SMEs POINT-OF-VIEW ON

MARKET, MATERIAL, PRODUCTION OPPORTUNITIES AND IMPLEMENTATION

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Project acronym	BioBIGG
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Summary

The bioeconomy is a crucial part of the low-carbon, resource efficient and circular economy, in which new biomass-based materials and products are introduced to substitute fossil-based materials and products. This development is a major contributor to both climate change mitigation and a sustainable and efficient use of resources. Small and medium-sized enterprises (SMEs) play a crucial role in the bioeconomy. It is therefore important to empower SMEs and other actors to participate in bioeconomy development in the South Baltic Area. In addition to the emvironmental benefits, a growing bioeconomy helps to create and secure jobs and development in rural areas. Thus, a special focus must be placed on modern infrastructure and logistics, as they are prerequisites to fostering biomass supply.

The aim of the report was to investigate SMEs point-of-view on market opportunities, material opportunities, production and implementation within the growing bieconomy. The work was initiated in a cross-border workshop and deepened in a survey and and in interview case studies. The results are presented and assessed for specific topics.

The respondent rate of the survey was very low, so it was difficult to draw major conclusions. However, some overall trends could be seen. Medium-sized companies were the most struggling enterprises in the bioeconomy. In contrast, small enterprises seemed to react faster to shifting market situations or technologies, while long-established large enterprises were able to apply their long-term experiences. The results showed that it is of importance to have larger companies as cooperation partners when it comes to the marketing of innovative products. Also there seems to be a weak political and governmental dissemination of the term bioeconomy, which is reflected in a low degree of familiarity in medium-sized companies.

A deepened assessment on the SMEs point of view was conducted based on the results from 11 interviews carried out in Poland, Germany, Denmark and Sweden. As an example of an identified barrier, difficulties to access biobased feedstock for processing was identified. Furtermore, a surrounding community such as specialized expertise networks were lacking to assist in quickly developing biobased products. Regulatory barriers sometimes place a high burden on small companies in using exisiting residueal side-streams as feedstock for new bio-based products, signaling the need for changes in legislation as a powerful driver for increase bioinnovation in the short-term. Profitability of biobased products was found to be negatively affected by high raw material prices and unprofitable technologies that are still supported by various forms of co-financing for pilot installations. Lack of profitability was found to be the single most mentioned barrier against innovation in the bioeconomic context, pointing out a need for support schemes. As a result, the fossil-based production was often more profitable than the new, innovative, bio-based production.

Another barrier or challenge for bioinnovation is grounded in the fact, that bioeconomy is a heavily multi-disciplinary branch of industry. To develop new ideas in this field, there is a need for experts from chemistry, biology, agriculture sciences, mechanical engineers and economists. Since it is hard to persue innovative ideas alone, networks should be used to associate experts from the mentioned fields, as well as stakeholders and decision-makers.

The interviews also showed various circumstances that bolster innovation activities. The motivation for the companies could be support from a regional policy. Financial support can play a major role in boosting innovation activities, as it allows companies to have a far-seeing scope at a limited risk. Examples of opportunities for biobased feedstock that were highlighted in the interviews were chaff from cereal production that can be utilized for biochar and heat production, intermediate crops and beet leaves that can be used for extracting plant proteins for human consumption and other components for food applications.

Content

1. Introduction

At an earlier phase in the BioBIGG project, four value chains were selected for assessing the biomass potential of residues and by-products available as feedstock for innovative, bio-based products in the bioeconomy. These included the cereal value chain (straw), residues from the wood production value chain, residues from the sugar value chain and residues from the food value chain. Furthermore, the potential of additional feedstocks (ley crops, intermediate crops and Ecological Focus Area (EFA) crops) were presented. This work was published within BioBIGG as Deliverable 4.1, *Report on mapped material flows of biological resources along agro-industrial value-chains.*

Based on these value chains, Deliverable 4.2 aimed at investigating the small and medium-sized enterprises (SME's) point-of-view on market opportunities, material opportunities, production and implementation. The work was initiated in a cross-border workshop (Section 2), investigated in a survey (Section 3) and deepened in interview case studies (Section 3.2.8). The results are presented and then assessed for specific topics (section 5).

2. Workshop

In June 2018 the BioBIGG project group organized an internal *Cross-border workshop on material potentials, potential products, and market and supply opportunities* (Activity 4.8). In this workshop, the structure for the Deliverable 4.2, *Survey on small and medium-sized enterprises (SME's) about their point of view and assessment of market opportunities*, was designed. The world café methodology was used to discuss both the aim and objectives of the survey and interview studies as well as the practical aspects of the study setup. The workshop concluded the following:

The survey is to be designed in preparation of the interview studies

- The interview studies were to deepen the assessment of the task, based on background data collected in the survey.
- It should evaluate the knowledge on innovation strategies and sustainability issues
- It should identify barriers and drivers for development of innovative products for the bioeconomy

The survey is to be designed to initiate work towards establishment of the South Baltic Bioeconomy Network (SBBN)

- The survey needed to identify common problems and topics according to which we can structure the network.
- The survey should investigate the ambition of companies to be part of a specific network, and drivers and barriers to join a network

The survey results were to be presented to stakeholders

- Multiple channels of result dissemination were to be used (report, homepage, newsletters, network contacts and direct contacts)

After the workshop, the survey questions were further developed and refined and finally the survey was disseminated in spring 2019. For a full list of the survey questions, please refer to appendix 6.1.

3. SMEs point of view based on survey

The survey regarding the SMEs point of view on market opportunities, material opportunities, production and implementation was implemented to prepare a deepened assessment of the task in the interview case studies.

