in order to build a biodiesel refinery. The market analysis showed that trading biofuel instead of building the plant would be more competitive as at the time a local manufacturer was already operating in the region and additional plant was not needed. Thus, the enterprise started to buy biodiesel from other producers and sell it to transportation companies utilizing their own experience in using it in their own farms. In 2018 the company bought a biorefinery developing the circular production starting from farming, producing and distributing biofuel. The company is still growing and at present has offices in three location in Sweden and distribution network in Sweden and Norway. In 2018, it bought another biofuel company and became owner of the largest net of filling stations for renewable fuel in Sweden.

Main activities

The main activity is buying, selling and distributing biofuels, RME, hydrotreated vegetable oil (HVO) and ethanol-based fuel for lorries (ED95). The three farming families' interest in developing fossil-free operations helped them to gain the experience and knowledge and use it to create a business opportunity for biofuel.

The owner families are still running their own farms as well with the ongoing goal to achieve sustainable production, including using Best Available Technology (BAT), for example, commercial fertilizers together with modern spreading technology in order to generate a large climate impact.

Market

Energifabriken distributes and sells biofuels, RME, HVO and ED95 to customers in Sweden and Norway. The company has approximately 60 filling stations. The company owns a factory for RME production in Karlshamn, Sweden. Energifabriken is mostly selling to other businesses. The company is selling fuel for vehicles in heavy transports (lorries and busses) with the customer segments growing over time. Bio-fuel is also sold for company cars and to taxi companies and for housing and to crematories. The fuel is distributed by bulk lorries. The company also leases tanks to over 200 customers.

In addition to the fuel station network for completely renewable fuels, Energifabriken has for a long time developed the infrastructure for biofuels with different types of tank solutions. Often these include permits, legal aid, level monitoring and rental solutions with various pumping systems for refuelling vehicles. Customers are typically pioneers in renewable transport and renewable energy. The Energy Factory is Sweden's largest specialized distributor of biofuels and bio-fuel oil and delivers to customers throughout Sweden. Company offers consultations regarding energy conversion and offers everything from advice and support to the implementation of the conversion and the follow up on the effects of the fuel change.

Challenges and solutions

The manager of the company sees large opportunities for innovation regarding bio-fuels as the norm in society has changed and there is a growing demand for bio-fuels of different kinds. There is a room and need for different sustainable solutions. One advantage for Energifabriken was that the company was fast and first mover, but it sees that there is room for many more companies and solutions.

The largest challenges are in the policy system. The industry is dependent on long-term regulation and cost-neutral energy politics and constant rule and policy changes are problematic for investment decisions. Also, the public procurement ought to be a driving force towards more sustainability.

Another potential challenge is that the requirements for more sustainable fuel production may lead into price conflicts regarding food production and fuel prices.

Funding

The Energifabriken has not received much financial support over the years. One important exception is support from the Climate Investment Program, which made it possible to develop the tank station network. The company also got some smaller support from the Vinnova, the Innovation Agency of Sweden for a pre-study. Otherwise, the company has financed itself over the years. The use of bank loans for the acquisition of the factory was an exception.

What makes this case innovative?

Energifabriken represents a good case of developing circular production motivated by interest in becoming more sustainable in production. The company handles the entire chain of biofuel from cultivation of raw material to production of fuel and use. The primary production in the owners' farms do not use fossil fuels. The use of this experience has boosted the development of biodiesel production and distribution system benefitting other producers and consumers.

BalticBiomass4Value

Case: Ziedi JP - circular economy in a Latvian farm

Name of the company: AS Ziedi JP
Country: Latvia
Size of the business: 100 employees
Website: https://skatskat.lv/virtuala-ture/lauku-seta/lv/kopskats/lauku-seta.html (virtual tour)

Background

The farm Ziedi is a family business. The farm was established in 1991 with family growing vegetables and flowers on 0.25 ha. In 1993, the management was taken over by another family member and in the following years, the area of agricultural land was expanded and the company's operations were supplemented with new activities such as cereals, oilseeds, dairy farming and later biogas and fish production. Expansion was financed by commercial bank loans that were attracted for the development of the farm. The farm has been reorganized several times, adding other interconnected enterprises and changing its legal status. From 2018, it is a family-owned joint stock company Ziedi JP and the business is run by owners' son and daughter. The family has been very energetic and active in gaining experience from around the world (especially from the EU countries, the USA and the New Zealand), supporting the entry of a new generation into the farm and developing more circular production. Funding opportunities after the EU accession have also played an important role in the development process.

Main activities

The main activities are agricultural activities (growing cereals and oilseeds, dairy farming), biogas production from slurry that is used for heat and electricity and for fish production. Fish farming mainly grows sturgeon, eel and caviar. Digestate, a by-product of biogas production, is used for own consumption. In addition, agricultural services are provided.

Market

As the farm is engaged in many activities, the target groups of the products are also different. Cereals and rapeseeds are sold to the cooperatives or processing companies, milk to the processing companies, electricity to the state -owned energy enterprises, and the fish products to the catering companies. Customers are reached in the traditional way, i.e., through direct contacts, negotiations and contracts.

Challenges and solutions

The biggest problems for the business development have been the short- and long-term financing. By using existing facilities, it is possible to increase milk production, as well as the production of fish products, but future plans depend on the ability to attract funding for investments. Future innovation lies in enhancing zero waste process and maximizing existing business results. The goals are to increase digestate drying and granulation for export and reach the intended capacity of 20 tons daily, and to intensify milk production and processing. There is a potential in using the excessive heat for new production opportunities to be set up nearby, i.e., greenhouses, to achieve more circular production.

Funding

The company has obtained bank loans for the development and used EU funds (European Agricultural Fund for Rural Development, European Maritime and Fisheries Fund) for variety of projects. In addition, annual agricultural direct payments and national livestock subsidies are used. The initial investment for establishing the circular production and biogas facilities has been more than 10 mil. EUR.

What makes this case innovative?

Unique aspect in this case is that the principles of circular economy are well presented in one farm as all the activities and branches on the farm are strongly interconnected and complement each other. Agricultural land is the beginning of production and also the end because the digestate returns to the soil

as a fertilizer. One of the products of each industry is the beginning of the production of another branch, thus all raw materials are used in the production process without waste.

Case: Wapnö Farm- sustainability and the circular economy example in a Swedish farm

Name of the company: Wapnö Farm
Country: Sweden
Size of the business: 85 employees
Website: https://www.wapno.se/gaarden/english/

Background

Wapnö Gård is an estate with an old history dating back to the 14th century. The current owner's family has owned Wapnö since 1741. Today, Wapnö is organized as a limited company with one owner. Lennart Bengtsson, the CEO, started to work at Wapnö in 1991, having previously worked at the Swedish Agricultural University, and with the owners diversified Wapnö's BM by expanding from regular milk production and from the being the primary producer at the onset of the agri-food value chain into processing and advancing in the agri-food value chain and getting closer to the end consumer.

The milk production was integrated with the wide variety of activities in the farm. The farm opened its dairy in 1998 and further developed processing and activities onsite with farm shop, brewery, restaurant, greenhouses etc. The farm has added biogas production for more circular production and in 2020, Wapnö is building a slaughterhouse at the farm. Wapnö has also applied for a permit to produce methyl esterbased on animal fat.

Farm opened its production to public through series of events and festivals such cow release day in May, Christmas market etc. Wapnö is an open farm and has around 60 000 visitors every year. The visitors are welcome year-round to get a closer look at the animals, barns and dairy. Wapnö's claim that it wants to be a place that restores the relationship between agriculture and the consumer's plate. The Wapnö focuses on animal welfare, taste experience and sustainable development with prioritization of reasonable use of natural resources and environmental responsibility. Over the years, Wapnö has received several awards, including the Taste Developer of the Year in the food industry and the Environmental Award of the Year. An important challenge for Wapnö is to continue to develop the farm's own production cycle in order to provide a more sustainable food production and at the same time make the food taste more and better. Wapnö claims that this strive makes Wapnö not only an interesting place, but also one of the most important ones.

Main activities

Wapnö is developing a circular economy with a diversified sustainable BM that included dairy and crop production, forestry, processing, sales and marketing. The farm has its own dairy, charcuterie, brewery, greenhouse and restaurant that refines everything that the farm provides.

Wapnö has about 2 500 hectares of farming land that provides food for both the farm's animals and people. Wapnö's assortment of cereals contains e.g., wheat and malt. For the last 25 years, Wapnö has not added sludge to the fields in order to avoid risk of heavy metals, remains from medicines etc. Instead, the biogas plant additionally provides fertilization, which improves the fertility and value of the farmland. Wapnö also has 450 hectares of forest.

Wapnö Farm has grown from 90 to 1 400 milk cows over the years that are kept free range and grazing outside during summer. The animals feed is produced in the farm. To achieve a sustainable production of meat and milk, Wapnö has four different breeds. Wapnö applies rotation on the fields and maintain the fertility of the fields, minimizes diseases and keep the landscape open. The animals contribute to biological diversity.

Since Wapnö farm is a large farm in comparison with ordinary farms in Sweden, Wapnö has been able to create a sustainable small-scale and artisanal food production for consumers. The dairy is an important activity at Wapnö Farm. Wapnö is producing milk, cream, cheese and other milk-based products. The

milk flows only 30 meters in a tube from the cowshed to the dairy farm. In order to show the organic cycle, Wapnö signs the milk packages with the actual milking time, not just the date. Wapnö organic meat comes from the farm's cattle, which are free range and never given antibiotics. In the charcuterie, sausages are soured with buttermilk from the dairy.

Wapnö has a 12 000 m^2 greenhouse, plantations and an apple garden. Wapnö grows tomatoes, peppers, chili, kale, cabbage, onions, apples etc. in soil with added nutrients from the farm's organic manure. The products are delivered to the restaurant and the farm shop and sold to consumers. The greenhouse is heated with renewable energy generated on the farm.

Thanks to the relatively large primary production at the farm, it has been possible for Wapnö to create an environmentally efficient biogas plant. Wapnö farm's biogas, produced from cattle manure, contributes to renewable energy in the form of electricity, heat and cooling, which is needed year-round in the food premises. Wapnö only uses manure from animals on the farm for biogas production and has cut the energy consumption with more than 90%. The biogas also provides high quality digestate which improves the fertility and value of the farmland.

In the brewery, Wapnö brews beer from the farm's water and grains, which are malted on the farm. The farm's brewery is growing fast and today Wapnö has a large range of different beers. In some special beers, leftover tomatoes or kale from the farm are used. Mash from its own brewery and from another large local brewery is used for the production of RME.

Wapnö has a restaurant in the castle and they have registered a trademark: Farm Dining®. The ingredients are coming from the farm. In the restaurant's bakery, bread is baked from malt leftovers.

The farm shop is situated at the farm, and a web shop on the internet is used, where all the farm's products can be bought (dairy products, beer, lemonade, vegetables, flour and meat, charcuterie products from the farm's beef). Wapnö also sells cakes, jams, sauces and other goodies from the farm kitchen in the shops. Wapnö also has a farm hotel and a conference centre that can accommodate 300 people.

Wapnö arranges three large fairs on a yearly basis. The Beer & Whiskey Fair, The Home & Garden Fair and the Christmas Fair. All the fairs are well-known and have visitors from large parts of the country.

Market

Wapnö sells different products. With the open farm strategy, strong focus is on sales and engagement with local customers, but products are also sold through national chains. Through the development of a sustainable diversified business model, Wapnö has climbed the value chain, got closer to the end consumer and developed a very strong brand. Therefore, Wapnö is able to sell its products at a higher price, which reflects the value end-customer put on the products. Wapnö Farm has built and communicated its brand for almost 30 years. Wapnö is focusing on all customer segments. Wapnö is a small company in comparison with the big companies in the food value chain as the market in Sweden is dominated by a few very large food retail companies. Today, the Wapnö Farm brand is very strong. However, nowadays it is much more expensive to use media to build a brand than it was during the early years of the Wapnö Farm development. Thus it is important to market the company and the place, not the specific product.

Challenges and solutions

A crucial challenge for Wapnö, as for other food companies, is the food value chain. There are a few strong actors in the value chain who are close to the end customer. These big actors catch a large share of the total value generated in the food value chain. Wapnö has managed this challenge by ascending in the value chain. Nowadays, Wapnö is closer to the end customer and has built a well-known brand.

A prerequisite for other companies to handle the challenges and develop a BM in line with Wapnö's, is that they regard a sustainability-focus as a possibility to build value for customers, and not as a cost-raising barrier.

Wapnö is a large farm, even though Wapnö is a very small actor on the market. Other large farms can be inspired by the case of Wapnö and develop a circular sustainable BM which brings them closer to the end customers themselves. However, it is a larger challenge for smaller farms. One solution can be that smaller farms cooperate in a network structure and create the same solution as Wapnö has created itself.

Another challenge is the supply of human competence. Wapnö often must train and develop the staff after they have started to work at Wapnö. This is especially important if a company, as Wapnö, has many different business activities and good managerial competences are needed for the different activities of the farm.

Funding

Today, Wapnö is run as a limited company with one main owner. Over the years, a part of the Wapnö area is been sold from the farm when the current main owner bought the other owners' parts of Wapnö. Wapnö has also bought neighbouring farming land over the years.

The company has used bank loans for financing. Wapnö Farm is a capital-intensive company. Further, when a company like Wapnö wants to raise production volumes, the company reaches investment steps, where the company must invest large amounts of money. Hence, it is very important to have good relations with banks. The potential strength is that the value of the farm and the land is high, making it an attractive customer for the banks. However, the potential risks related with external capital are costs that have to be considered. Wapnö has received some financial support from the EU Rural Development Program over the years.

What makes this case innovative?

For more than twenty years, Wapnö has developed its own ecological cycle directly on the farm. The case represents a good example of circular production and integration of variety of activities to achieve higher sustainability. The focus of the farm is on animal welfare, openness to consumers, sustainable farming and reducing the energy consumption.

BalticBiomass4Value

Sustainable Bio-based Products from Plant-based Biomass

Case: Aloja Starkelsen- organic starch and plant-based products for home and industrial application

Name of the company: Aloja Starkelsen Ltd.
Country: Latvia
Size of the business: 87 employees
Website: www.alojas.lv

Background

The enterprise was established on the basis of a partnership. Aloja Starkelsen was founded in 1991 in cooperation between the employee cooperative "ALOJA" and the farm cooperative "LYCKEBY" from Sweden. It was the first food company with foreign capital in Latvia. The company's largest shareholder is Swedish group "Sveriges Stärkelseproducenter".