The survey focused on gathering background data on companies, but also investigated the use of biomass-based feedstock, the awareness and application of bioeconomy principles and sustainability measures, the SMEs knowledge sources and innovation strategies as well as sustainability strategies and market assessment. The common aims of this assessment are presented in Table 1. Furthermore, and in preparation of upcoming tasks in WP6, creation of the South Baltic Bioeconomy Network (SBBN), the survey evaluated the value of network connections to SMEs.

Table 1. Aims of the survey and interview case studies in comparison.

Aims	Source of information / data	
	Survey	Interviews
• to identify key barriers to innovation in the bioeconomy	X	X*
• to identify key drivers for innovation in the bioeconomy	X	X*
• understand when a company want to develop a product from their by-products or sell the by-product as feedstock	X	
• differences between SME and large companies	X	
• possible products, materials, services		X
• market opportunities / demand		X
• interest in specific processes (production / implementation)		X
• investigate investment potential		X

* In more detail, more specific

3.1 Survey development and outline

The design of the questionnaire underwent many iterations. Starting in May 2018, Greifswald University created an initial draft based on their experience from earlier surveys. This draft was presented at Greifswald University on the 13-15 June 2018 during a presentation, as well as discussed in detail in a workshop session in a world-cafe format. At the end of the workshop, the partners agreed upon the rough categories the questionnaire should include and an initial plan on how to approach actors in the project regions. Throughout the next six months, the contents of the questionnaire were discussed in the context of numerous telephone conferences. Planning on how the actors need to be approached in each region took place at this time, as well (see 3.1.2). Content-wise, the topics of the questionnaire were finalized in December 2018. Afterward, programming and translation into five different languages (English, German, Swedish, Polish and Danish) took place. The web-application SoSci Survey was used to transform the contents of the survey into an online-questionnaire that can be accessed by a link or scanning a QR-code. SoSci Survey was specially designed for scientific surveys. Once the questionnaire had been programmed, it went through another internal test phase before being sent to two selected companies per project region as part of a pre-test. This final refinement took place throughout January 2019 and concluded in adapting the remarks of the pre-test at the beginning of February 2019. The final online version went live on 14th of February 2019 and stayed online until 1st of May 2019. Each region had a different approach to identifying eligible companies and sending the questionnaire in the end.

3.1.1 Survey recipients – Poland

In Poland, a database that includes data of about 300 stakeholders from different sectors (among other fruit and vegetable industry, meat and fish industry, bakeries, distilleries, and other alcohols, cosmetics industry, wood industry) in Pomeranian, West-Pomeranian and

Warmia-Mazury Province was prepared. E-Mails were afterward sent out to these companies with an invitation to complete the survey. Also, Poland called many companies individually from various sectors in the Pomeranian Province to arrange a meeting, but only few agreed. During various meetings, the survey questions were also presented and companies encouraged to complete the survey online.

3.1.2 Survey recipients - Germany

The University of Greifswald initially discussed internally, which NACE (the statistical classification of economic activities in the European Community) categories could potentially inhibit companies that follow the concept of the bioeconomy. With help from the Chamber of Industry and Commerce (IHK) in Neubrandenburg and Rostock the survey was distributed by letter as well as personal e-mail. Inside the letter, a formal introduction to the project, the survey, and the partners were given as well as the link and a scannable QR-code that referred to the online-questionnaire. At the end of March 2019, a reminder e-mail was sent to all companies, in which again, the importance of participation was underlined.

3.1.3 Survey recipients - Denmark

In Denmark, contact information were retrieved from an online company called Kompass - Danmark. Kompass offers a database, where personalized company lists can be created by users. This service was utilized to select and sort companies into 20 predefined categories within region Zealand:

- Food
- Beverage
- Agriculture and forestry
- Organic products
- Agricultural machinery and equipment, beverage industry, tobacco industry and catering industry
- Paper and cardboard
- Leather, pelt, hide, fur and products thereof
- Textiles
- Rubber products
- Chemical products
- Chemical raw materials
- Health, medical and pharmaceutical
- Carpets, woods, machinery and equipment from the wood industry
- Sustainable energy and environmental services
- Equipment and plants for petroleum and gas industry
- Energy, fuels and water
- Scrap and waste (trade)
- Trade with commodities and raw materials
- Wholesale trade
- Furniture and furnishing

From the above mentioned company list, 123 SMEs was selected for the online questionnaire. This process entailed a qualitative assessment of stakeholder relevance in relation to BioBIGG principles (1. cascading, 2. use of waste, leftovers and residues, 3. circular economy). A link to the survey and a short informative text was send by e-mail to the SMEs.

3.1.4 Survey recipients - Sweden

A company that sells contact information to companies, UC Affärsinformation AB, was contacted to buy email addresses for the companies within the bioeconomy in Skåne. It was decided that only one email address per company was going to be bought and in the following ranking: 1. Environmental Manager, 2. Marketing Manager and 3. CEO. The survey was sent to 882 unique e-mail addresses. The survey was sent out both in Swedish and in English. The survey link was sent out on the 15 February 2019 and a reminder was sent on the 2 April 2019.

Companies in several industrial sectors were contacted for the survey. The choice included companies in the following NACE categories (the statistical classification of economic activities in the European Community):

- Crop farming
- Animal production
- Mixed farming
- Forestry and logging
- Aquaculture
- Fishing
- Other agricultural related
- Manufacture of food products, beverages, textiles, wearing apparel, leather and related products, wood and of products of wood and cork, except furniture, articles of straw and plaiting materials, paper and paper products, coke and refined petroleum products, chemicals and chemical products, basic pharmaceutical products and pharmaceutical preparations, rubber and plastic products, other non-metallic mineral products, basic metals, fabricated metal products except machinery and equipment, machinery and equipment, motor vehicles, trailers and semi-trailers, other transport equipment and furniture
- Other manufacturing
- Electricity, gas, steam and air conditioning supply
- Water supply, sewerage, waste management and remediation activities'

3.2 Results of the survey

In total, 64 companies completed the online-survey. More than half of them reside in Germany. When considering the amount of effort and work that went into the creation of the survey, this response can be regarded as very poor. Due to such a low response rate, a more in-depth statistical analysis was impossible. As a result, the analysis has been limited to simple methods, and it is recommended that all results be looked at with the caveat that only 64 companies responded (Figure 1).