Production is based on a plant operating in Latvia since 1937 and producing spirits until 1974 and since 1974 producing starch. Organic potato starch production started in 2004 with the first 20 tons, however, only small quantity of it was marketed as organic, while rest was sold as conventional product because at the time the product was not accepted in the market. Organic potato starch production on regular basis was started in 2008, when demand for organic food increased in the world market significantly.

Idea of organic potato starch production comes from Andrejs Hansons, former CEO of the company, who searched for new business niche. Since 2008, volumes of organic potato starch have grown steadily. Since 2013, the company is the second world's largest organic potato starch producer.

While starting organic potato starch production, the driving force was necessity to sustain the product (potato starch) in the market, to keep and increase competitiveness of the company. Finding new business niche was one of ways to be in front of other business players, instead of lagging behind.

In a later phase, when increase of demand for organic potato starch was realised, the company decided to focus on organic food and food ingredients production. The new business strategy was developed, and it included measures to build production chain, where starch processor and producers of raw material – potato – are linked by cross-cutting interests. The company strives to satisfy world market demand and, to do it, must have access to the raw material – organic potato, meeting certain quality requirements and in volumes, satisfying the company's production targets. In order to ensure all of the abovementioned, the company has created a network by joining organic potato growers, breeders and researchers in one chain, and has established an organic potato starch competence centre, whose main objective is to promote knowledge on organic potato breeding and growth in the Baltic states. More than 100 Latvian and Estonian farmers are growing and delivering organic potato annually to the enterprise, and due to the world market's growing demand, volumes purchased from the farmers are still increasing.

New direction for the company is the products made from organic brown pea and fava bean. Those have been developed due to two strategic considerations: business interests in developing organic products portfolio and interest in using legumes, because according to the most effective growing technologies, legumes are excellent pre-crops for potato, thus letting to achieve good yields.

Main activities

The company is producing organic and conventional potato starch. Potato starch demonstrates many valuable characteristics: a superior water binding capacity, the ability to build excellent viscosity, low temperature swelling, lack of taste, transparency, GMO and gluten-free qualities, as well as lack of

allergens. Production residues are delivered to farmers – potato juice for fertilizing fields and potato pulp for animal feed.

Besides starch, the company is producing packed products: jellies, deserts, spice mixtures, baking powder, and vanilla sugar. The most of them contain starch as one of ingredients. In 2017, the company started development of new business direction – production of flour and protein concentrate from organic legumes – brown pea and fava bean.

The company holds a small laboratory, where it, on demand of customers, develops recipes for different dairy, confectionary, drinks, snacks, meat produce and other products. Each recipe is custom made and unique.

The company is maintaining internationally recognised quality standards and is certified organic producer. It maintains certificates such as: EU organic (LV-BIO-02), Krav (Sweden), USDA Organic (BCS), China Organic (COFCC), JAS Organic, BRC, GMP+. It is certified also to supply ingredients for Kosher and Halal production systems. It is worth to mention that the company is also certified as gluten free production site.

Market

The main customers are food industries, supply chains, supermarkets (RIMI, Maxima, LIDL, ALDI COOP etc.). The main destinations are the Eastern Europe, Scandinavia, Italy, Taiwan, Japan and the USA.

Each year, the company participates in thematic exhibitions such as the Food Ingredients, BIOFACH, Snack Expo, Riga Food and other, and takes part in business missions to Asian countries. Here customers are found in many cases. Informative leaflets about the produce are distributed. The company's website, social media (Facebook, YouTube) and organic products and recipes advertising websites (www.organicpeaprotein.eu, www.organicpotatostarch.com, https://www.culinar.se/english/) are used.

Challenges and solutions

There are several channels for potential customers who are looking for organic potato starch or pea protein, but still a challenge to reach customers who are not aware of those unique organic ingredients exists. In the future, the enterprise's interest is to expand its customer base. The challenge is that it can take a rather long time before market is familiarised with new products and ready to use them (for example, organic pea).

Company plans to continue with organic product production and sales, to follow worldwide organic product growth. Major investments are planned, including development of pea peeling production unit, dry products mixing and packaging unit and development of pea melting and classification production unit. General target is the development of diverse organic products.

Funding

Owners of the company are shareholders and they make decisions on the use of the profit. Funding used for the development measures, especially for the investment in infrastructure is coming from: the company's revenues; bank loans, the EU funding acquired via open calls for proposals.

Starting production of organic potato starch did not require investments in infrastructure, however, it required a lot of management and development measures related to introduction of quality management system, increase of knowledge level of employees, thus enabling them to execute, supervise and monitor production process.

The public sector and the EU funding have been used for the development of production facilities and increase of energy efficiency, and for participation in international exhibitions and fairs. For this, the EU financing managed by national Rural Support Service (LAD), Investment and Development Agency of Latvia (LIAA), and state-owned development finance institution "ALTUM", was used. Public

funding, such as the Estonia – Latvia Cross Border Programme supported by the European Regional Development Fund (ERDF), was used for strengthening the network of Latvia's and Estonia's organic potato growers, breeders, researchers, and processors, and for the development of the organic potato food production chain. The organic pea and bean production require development of new infrastructure and for this purpose the EU funding (40% of total amount) was acquired via open calls for proposals, while 60% of financing came from bank loan.

What makes this case innovative?

The enterprise is working on product and processing innovation and offering in the market organic plant-based products for industrial application and developing new protein products for customers. Important aspect is development of unique recipes for different dairy, confectionary, drinks, snacks, meat produce and other products with each recipe custom made. The company is certified as gluten free enterprise helping to develop and cater to this fast-growing market niche.

BalticBiomass4Value

Case: Lilli Agro – organic straw pellets for animal bedding

Name of the company: Lilli Agro OÜ
Country: Estonia
Size of the business: 3 employees
Website: http://lilliagro.ee/?l=en

Background

The idea to create Lilli Agro arose more than ten years ago, when the owner of the company was engaged in the distribution of straw pellets produced in Lithuania to the Estonian and Finnish markets. As the owner of the business is also a farmer, he started using imported straw pellets as bedding for his animals.

The straw pellets were novel at that time and, according to the company, there were actually the best animal litter on the market so far. The straw pellet has good moisture and urine absorption properties. In addition, the use of straw pellets has a fast and efficient circular economy effect, thus saving the working time and space of the straw pellet user. The straw pellet decomposes quickly compared to other litter (sawdust, planer chips, etc.) and this allows the used straw pellet to be brought to the field immediately after a few months as an organic fertilizer.

Encouraged by the ease of use and good properties of straw pellets, in 2013, the company decided to start producing straw pellets itself. This activity was profitable and the company already had a market for their production from previous distribution and sales activities.

Main activities

The company's main activity is mixed farming. Horses, cattle and grain are raised and feed is produced for own consumption. There is a total of 1 350 hectares of arable land. Thus, most of the raw material or straw is obtained from their own fields. The additional raw material is bought from local farmers. Years ago, the company provided agricultural services, but with the rapid growth of production of straw pellets, over time it no longer possible to provide agricultural ancillary services.

Straw pellets are mainly produced for bedding for horses. In the past, straw pellets have also been offered for bedding for birds, mulch, heating and pets, etc., which have been praised by customers, but the company decided in favour of the horse breeders' market segment. Thus, the company has found a niche for its production. While in other countries most straw pellets are produced for biofuels, Lilli Agro produces straw pellets primarily for animal litter.

Market

The main and largest segment for Lilli Agro's straw pellets is horse breeders. Prior to the creation of Lilli Agro, the company was an intermediary for straw pellets produced in Lithuania. The pellets were bought in and resold mainly to the Nordic countries (Finland and Sweden). In this way, the company created a market for itself and had previous experience in the horse breeding field.

The sales of self-produced straw pellets are based on the direct contacts that have developed over the years. In order to find new customers, the company attends trade fairs, but recently the main emphasis has been on web marketing and direct contacts, i.e., the advertisement is sent directly to the customer's e-mail address or by calling the customer. Customers' own recommendations contribute a lot to sales.

The retail sale of straw pellets is organized by the company itself and the sale takes place directly to the final consumer. The company uses a logistics company through which direct deliveries are made to the end customer. Intermediate warehouses and intermediaries are not used, because the use of intermediate warehouses makes the product more expensive, which in turn has a detrimental effect on product sales.

Challenges and solutions

Although the use of straw pellets is widespread, the company remains in the equine market segment. One of the biggest challenges is Estonian climate and weather-related risks. The unpredictability of weather affects straw collection from the fields and the ability to fulfil the orders. Excessive moisture causes quality problems and, due to the droughty summer, the crop remains low, and it is not possible to collect enough straw from the field, creating new risks for the enterprise.

There is fierce competition in the straw pellet market, and those whose production costs are low remain competitive. This, in turn, requires a sufficient amount of arable land to produce enough straw and a sufficiently long and suitable harvesting time to obtain straw of sufficient quality. Lilli Agro has a sufficient amount of agricultural land, which gives it an advantage over some other farmers, such as Finnish farmers, for example, who have very small farmland. Farmers in neighbouring countries south of Estonia (Latvia, Lithuania, Poland, Ukraine, etc.) who have better preconditions for straw pellet production (larger production areas and longer harvesting time) have a competitive advantage, which makes the cost of straw pellet production lower. Therefore, in order for production to be competitive, the availability of raw materials and the location of final customers must be carefully considered. It is not worth transporting raw material very far, and since the production weighs a lot, it is also not worth selling pellets very far. All raw materials should be available close to the production and also customers could be located no further than in a neighbouring country. In addition, straw processing is energy intensive. It is not possible to make a pellet from wet straw, because in this case the granule will mould and product quality problems will occur.

Funding

The company has been financed by creditors' investment loans for the purchase of a production line and, to some extent, support has been received from the ‘LEADER’ measure of European Agricultural Fund for Rural Development for the improvement of buildings. For the enterprise, the minimum investment for the optimal production quantity in Estonian conditions and for the acquisition of a new production line for straw pellet, was around 0.5 million EUR.

What makes this case innovative?

Case represents use of agricultural residues for circular production and sustainable products. Straw pellets are a pure, unadulterated natural product for animal bedding. The straw pellet has an excellent absorption capacity and is hygienic. Straw pellets are also supported by their ease of use and easy disposal.

Sustainable and Novel Bio-based Products from Food Waste and Biomass for Replacing Plastic

Case: Kaffeeform - coffee cups made from coffee grounds

Name of the company: Kaffeeform
Country: Germany
Size of the business: 5 employees
Website: https://www.kaffeeform.com/de/

Background

Kaffeeform was founded 5 years ago, but the development goes back to at least 8–9 years. Julian Lechner, the CEO and founder of Kaffeeform had studied product design and had interest in material innovation and material composition. The observation that the coffee grounds from sieve carrier machines already have a solid form triggered the founder's interest in whether the whole thing could be made more durable and coffee grounds or waste could be used as a resource.

Eight years ago, scarcity of resources, waste of resources and the worldwide increase in coffee consumption were not yet the big issues as they are today. At that time, the founder had the vision that there should be a way to bind this coffee grounds permanently, to "fix it" and make a new product out of. Founder Julian Lechner worked on this during his studies and in his thesis preparation. The research included a lot of trial-and-error testing of various additives. The aim of the development was not a once-only product, but a durable, long-lasting product to take the waste out of the cycle and to bind it in the long term. At some point, after various exchanges with material and technology experts, the founder Julian Lechner had found a suitable "formula" and came up with very robust, durable, light material which, apart from small changes, is still used today. In 2014 and 2015, the first prototypes were available and they received a lot of positive press and interest even though the product did not even exist yet. The founder decided to take the risk and establish the company and build it according to their own guidelines, visions and ideas and without outside capital.

In 2015, the first product, the espresso cup came on the market as a tangible product with a great symbolic character and beautifully describing the cycle: drinking the coffee, is how the coffee grounds are created, and in the end, coffee is drunk from the coffee grounds based cup, and this closes the coffee cycle. The espresso cup financed the development of the next size, the cappuccino cup. The somewhat bigger breakthrough came in 2018 with the Take Away Cup. The development of this cup was a mixture of own ideas and own product development, but also included the consideration of the current zeitgeist and the feedback of the customers. This cup then drove the business up again and it has a certain lifestyle character according to the motto "This is now my coffee cup".

Employees of Kaffeeform organize the whole production process themselves starting with collecting the coffee grounds in Berlin from larger co-working spaces by a bicycle courier. At first, the idea was to collect coffee grounds from cafes, that was not feasible and a little bit bigger approach was needed. Using co-working spaces has many advantages such as the co-working spaces also know which coffee beans they use, support fair trade with money going directly to the farmer and information is available from which farmer it came from. The transparency on the raw material is very important to the Kaffeeform.

These coffee grounds are processed in a workshop employing people with disabilities in Berlin, thus company's activity has another social component. Production process has a lot of manual work. Grounds are dried, processed, vacuumed and collected. In the next step, the coffee grounds go to their partner in the southern Germany, who has the expertise in the processing, how to generate an intermediate product in form of pellets and the different material components (biopolymers). These pellets have been developed in such a way that theoretically any shape can be made from them by injection moulding.

The partner shapes the cups, which are then sent back to them or to the Förderwerkstatt in Berlin. This company takes over the entire storage and logistics for products and has link to their online shop and ships the products to end or business customers.

Thus, coffee cups are made from a fairly large amount of recycled coffee grounds and that product consists only of plant substances. The marbled surface is created by beechwood chips and then there are the biopolymers that do all the binding. These include cellulose fibres, natural resins and oils. There is no added dye. This product is designed to be recyclable. The cups can be thrown to the household rubbish or sent back to Kaffeeform, where they will be received and used to create new products.

Main activities

Production and sale of coffee cups that are made from coffee grounds.

Market

Kaffeeform has a retailer program and they sell through their own web shop, plus the partner network with over 400 active retailers in Europe. They have not defined very specific target customers. Their clients include everyone from "coffee-earth", families who like Kaffeeform large milk coffee cups very much, to large corporate customers. The later includes retailers, cafes, concept stores or museum stores in which Kaffeeformis represented for certain exhibitions.

The branding and utilizing the take-away cup, a high-quality product with the option to include a logo for corporate and event related gifts, is an important marketing tool. Publicity in Germany and international press has been important. Kaffeeform has appeared in various TV productions, has social media channels with their own community. The company has been also present at events like the Berlin Coffee Festival, or Zero Waste events.