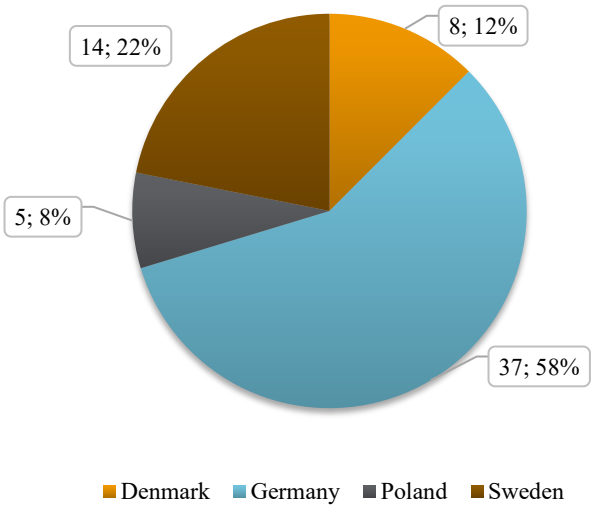

Figure 1. Number of responses per region

3.2.1 Employee situation and specific implications of company size

Regarding the company size, it becomes apparent that most of the responses came from SMEs; especially in Germany, the number of micro-enterprises and small enterprises that answered the questionnaire is, in comparison, considerably higher than in the other regions, in which the response rate was around the same for micro-, small- and medium-sized enterprises. However, the very small total number of responses remains and needs to be taken into consideration. Only few large enterprises answered the questionnaire (Figure 2).

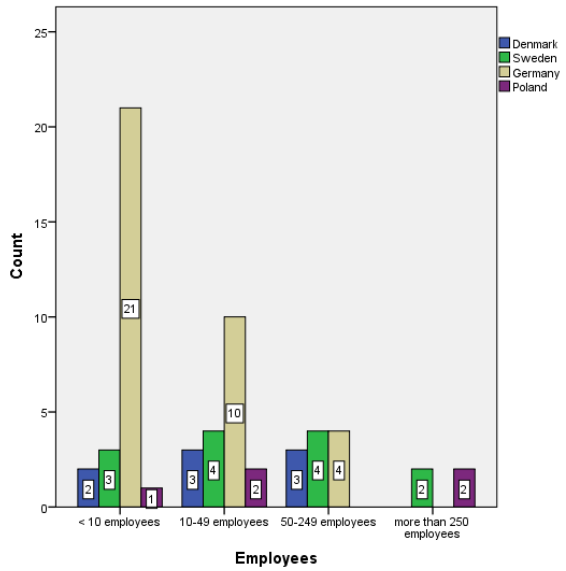

Figure 2. Number of employees per Region

3.2.2 Contributing sectors

The companies were further asked in which economic sector they are currently active and had a list of NACE-based options to choose from. The most prominent sectors were *Crop Farming* (n=9), *Animal Production* (n=7), *Manufacture of food products* (n=7) as well as *Forestry and logging* (n=5). However, the option *Other* was chosen 16 times, which leads to the assumption of a not sufficient NACE-base in the first place but can also be seen as an example of a

particular allocation problem of companies working in the bioeconomy, thus underlining a certain fuzziness. When asked about in which parts of a typical value chain the companies are active in, most answered *Manufacturing* (53%), followed by *Primary Production / Raw Material Production* (32%), *Processing* (31%) and *Distribution* (30%). Companies were less active in *Research, Development and Design*, *Retail and Wholesale*, *Waste Handling* and *Equipment Manufacturing*, leaving the impression of being mainly involved in early parts of the value chain. The result is similar across all company sizes, with 42% of the companies processing biomass in some form.

3.2.3 Utilization of biomass

Biomass is also handled more often by small and large enterprises, than by medium-sized and micro-sized companies according to the results of the survey. If a company did not handle any biomass at the time, it received the follow-up (multiple-choice) question about its potential motivation to include biomass or biomass-based raw materials in the future. If the size of the company is not taken into account, the most significant motivators were *Improved sustainability of products* (33%), *Increased possibility of innovative products* (33%), and *Increased profitability over fossil raw materials* (25%). *A more positive image* and a *Better quality of the final product* received less interest in the surveyed. Again, the number of companies also checking the *Other* option was high (31%). However, when analyzing their input into a free text field that followed the *Other*-option in the questionnaire, it became clear that there seemed to be a problem with understanding the question. None of these companies formulated a clear motivation, instead of using the option to state why biomass is not applicable in their case. Companies that do use biomass received the follow-up question about why they use biomass or biomass-based raw materials. The *Improved sustainability of products* (48%) received the most answers, closely followed by a *long history of use* (44%). Besides a high number of *Other* answers (37%), with again not sufficient context, options that were chosen more often in the previous question (*Possibility of innovative products* (26%) and *Increased profitability over fossil raw materials (*11%)) amounted to far fewer numbers here. A reason for that could be that the current biomass use is regarded as the most innovative. Another explanation might be that it is difficult to change the existing production system, but easier to adopt a new system. A reason for the low number of choices of *Increased profitability over fossil raw materials* might reflect a certain lack of urgency for change at this moment from a company´s point of view. Companies were then asked where they see themselves in terms of their use of bio-based raw materials, with the options of *Frontrunner*, *Fast follower*, *Average firm* and *Straggler*. No company sees itself as a straggler, and 54% see themselves as a frontrunner. The middle option (*Fast follower*) was only picked by 8% of the companies, while 38% answered with *Average firm*. Especially large and micro-enterprises see themselves as frontrunners in this regard, while small and medium-sized ones checked *Average firm* more often. Of the companies that filled out the online-survey, 38% generated waste, residues or by-products out of biomass. Large companies tend to generate more, but then again, the number of responses from large companies (n=4) is small and thus cannot be seen as a sufficient base for more in-depth analysis.

3.2.4 By-product generation and utilization

Only 29% of the companies expect that their current utilization of residues, by-products or wastes will change in the future. One explanation could be that no changes are expected or needed, as no other sufficient potential is seen or no other potential exists. There may also be a communication problem where the need is not communicated enough. Many companies are also unlikely to expect a change towards a bioeconomy, which further underscores the current

lock-in status of the economy as a whole. This is also the case across all company sizes (Figure 3).

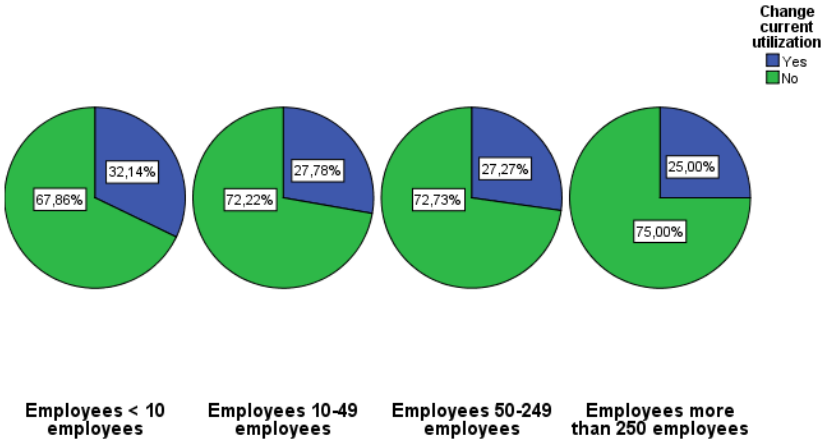

Figure 3. Change expected for the current utilization of residues, wastes and by-products

The motivation in regard to a transition towards a more intensive or innovative utilization of by-products is again quite the same in the different company size categories. The *Improved sustainability of products* (33%), as well as the *Possibility of innovative products* (33%) are the biggest motivators. Afterwards, companies were asked a second time about their assessment of themselves in terms of innovative waste treatment, recycling, as well as the re-use of residues, by-products, and waste. Most of the companies (56%) see themselves as *Average firms* in this regard, 21% answered *Frontrunner* and 18% *Fast follower*, and three companies see themselves as a *Straggler* in this regard (Figure 4).

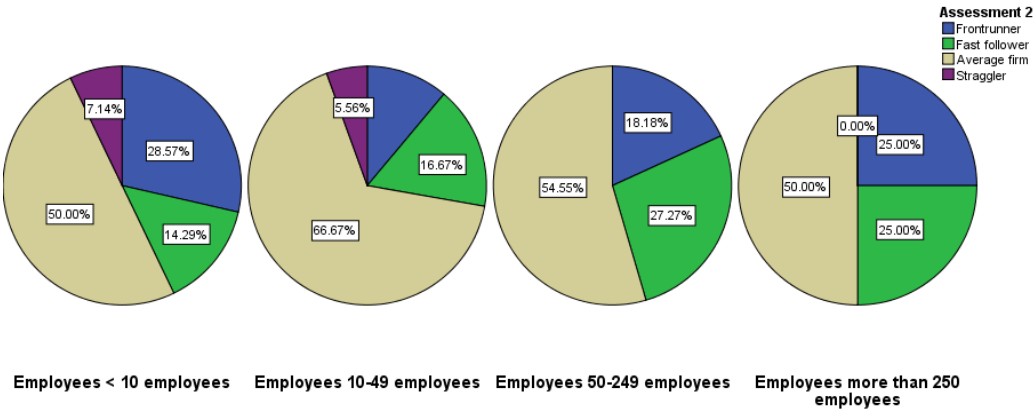

Figure 4. How do companies assess their perceived role in innovation

While micro-enterprises tend to have the self-view of a frontrunner, small enterprises see themselves rather average, while medium-sized companies checked *Fast follower* more often. As a result, in the case of the micro-enterprises, start-ups and innovative, new companies come to mind when looking at this result. Companies with more employees seem to have a somewhat lower self-assessment, maybe because of more elaborate requirements for change company-wide.

3.2.5 Research, development and innovation efforts

The low-tech structure of the bioeconomy gets underlined by the results of the question if the company conducted any structured research and development (R&D) in the last three years. Of the responding companies 60% did not conduct any research and development, 21% did so in other ways, and only 19% had a dedicated R&D unit. The bigger the company, the higher the probability that it will carry out R&D or have its department for this purpose. Then again, the lack of R&D units in companies is quite striking. Of the companies that conducted R&D, most (64%) included wastes, residues or by-products in it, with all of the large firms doing so and micro- as well as small enterprises (66%) having a higher probability than medium-sized enterprises (43%). An explanation for this circumstance could be that it is more economically pressing for smaller companies to take care of residues, by-products, and waste compared to larger companies because it is easier to take care of more substantial quantities of these value-flows.