Challenges and solutions

The enterprise is strengthening core business in Berlin where its activities started. The company wants to grow organically in the European market and initially positions itself securely. Especially because the company does not have a financial backup that would allow them to expand worldwide quickly. However, the enterprise would like to open itself up to the international market step by step. There is a demand from the USA and the South America, but enterprise has to make sure that their production structures could be met there. In the long term, establishment of a second location could be considered. In addition, the enterprise is continuing to work in the area of product development, as the company wants to expand its product range to show what can be done with their material in the area of household products and lifestyle.

Funding

Outside funding has not been used. New products and the development have been financed from the proceeds of the previous product. The enterprise does not have its processing facilities, but uses a network of partners to do the processing. Thus, there were no investment costs.

What makes this case innovative?

Case represents product innovation for a more circular production and waste utilization, more specifically the innovation has been in the development of the material. Right now it is used in the form of coffee cups, but in the long-term other forms are also planned. Support to fair trade practices and social enterprises adds a social dimension to enterprise’s activity.

BalticBiomass4Value

Case: Spoontainable – edible ice cream spoons

Name of the company: Spoontainable
Country: Germany
Size of the business: 7 employees
Website: https://spoontainable.com/

Background

The founders met at the University of Hohenheim at the end of 2017 where they were studying plastic alternatives. Whilst eating ice cream they got the idea of the edible spoon, as they realized that it would be super convenient to also be able to eat the spoon. Afterwards, they tested their idea in their shared kitchen, starting with plain cookie dough and developing their first prototypes in that very kitchen. They noticed that the plain cookie dough wouldn't work. After several different trials, the skin of cocoa seeds, the waste created by the chocolate industry, was found to be a suitable option. By baking the 'choco-waste' into their dough they created an alternative to plastic and have contributed to finding a super sustainable use for food waste for a more circular economy.

In the beginning, founders were driven by the curiosity, but the products also were very well received by the clients, and there is a great societal interest in sustainability. Additionally, the plastic-ban for 2021 provided a good opportunity for building the business. The entrepreneurs saw their chance to show that small changes can have great impact and therefore they held on to their product. The oat husks are purchased regionally. The processing into fibres takes place in Poland

Main activities

The company's revenue model relates only to the development and sale of edible ice cream spoons.

Market

In the start-up phase, the entrepreneurs sold their products by personal direct sales by visiting and introducing their spoons to ice cream parlours. Through the personal contact, it was much easier to present their new and unusual product that required many explanations.

At present, the enterprise has a wide range of customers such as classic ice cream parlours, cafes or food trucks at festivals selling ice cream, frozen yoghurt and bubble waffles. The cafes benefit from offering a sustainable alternative and thus attracting more customers. Many parlours integrate the price of the spoon into the final price. Others take a so-called small 'environmental fee' to be paid extra by the guests if they decide for the more expensive alternative. Therefore, in the end it is the decision of the consumer.

Caterers have also been a very interested segment. They sell their products directly to traders who then include them into their portfolios, which are presented to their restaurateurs. That is how the trading system in Germany works.

Enterprise is currently working on a deal with a big supermarket chain, so they expect to start selling their products through retail chains soon, and with integrating their products into retail, they are trying to reach a larger customer base.

Enterprise also is currently maintaining a website and an online shop, which works more or less automatically. Enterprise is very active on social media, because it is a good way for reaching out to end consumers and raise awareness about the products and sustainability.

Enterprise has applied for patent and has their trademark protected. There are some imitators, but so far those have not offered better products. The enterprise has sustainable value chain and a strong unique selling point with their cocoa skin residues and fibres from the food industry.

Challenges and solutions

Their goal is to become the market leader in the area of sustainable -alternatives to plastics for the gastronomy sector. Which means working on and launching a bunch of new products. Currently, the enterprise is developing stirring sticks for coffee, small forks, a whole cutlery set, which will be launched soon. This will require a new production and additional research. Enterprise is already selling the spoons in ten different countries and would like to expand to outside of the EU markets.

Enterprise is in a very good position thanks to the plastic ban. Since they not only use the skin of the cocoa seed but also oat husks there is no shortage of raw materials. On the one hand, the food industry is full of wasted peels, husks and skins, which can be processed into fibres that can be used in their products. Moreover, the market is growing creating demand for this kind of products.

Funding

The entrepreneurs founded the company whilst studying in the university and without having savings or other capital. Therefore, they started a crowd funding campaign, which allowed them to finance the first production of the spoons. For further financing, bank loan was used and later the revenues from selling spoons was used for financing. For further growth and optimization, another investment has been made recently.

What makes this case innovative?

Case represents a smart production innovation based on recycling food industry waste. The basis for their edible ice cream spoons is 100% sustainable raw materials as the enterprise uses biogenic residuals from the food industry. Therefore, they create a sustainable value chain for edible spoons that has no food waste, the products are suitable for vegans and plastic free.

BalticBiomass4Value

High-value Products from Knowledge-based Processing

Case: Est-Agar – sustainable enhancement of the red algae *Furcellaria lumbricalis*

Name of the company: Est-Agar AS
Country: Estonia
Size of the business: 25 employees
Website: http://estagar.ee/

Background

The enterprise is currently owned by three friends who were interested in engaging in the blue economy, namely the cultivation and processing of seaweed on the Baltic coast, on the island of Vormsi. The entrepreneurs studied the value enhancement opportunities offered by algae growing on the Estonian Baltic coast and their uses. They learned that it is possible to extract various useful substances from seaweed growing in Estonian coastal waters with the help of different technologies, which can be used mainly in the food and cosmetics industry. As a result of long research and considerations, it was decided to buy the Est-Agar plant on the largest island of Estonia, Saaremaa, which is the only producer of a unique texture-adding additive produced from the red algae *Furcellaria lumbricalis* – furcellaran. The deal was reached in 2016, when friends bought all the shares of the factory together. With this, they gained access to a working industrial plant, an opportunity to realize their ideas, access to an algae quota and raw materials, and existing market.

The history of Est-Agar dates back to the 1960s, when Estonian marine scientists established that the stabilizing, thickening and gelling agent furcellaran can be produced from the red algae *Furcellaria lumbricalis* found in the Väinameri Sea in Estonian western coast . This discovery was followed up by 'Kalev', Estonia's largest candy factory, which developed the technology for furcellaran production and in 1966 built the furcellaran industry in the island of Saaremaa. The 'Kalev' candy factory used the industrial production primarily as an input for its production, but furcellaran was also supplied elsewhere – to Russia, Ukraine, Latvia and everywhere else. At the beginning of re-independent Estonia, in 1996, another company bought the furcellaran factory from the candy factory, and in 2016 the industry was bought by its current owners who proceed with working on new R&D.

Main activities

Est-Agar's production is unique because it is the only producer in the world of the texturizing additive furcellaran produced from the red algae *Furcellaria lumbricalis*. It mainly produces fluffy furcellaran, the processing technology of which dates back to 1974. The company also has a pilot plant for the production of small quantities of furcellaran in powder form for the cosmetics industry. The plan is to proceed with design and development of production plant for producing furcellaran in powder form with larger equipment and in larger quantities. Furcellaran in powder form would allow the company to enter not only cosmetics industry, but also further expand in the food industry market and its customer base.