3.2.6 Cooperation partners

Regarding innovation activities, the companies stand in cooperation with various actors (Figure 5).

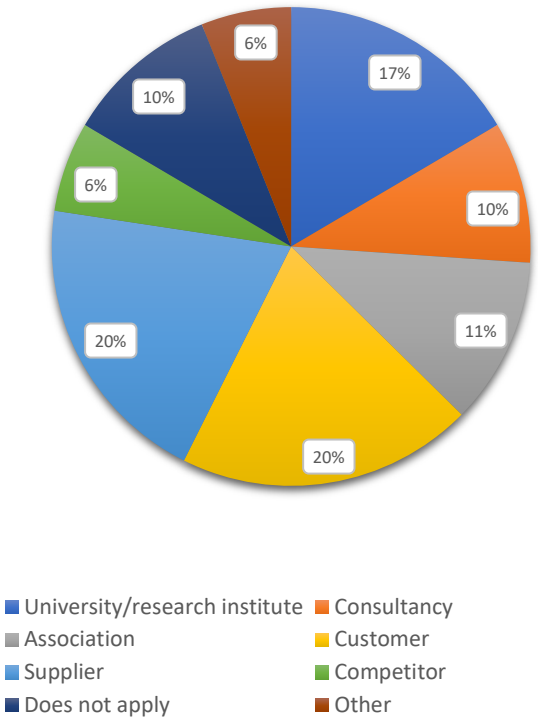

Figure 5. Cooperation partners for innovation activities

It is apparent that companies mainly cooperate with universities/research institutes, customers and suppliers, while cooperation with consultancies, associations, and competitors occurs less often.

Looking at the various company sizes (Figure 6), it becomes clear that there are definitive differences between their choices of cooperation partners.

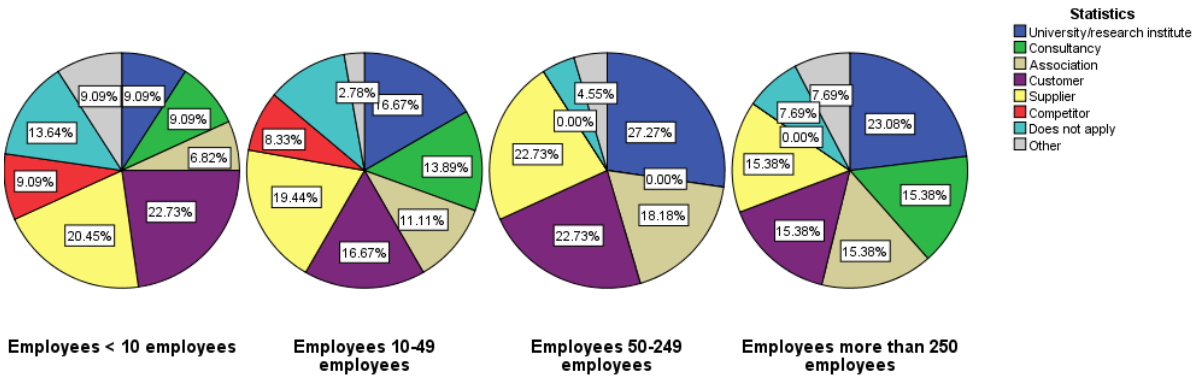

Figure 6. Cooperation partners for innovation activities by company size

While micro- and small enterprises cooperate with competitors, probably due to their financial need to do so, larger companies do not. Cooperation with suppliers is similar across the board, as is cooperation with customers. Consultancy- and association-cooperation is more common, the bigger the company is as is cooperating with universities or research institutes.

The question if technological push or market pull describes the innovation pressure is presented in Figure 7.

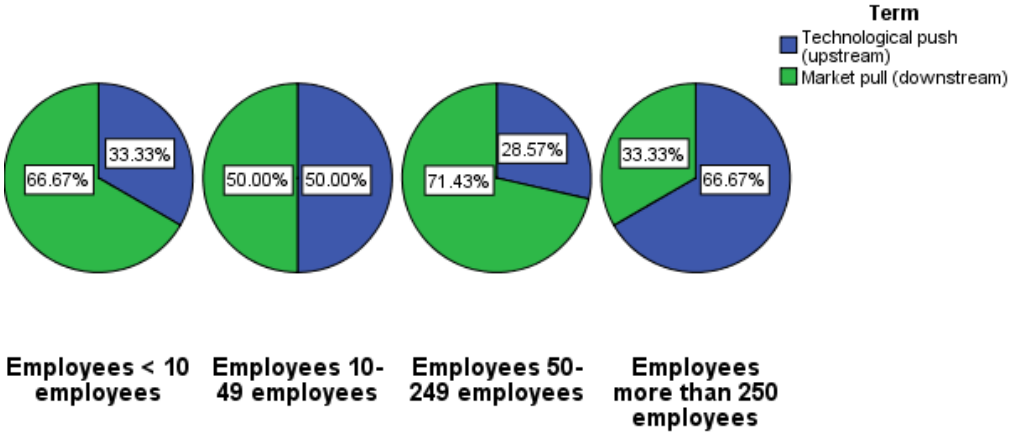

Figure 7. Drivers for innovation

Micro-, small- and medium-sized companies see the pressure for them mainly in the market pull, while for large enterprises the technological push plays a more prominent role. Thus, smaller companies can be seen as unable to shape the existing market as efficiently as larger companies.

Cooperation partners of the companies are located not only in the same region or the same country but also in northern Europe, the rest of Europe or the rest of the world (Figure 8).

Figure 8. Location of cooperation partners

From the figure, it can be seen that the bigger the company, the more are partners located outside of their country. Micro- and small enterprises are also more likely to have no partners at all, while for every company size at least half of their partners are located in the same country or the same region. The importance of regional and national cooperations or collaborations can be stated, also independent of size.

Regarding innovation as bringing new products to the market, only 23% of companies did introduce any new biobased product in the last three years. Of the responding companies 31% did, however, start using any new form of biobased raw material. Furthermore, again only 23% of the companies did introduce new processes for treating waste, residues or by-products. The larger the company, the higher the probability of them introducing new processes in that regard. Another critical question regarded the main reasons for innovation. For over half (55%) of the companies, the willingness to *Improve their competitiveness* was one of their main reasons, followed by *Corporate Social Responsibility* (29%), *Improved energy consumption* (21%) and the *Price of handling waste and residues* (16%). *Staff costs*, *High input in the form of material costs*, *Falling price contribution margin for the main product* or *Regulations* were not checked as frequently.

Knowledge of innovation activities was derived from various sources (Figure 9).

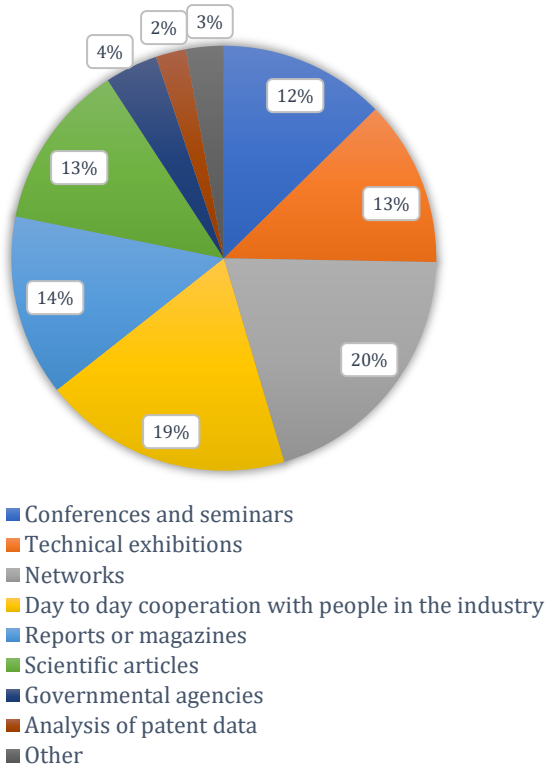

Figure 9. Source of knowledge for innovation activities

Especially *Networks* and *Day-to-day cooperation* play a significant role as knowledge sources for innovation activities, with *Literature*, *Exhibitions*, and *Conferences* as follow-ups. Direct input to micro-companies concerning innovation activities is received mainly from *Subcontractors* and *Development consultants*. Small- and medium enterprises receive input from their *Internal development department* and large firms from a mix of *Development consultants*, *Universities*, and their *Internal development department*. Again, the bigger the company, the higher the probability of it receiving input from *Universities or Research institutes*.

3.2.7 Sustainability and company strategy

Of the responding companies 60% have a sustainability strategy, and of these, 84% also include side streams. That means that residues, by-products, and waste are an essential aspect of the sustainability strategies of companies, regardless of their size. Furthermore, 81% of companies that use a fossil-based raw material at the moment would be willing to exchange it with a renewable one, if it was more profitable. A general willingness to transition can be derived if profitability does not decrease as an effect of the transition.

Out of all participating company representatives, only 56% have heard the term *bioeconomy* before. There are again significant differences between the company sizes. While 58-59 % of the micro- and small enterprise representatives were familiar with the concept, medium-sized companies were far less likely (36%) to have heard of the term before. Representatives of large companies were most familiar (75%) with the term *bioeconomy*. One reason for the lack of knowledge of medium-sized companies could be that while large companies need to keep track of political and institutional change, for medium-sized ones these factors are not as important. Then again, this difference is quite remarkable, because it paints a picture of a lack of information channels for medium-sized companies.

Furthermore, companies were asked, which utilization opportunities they see as the most promising when it comes to adding value to their main biomass-based residues, by-products or wastes from their company. Choosable options for this question were:

- animal feed (31%)
- chemicals or enzymes (31%)
- ingredients and proteins (35%)
- building materials (37%)
- new food and beverage products (37%)
- fertilizer (40%)
- soil improvement (40%)
- energy utilization-recovery (biogas) (48%)
- biomass-based materials (53%)
- energy utilization-recovery (incineration) (55%)

Companies could then choose from a scale ranging from *not promising* over *possibly promising* to *very promising*, with a *does not apply*-option also in place. For the purpose of analysis, initially, the number of companies that did not choose the *does not apply* option was investigated (see bullet point list above). The most attractive utilization possibilities are both energy options as well as biomass-based materials (Figures Figure 10, Figure 11 and Figure 12).