The raw materials used for the production are local and the enterprise trawls red seaweed from the Baltic Sea and processes it. Although the company has an alga catch quota, in addition to red algae, it is also purchased from local coastal residents, who collect algae drifting ashore from the shores of the Saaremaa island. The tradition of collecting algae is passed on in local coast areas.

Market

Most of the production is sold to the confectionery industry, the customer base of the cosmetics industry is growing and there are a few customers in the medical industry. The largest customer in Estonia is the confectionery industry 'Kalev' and 80% of the products are delivered worldwide. The production is sold directly to the customer, i.e., the company does not use intermediaries.

Although the company is the only producer of furcellaran in the world, it competes in the whole market of hardeners, thickeners and hydrocolloids. The company's competitors are producers of gelatin, pectin, carrageenan, alginates, agar-agar and other products. The company consciously tries to make itself more visible and is constantly looking for new customers, including visiting exhibitions and fairs to create direct contacts and communication with potential customers and for direct marketing. The marketing includes the development of new website to be even more visible, searchable and easier to access than before. The company does not position itself in large markets, i.e., it does not seek large customers, because the company's production volumes are marginal in terms of the world's major producers, depending on the volume of raw materials and plant capacity. Position itself as exclusive, different and for different customers whose products have the same exclusive output.

Today, it is very difficult to find a customer in another industry, because it also requires a lot of recipe development ability by the company. Therefore, Est-Agar sees companies and laboratories that develop formulations for factories and manufacturers and a final mixture consisting of different substances (texturizing agents, emulsifiers, etc.) as their main customers.

Challenges and solutions

One of the biggest challenges is to find new customers, to increase sales and volume. Another challenge is technological developments in order to develop new products and market those. The company has several ongoing cooperation projects with research and development institutions. The Danish University of Technology is studying the technological possibilities of separating substances different from the second growing algae species in Estonia. In co-operation with Estonian universities and biotechnology companies, ways how to produce a dye from furcellaran and how to add extracted algae residues to fertilizer are being studied. The aim of cooperation projects is to make maximum use of available natural resources. As a side activity of the company, the cultivation of shellfish in the Baltic Sea is being tested. Shellfish farming and enhancement are studied in cooperation with research and development institutions.

Funding

Est-Agar has been funded by using creditors, investment loans and owners' own capital. In addition, public sector opportunities (investment grants from the ERDF) have been used. It is planned to continue such a funding scheme in the near future.

What makes this case innovative?

Case represents a unique product from aquatic biomass. Est-Agar is the only producer in the world of a unique texture-adding additive produced from the red algae *Furcellaria lumbricalis* – furcellaran. In order to expand the use of furcellaran, in addition to production, technology and product development are actively pursued in cooperation with research and development institutions.

BalticBiomass4Value

Case: SatiMed- wellness and health products from the hemp plant

Name of the company: UAB SatiMed
Country: Lithuania
Size of the business: 8 employees
Website: https://www.satimed.eu

Background

SatiMed is a biotechnology R&D company that started with research ten years ago in the field of biochemistry and concentrates on natural herbal remedies such as hemp-based products. The driving force was the trend towards the integrated, personalized medicine and wellness through taking care of personal life and one's health. The enterprise is built on international team working with molecular biotechnologies for innovative solutions. Successful discoveries have become the basis for developing intellectual property in the phyto-biotechnology niche.

Main activities

Activities include R&D and product development for a full spectrum of hemp-based products, production and distribution. SatiMed manufactures organic hemp oil-based products which comprises essential combination of non-psychoactive phytocannabinoids from hemp plant: cannabidiol, cannabidiolic acid, cannabivarin, cannabigerol and other useful compounds including terpenes, omega fattywacids and waxes. The enterprise has four patents and they license intellectual property. In addition, they have specific intellectual property rights (IPR) strategy. They are niche leaders in the specific R&D field with the goal that their inventions transfer to the market always step ahead.

Market

The customers for organic hemp oil-based products are persons with interest and knowledge in wellness and living environment. Normally, customers are acquired via affiliates. SatiMed exports most of production to the USA, so it sees that it is crucial to strengthen their position in the most significant global market further, as well as to seek new markets in the European Union and in the UK. Products and services are marketed at exhibitions, trade shows and by training of affiliates. Participation in international exhibitions is an important investment that promotes enterprise progress, technology deployment and export market development.

Challenges and solutions

The biggest problems for the business development are unsustainable business environment and regulation due to lack of expertise in public authorities. Solution would be an improvement of regulatory environment with inflow of life science expertise and knowledge on hemp products.

Funding

Financing of company has been based mostly on private investment. The public support has been utilised for the R&D, exhibitions, overseas missions and publicity.

What makes this case innovative?

Case represents R&D intensive use of local natural resources as SatiMed focuses on research and development of hemp plant-based full spectrum products, incl. hemp plant-based natural remedies to cosmetic industry, dietary supplements and functional food products that support wellness and a healthy lifestyle. High quality products are manufactured in good manufacturing practices (GMP) standards compliant facility. The company employs science to develop process innovation for extracting herbal compounds in the cleanest and most effective ways.

Case: oceanBASIS - natural cosmetics and food from seaweed

Name of the company: oceanBASIS GmbH
Country: Germany
Size of the business: 20 employees
Website: https://www.oceanbasis.de

Background

In 1994, CRM – Coastal Research & Management was founded in Kiel, Germany, by experts of marine ecology and economy. The aim of the company is the protection and the sustainable utilisation of the sea and the coastal zone. CRM conducted environmental studies and projects for private and public clients. Different studies about the impact of aquaculture on the aquatic environment have led to the development and establishment of the first seaweed farm in the Baltic Sea, followed by the first certified organic mussel farm in the Baltic Sea demonstrating the principles of Integrated Multitrophic Aquaculture (IMTA). In 2000, the first biomass produced was *Saccharina latissima*, the sugar kelp, which served as the basic material for the development of two bioactive extracts for the cosmetics industry, and for own natural cosmetics line. A seaweed processing chain was established, including algae-specific adaption of disruption, extraction as well as filtration technologies. Since 2005 CRM has specialised also in investigating marine natural substances, i.e., different seaweed extracts as antiviral and antitumoral agents. Since 2012, bioinformatics research has been established as a new field of R&D and service at CRM exploiting algal genomic resources for bio-industrial purposes.

First successful seaweed cultivation and application of the processing chain initiated the foundation of oceanBASIS GmbH in 2001 aiming at the development, marketing and sales of bioactive skin care extracts and natural cosmetics derived from sustainably used marine organisms. The first skin care products ("Baltic Care") containing a new fermented seaweed extract was launched in 2002. In 2009 the brand name changed to "Oceanwell" and the marketing has been professionalised with the help of a marketing agency. Furthermore, "Oceanwell" received the NATRUE-certification as "natural cosmetics". In 2010, company patented a native collagen isolated from a jellyfish. While the technical development of two medical products on the basis of the jellyfish collagen – a wound gel and a bioscaffold – was successful and oceanBASIS gained valuable knowledge on quality management (ISO 13485), the market introduction failed. In 2012, the brand "Oceanwell" was expanded by the sub-line "Ocean Collagen", the first skin care on the basis of a native collagen from a marine invertebrate organism. In 2014, a near shore integrated multi-trophic aquaculture (IMTA) facility was separated from company and established as a separate limited liability company "Kieler Meeresfarm UG". Its facilities were extended with a research module for cultivating microalgae and bladderwrack.

Main activities

Revenue is created by sales of bioactive extracts for the cosmetics industry, as well as by sales of natural skin care products and food (supplement) products. Main activities are developing, marketing and sales of these products. Side activity is R&D in Marine Biotechnology. Focus of oceanBASIS is the manufacturing cosmetics products and ingredients from sustainably produced marine living resources. The brand "Oceanwell" is the only marine cosmetic brand, which is certified as "natural cosmetics". The company holds two patents on jellyfish collagen and one application on an antitumoral extract.

Market

Customers are distributors of skin care products or directly the end consumers. In case of bioactive seaweed extracts, the manufacturers of skin care products are customers as well. Costumers are reached via the direct offers, online marketing, e-commerce, social media, PR and exhibitions.

Company has also used the unconventional marketing strategies, especially via online channels. The marketing budget is relatively low compared to other cosmetic brands. Marketing is supported by the fact that natural cosmetics are a growing market in Germany.

Challenges and solutions

The natural cosmetics market is well developed in Germany. The company sees a good potential in further expanding the share of the brand "Oceanwell". In the future, they would like to grow in a way that is allowing them to work as a productive, self-determined organisation doing meaningful work by fostering a healthy society and the environment.

The biggest problems for the business development are: reaching the bioactives market, because there are only a handful of relevant players dominating it, and reaching the customers as a newbie in the natural cosmetics market.

Funding

oceanBASIS is performing its business financially independently. In the beginning, public funding was received in order to establish the seaweed farm and a B2B IT-infrastructure. Support has been received from the public sector for R&D projects and exhibitions as well.

What makes this case innovative?

The case represents innovative use and R&D in aquatic biomass. As the oceans harbour an immense wealth of natural substances, oceanBASIS specializes on utilizing those in developing marine based natural health and wellness products and marine products for food industry. A team of experienced marine biologists and natural product experts develop and market products for cosmetics and pharmaceutical industries. Natural cosmetics are based on mainly bio degradable compounds and free of microplastics which comes with a lot of environmental benefits. oceanBASIS thereby complies with strict sustainability and quality criteria.

High-value Products from Circular Bioeconomy

Case: Borregaard – production of sustainable and environmentally friendly alternatives to petrochemicals

Name of the company: Borregaard
Country: Norway
Size of the business: 1 103 full-time equivalent (FTE) employees
Website: https://borregaard.com/

Background

Borregaard is a company with rich traditions and with the first industrial plants dating back to the 1600s. The modern industrial activities began with the English owned Kellner Partington Paper Pulp Company Ltd. in 1889. In 1918 Borregaard was taken over by Norwegian owners. The company built a cellulose factory near Sarpsfossen waterfall. This ushered in the era of modern industry with what would later become one of the largest industrial plants in Norway. Until the Second World War, Borregaard's main products were cellulose and paper. Since then, production has been expanded to include a wide range of chemical products, and Borregaard has engaged in several important activities in other areas. In 1986, the two companies Orkla Industries and Borregaard merged into one company, Orkla Borregaard. When Orkla Borregaard merged with Nora Industries in 1992, the new company took the name Orkla, while the chemicals business area was kept under the Borregaard name. Sarpsborg remained the headquarters of Borregaard. On the 18th of October 2012, Borregaard was separated from Orkla and listed on the Oslo Stock Exchange (BRG).

Main activities

Borregaard produces advanced and environmentally friendly biochemicals that can replace oil-based products. Borregaard is organised in three business segments:

- Segment of performance chemicals develops, produces and sells lignin-based products used as binding and dispersing agents in a wide range of end-market applications, such as construction, industrial binders, agrochemicals and batteries. In addition, the performance chemicals segment includes trading of chemicals which are either linked to lignin-based products or have previously been produced by Borregaard.
- Segment of speciality cellulose develops, produces and sells speciality cellulose mainly for use in the production of cellulose ethers, cellulose acetate and other speciality grades. The production and sale of second-generation bioethanol are also part of the speciality cellulose segment.
- Other businesses consist of ingredients, fine chemicals and cellulose fibrils. Borregaard supplies vanillin products to flavour and fragrance companies, as well as to the food and beverage industry, and is the only producer of wood-based vanillin in the world. Fine chemicals are supplied to the pharmaceutical industry, and the company is the world's largest supplier of intermediates for non-ionic X-ray contrast media. Cellulose fibrils consist of two product ranges: SenseFi for food products and Exilva for industrial applications. Other businesses also include sales of basic chemicals from the chlor-alkali production.

Company has a biorefinery in Sarpsborg, Norway and seven production sites outside Norway dedicated to producing lignin-based products. The company also has sales offices in 16 countries in Europe, Asia, Africa and the Americas serving its global customer base.

Market

Borregaard sells to industrial customers all over the world, and is a world leader in its corresponding industrial markets. The strong market position has been developed through in-depth understanding of its markets, production of advanced and specialised products and local presence in the form of a global sales and marketing organisation. 59% of revenues came from biosolutions, where 650 products are sold to around 3 ,000 customers. 34% revenues are from biomaterials, 7% from fine chemicals. Geographical distribution of sales for 2019: Europe – 50%, Asia – 21%, Americas – 28% (USA/Canada 23%, rest of Americas 5%), rest of the world – 1%. Approximately 90% of sales are handled through own organisation.

To maintain its leading position, Borregaard has a strong focus on training programmes and cooperation between the various disciplines and R&D. Approximately 13% of Borregaard's revenues come from new products (average in the last 5 years).

Challenges and solutions

Borregaard is a publicly traded company, so anything related to strategy and growth intentions is only available on investor updates and the official strategic documents.

Funding

The company has a very long history and is a publicly traded at the Oslo Stock Exchange (BRG).

What makes this case innovative?

The Borregaad case is unique case, not only in the Nordics but in Europe. Unique business model with high value added through full utilisation of raw materials and production of several co-products. Production is sustainable (profit+environment) and environmentally friendly, and the products create alternative to petrochemicals. Borregaard's niche products (biopolymers, specialty cellulose, cellulose fibrils, pharma intermediates, biovanillin) have applications in a wide range of end-markets including construction, agriculture, food and beverages, transport and pharmaceuticals.

BalticBiomass4Value

Case: Emsland Group - sustainability through 'using nature to create'

Name of the company: Emsland Group
Country: Germany
Size of the business: 1 200 employees
Website: https://www.emsland-group.de/

Background

The Emsland Group manufactures vegetable (potato, pea etc.) based innovative products for the processing industry. The Emsland Group is not only Germany's largest producer of potato starch, but also the market leader for flakes, granules and specialties. Since 1928, the solutions developed by the Emsland Group have been used worldwide in the processing industry. Since then, more than one hundred products were created and now used in the food sector, food retailing, in technical applications as well as for animal feed. When the German government changed the fertilizer legislation, the Emsland Group saw opportunity in the starch-based flocculants as a good alternative to synthetic polymers. The starch is renewable and ecologic friendly. The production facilities are situated in seven locations with each site having its own unique core competencies.

Main activities

The main activities are processing of potatoes and peas, and modifying the starches and proteins. Enterprise produces pea and potato starch derivatives, potato flakes and granules, pea and potato fibres and proteins. According to the company, they are the only ones in the world which are producing pure starch-based flocculants for waste water, liquid manure and digestate.