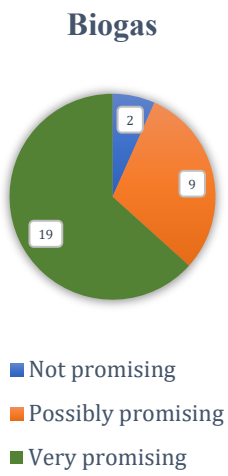

Figure 10. Utilization for biogas production

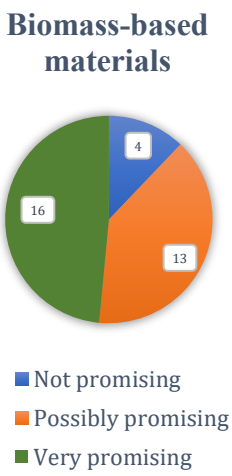

Figure 11. Utilization for biomass-based materials production

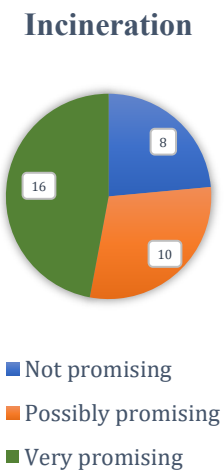

Figure 12. Utilization for incineration

Even though many companies receive part of their knowledge-input from networks (20%, Figure 9), only 10% are part of one, with larger companies having a higher chance of being a member of a network. The incentives of companies to join a network, however, underline the previously analyzed question about where companies receive knowledge from. *Sharing of knowledge* (33%) is the most important reason to join a network, followed by *Finding companies that struggle with the same challenges* (26%) and *Finding inspiration from success stories* (17%). *Receiving updates on sector developments* (14%) played only a side role, as well as *Other incentives* (10%). Medium-sized companies tend to share much less compared to

micro-, small- and large companies, thus leaving the impression of them being more cautious and in a more vulnerable situation on the market. Smaller companies may be in a niche position and have a specific product without an already developed market in place, while large companies are already in an enough established position to be able to share knowledge.

Another part of the analysis was to examine the effects and cross-overs of the production chain. The first question that arose was, with what types of partners companies from one step of the production chain are in collaborating with. Expectantly, companies focusing on *R&D*, as well as *Design and manufacturing*, are mainly in contact with *Universities and research institutes*. Then, competitors are only in contact with *Manufacturers*, *R&D and design*, *Distribution* as well as *Waste handling*. *Suppliers* play a significant role for *Manufacturers*, *Distributors*, *Retail and wholesale*. *Consultancies* are only really consulted by *Primary production* and *Raw material producers*. Regarding which production stage believes in a future change of their current utilization, only *R&D and design*, as well as *Wholesale companies* do so. The rest is somewhat skeptical in regards to change and answered negatively in 66% of the cases. While companies that are in the *Primary production* step of the production chain are most likely (89%) to have a *sustainability strategy in place*, all the other steps (*Processing* (63%), *Manufacturing* (59%), *R&D and design* (60%), *Equipment manufacturing* (75%), *Distribution, retail and wholesale* (80%), *Waste handling* (80%)) are less likely to have one.

3.2.8 Conclusions and discussion

Medium-sized companies can be seen as the most struggling in the bioeconomy. In contrast, micro- and small enterprises can react faster to shifting market situations or technologies, while larger enterprises are long-established and can draw on their wealth of experience and, in most cases, their good financial situation. The results of the survey showed that it is of importance to have larger companies as cooperation partners when it comes to the marketing of innovative products. Larger companies often have dedicated staff responsible for different issues, including the topic of *bioeconomy*. The data also showed that the ability of smaller companies for innovation activities could be improved by directly improving their contact with universities or research institutes for example via networking within the bioeconomy field. Furthermore, companies regarded utilization of energy sources such as biogas as the most promising utilization opportunity for the side streams. This option was ranked highest, followed by utilization as feedstock for biomass-based materials and energy recovery via combustion (also see Figures Figure 10, Figure 11, and Figure 12). A better cross-linking of companies can be one possibility to optimize the use of by-products following the cascade of reuse, recycle and recovery of energy.

There seems to be a weak political and governmental dissemination of the term bioeconomy, which is reflected in a low degree of familiarity in medium-sized companies. This group also had fewer collaborations with research institutions. On the other hand, knowledge-intensive production-chain parts, for example R&D and design are most likely to have heard about the term bioeconomy, where research-related collaboration partners likely contribute with discussions around the development of the bioeconomy.

The meager response rate of the survey must be seen as critical and may lead to the assumption that a general lack of interest for the topic prevails. However, another explanation is that the countries/regions are indeed very different in how well the term *bioeconomy* is established. Sustainable development may of course still happen even if it is not explicitly indentified as a part of the bioeconomy. For example, Polish responses in the survey may reflect a low familiarity with the term *bioeconomy*. However, as the folloing part shoes, there are many good

examples of innovative bioeconomy projects and showcases in Poland, where sustainability and cascading are implemented.

4. SMEs point of view based on interviews

4.1 Interview methodology

Several interviews were carried out with the focus on enhancing the findings from the survey. In-depth interviews did not follow a specific manuscript, but were carried out as openly and flexible to be able to accomplish context-sensitive assessments. The interviews were carried out with interesting actors within the bioeconomy and key elements of the interviews are reproduced as memory protocols in this report. The interviews were then analysed with regards to specific topics as presented in section 5.

In Poland, the general idea about interviews was to learn how different entities view the concept of bioeconomy – agricultural farms, industrial companies and legislative units. A list of general questions was prepared for each type of interlocutor and several detailed questions adjusted to the company profile. It allowed standardizing responses and later to compare them.

In Germany, the interviews were aimed at getting a better understanding of the concept of bioeconomy on a small scale from a practical angle of view, and especially to examine the connection between farmers and the typical farmer associations. All three interviews were conducted along with a pre-designed guideline and were recorded as well as transcribed afterward. In order to ensure a common thread and a thematic delimitation, the interviews were structurally divided into four different areas with different numbers of questions.

In Denmark the selection criteria for relevant stakeholders where based on the BioBIGG principles (1. cascading, 2. use of waste, leftovers and residues, 3. circular economy). Chosen stakeholders had an existing strategic focus on all principles, and a considerable amount of homogeneous waste, by-products and residues. The information provided by the stakeholders were based on semi-structured in-person interviews, followed by telephone meetings. The primary aim of the interviews was to define existing processes and utilization pathways of waste and residues, potentially new utilization possibilities and barriers related to market, material composition and implementation. Semi-structured interviews was also conducted with anonymous stakeholders. Hereof, one stakeholder explained that the primary barrier related to added value utilization of residues and by-products, was a lack of market transparency on supply/demand, such as intermediate platforms facilitating material exchange and compatibility between stakeholders.