Market

The Emsland Group is one of the leading companies in creating innovative product solutions based on renewable raw materials, mainly from potatoes. The Emsland Group's products are used in many industrial branches like food-, adhesives-, textile or paper industry. Products are distributed via agencies located worldwide. Different kind of marketing tools like online marketing, social media, exhibitions, trade shows, advertising activities are incorporated. Company exports 76% of its production, and its market includes 120 countries worldwide.

Challenges and solutions

The Emsland Group has plans to further grow in the future. Enterprise has invested a lot into modernization and new equipment as well as into new product developments in all kind of segments. The challenge lies in the full utilization of the existing equipment.

The biggest problems for the business development are legislation and its implementation; an adaptation of existing systems to the starch-based flocculants.

What makes this case innovative?

The case represents a strong processing and production innovation focused company exploring the opportunities to expand the use of selected agricultural produce for wider variety of applications within food industry as well as in other industries. The company is the only one in the world which is producing pure starch-based flocculants for wastewater, liquid manure and digestate.

BalticBiomass4Value

Utilization of Municipal Waste and Sewage

Case: Greve Biogass – biogas from agricultural and municipal waste and sewage

Name of the company: Greve Biogass AS
Country: Norway
Size of the business: 12 employees
Website: http://grevebiogass.no/

Background

Greve Biogas is a partnership established by 11 different municipalities in the Western region of Oslofjord. The story of the company started in 2008, and then, on one hand, the local politicians wanted to do something regarding green sector, and on the other hand, the farmers in the region had problems with too much manure. Thus, the establishment of Greve Biogass provided an opportunity to address both issues and keep up the agricultural production, while using the manure and agricultural residues for biogas production. It was decided that all public transport (buses in the region) should be fuelled by biogas and thus a market was established.

Main activities

Greve Biogas produces biogas from household waste and manure from agricultural production. Company has a biogas distribution network. The company is focused on circular bioeconomy development in cooperation with local farmers and public sector.

Market

Company sells biogas directly to local public transportation companies. Company operates its own biogas station and has one selling site and one production site. The digestate is sold directly to farmers.

Challenges and solutions

At the time being, the market outlook is positive. One possible development is the impact of electrification of transport, as the company has to find new ways of using biogas then. The biggest problems for the business development have been how to prepare household garbage before processing into biogas. The future plans are related to the company's expansion. There are plans to invest in one more production line to start processing sewage sludge.

Funding

Total investments were around 50 million EUR of which 20 million EUR are public funding and 30 million EUR are financed by loan. **What makes this case innovative?**

Case represents the using of municipal waste and sewage for biogas and thus developing circular economy by utilizing waste for new product streams.

Case: Pageldynių plantacija - a full scale self-sustainable closed loop circular economy model for large cities' nutrient rich waste

Name of the company: UAB Pageldynių plantacija (NutriBiomass 4LIFE project)
Country: Lithuania
Size of the business: municipal water supply and waste water treatment plant – 650 employees, biomass boiler – less than 10 employees, nutrient rich waste management company and biomass supply – less than 10 employees
Website: www.nutribiomass.eu

Background

The establishment of the company was driven by the need to find solution to utilize problematic nutrient rich waste (waste-water treatment sludge and biomass ashes) and to find solution to increase woody biomass yields while growing biomass on non-fertile marginal lands. Thus, circular economy model to benefit both parties was established to introduce economically and environmentally feasible solution.

The search for solution while combining these two problems started 5 years ago via some research and experimental development – search for fast growing tree clones adapted to local climatic conditions and fertilization trials using nutrient rich waste. The initial research was conducted during the EU Eurostars funded project "Snowtiger", during which first poplar plantations were established in Lithuania and fertilized with municipal water treatment sludge. During the project frost resistant poplar varieties were tested in Lithuania, Latvia, Estonia and Sweden and fertilization trials with municipal water treatment sludge digestate were performed in Lithuania.

Business partnership (without establishing a legal entity, but via implementation of a project) is formed by private limited liability company (land owner and biomass grower), municipal company (water supply and waste-water treatment plant), private limited company (biomass boiler), NGO (forest and land owners association) and state research institutions.

Main activities

The main activities are biomass plantation establishment and management, biomass production, waste management (reuse of nutrient rich waste for fertilization purposes), while side activities include substantial CO2 sequestration throughout the whole circular production cycle, biogas production from sludge and power production from biogas.

Some changes have been made since the start of the project. During the project additional biomass plantations were established in a larger area. Its was needed to ensure reuse on municipal waste water sludge from a large city according legal regulations. The project demonstrates shift towards circular mode as nutrient rich waste is being reused for biomass yield improvement and CO2 sequestration in tree biomass instead of being disposed to the landfills. The partnership differentiates itself as it provides sustainable solution to nutrient rich waste management through multiple stakeholders' cooperation activities, and this is unique as there are no similar models operating in Lithuania.

Market

There are different customers for different products and services. Biomass can be sold to local biomass boilers and wood processing industry (particle board mills). Municipal water treatment plants and biomass boilers are clients for nutrient rich waste management. Waste-water treatment sludge digestate and biomass ashes can be used for fertilization by land owners, farmers, forest owners to grow biomass. Heat produced from biomass is sold to district heating network. Customers are usually reached by direct sales. Biomass is sold via biomass energy exchange, specialized intermediary.

Challenges and solutions

Internally in Lithuania, the partnership considers replication of circular bioeconomy model in other municipalities of Lithuania to reuse their waste-water treatment sludge digestate for woody biomass growing. Within implementation of the project, there will be small replications in Sweden and Latvia. The model to use waste-water treatment sludge for biomass growing is a local circular bioeconomy concept and can be replicated based on legal framework and existing biomass growers' interest in different municipalities, as waste water treatment sludge is available everywhere. At the same time, publicity is needed to promote proposed circular economy model within society.

The major limitations are legal framework and social perception – each country defines its own legal framework for usage of sewage sludge or biomass ashes in agriculture and biomass growing (besides the EU Sludge Regulation) due to certain contamination risks. Despite unlimited market potential, biomass growing is a very challenging business – market prices may fluctuate over 100%, high initial investment costs usually need subsidies to make this activity feasible. This is particularly challenging as investment into biomass plantations is quite long term – ranging from 4 years to 15 years, when the revenue from harvesting of biomass may be expected, while initial investment is significant.

Up till now, the biggest challenge has been unclear legal framework. Over time legal framework was changing constantly – stricter regulations are being imposed of nutrient rich waste usage in biomass growing. Climate change introduces new opportunities but also challenges to biomass growers – more summer droughts make biomass growing business riskier, requires more research for drought and frost tolerant biomass crops.

Funding

Circular economy model as demonstration model was financed by the EU funding (LIFE programme), the Ministry of Environment of the Republic of Lithuania, the Swedish Energy Agency and project partners. The total cost of the project "Nutribiomass4LIFE" is 4 million EUR. In addition, the project has received additional grant from public authorities for demonstration model.

A municipal waste-water treatment company and biomass boiler receives benefits via waste management cost reduction immediately, waste management company receives profit after two years of operations, while biomass growers 8–12 years after biomass sales.

What makes this case innovative?

The project represents a full scale self-sustainable closed loop circular economy model for large cities' nutrient rich waste – municipal wastewater treatment sludge and biomass ashes – recycling into renewable energy for city's needs via environment friendly biomass plantation filter.

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