In Sweden, interviews were carried out with companies that exemplify the possibilities of increased resource use, cascading approaches and more sustainable product development within the bioeconomy. Selection of stakeholders was based on how companies have been driving the development of innovative products and processes. Focus was put on the development process, the barriers and threholds along the way and - last but not least - individual people driving the process. The catalog of questions from the survey was used to collect background information. Specific topics in the interview were what kind of barriers were experienced and how these barriers and thresholds were overcome.

4.2 Interview results

4.2.1 Poland

Renewable materials in beverage bottles

This portrait based on an interview with:

Waldemar Karaszewski at the company TES sp. z. o. o., in Kowale, Poland
Interviewers:
Dariusz Mikielewicz, Jan Wajs and Paweł Dąbrowski from GUT

Introduction to the enterprise and the value chain it is part of

TES sp. z o. o. was established in 1987 as a typical engineering company, which since the beginning aimed at the highest quality of tasks providing equipment guaranteeing the most modern technologies in the packaging industry: robotic automation systems for technological sections of any processes, dedicated machines and devices for defined applications. From 2007 this includes also the blow molding machines to make Polyethylene terephthalate (PET) containers from preforms which became the main activity of the company. All the solutions use international achievements of electronic and mechanical engineering. TES sp. z o. o. (TES Ltd) has won many awards, in particular the TOP SELECTION 2000 for the best product in machines category on International Packaging and Machines Exhibition "EMBALLAGE" in Paris in 2000.

TES Ltd employs about 60 peoples. These are manual workers as well as engineers. The main economic sector in which company is active is manufacture of machinery and equipment which means that TES Ltd covers the middle part of the production chain, namely "Design and innovation" and "Technology and equipment manufacturing". The projects the company is involved in right now, excluding the main activity, namely blow molding machines, are among others:

- Adhesive application machines
- Cans pairing devices
- CNC plotters
- Coil manufacturing machines
- Gas flowmeters tightness testing devices
- Roller conveyors
- Tube crimping machines

The company's president is also a professor at the university, which results in a company's high involvement in research & development (R&D). At TES Ltd, a 4-person R&D unit has been established that deals with the development of manufactured machines, introducing improvements and looking for new solutions and trends in the production of disposable PET bottles. The company has about 15 patents, e.g. new pre-heating system. The power needed to heat prefabricates has been reduced twice thanks to this novel solution. Now, 5 W is sufficient to produce one PET bottle in the optimized process for 0.5 litre bottles of 12-14 g.TES Ltd claims that the company gets knowledge about innovation opportunities from:

- Conferences and seminars
- Reports and magazines
- Scientific articles
- Technical exhibitions

Amounts of biomass-based residues including current utilization and costs

TES Ltd. exports about 80% of their machines. The machines go to such companies as: Wysowianka, Retal (production of preforms) or Maspol (a company that supplies beverages to the international grocery store). It shows that TES Ltd is an international enterprise with broad horizons and vision of the future. The local policy has no impact on the decisions made

by the management, nor the development of the company. On the other hand, the national or international (European Union) policy significantly influence TES Ltd. The company uses co-financing from the European Union for the development. In addition, any legal regulation that changes the way disposable bottles are produced forces TES Ltd to change the machines it designs and manufactures. The main reasons influencing the search for innovative solutions, which the company mentions are:

- Corporate Social Responsibility (CSR)
- Demand for more sustainable products
- Energy consumption
- Political regulation
- Price of handling waste and residues

Current disposable bottles are usually not made using biomaterials. Consequently, TES Ltd does not develop machines that would use such material. However, a solution based on bioplastics for the production of disposable bottles is known to the company for years. This material is Polylactic Acid (PLA), a biodegradable thermoplastic aliphatic polyester derived from renewable biomass, typically from fermented plant starch such as from corn, cassava, sugarcane or sugar beet pulp. The limitation of application of that material is the fact that it can be used only for the non-fizzy drinks in bottles with thick walls due to the high permeability of the carbon dioxide. The increased thickness of the bottles requires more material to manufacture the bottle and hence making it more expensive. In addition, it is more expensive by 30 ÷ 40% than the widely used PET.

There was however a company that had already tried this material, but it stopped after a few years and no longer develops it. PLA material is 100% biodegradable and decomposes into simple chemical compounds after approx. 70 days at 50 ÷ 60°C. That also limits the PLA applications. However, by far the biggest issue hampering the application of this material and its use in the production of disposable bottles is the overall huge demand for similar packaging in the world. If we wanted to replace PET with PLA, we would have to devote very large areas of arable land to maize, sugarcane or sugar beets which is problematic. Moreover, these are actually the edible parts of plants which are used for production of packaging and not the inedible waste, so we would not use biowaste, but only replace plastic with bioplastic, leading to shortages in the supplies of maize, sugarcane or sugar beets.

Perspective of the enterprise on opportunities for valorization of biomass-residues

TES Ltd has their own sustainable strategy for development. The company's president is eager and ready for the changes in the bio direction. He thinks that there is a need to develop in two directions. The first is the continuous reduction of the production costs of a single disposable bottle, which is what customers expect. With today's capacity of 8000 bottles per hour, even small reduction in bottle's cost can provide huge earnings for the producer. The second direction is the introduction of bio-additives for production or the complete replacement of PET with other material, which seems unlikely due to the high level of production. Additives are unavoidable and it is only a matter of time and expenditures for research when such PET material with bio additives meeting the technological requirements, repeatability of its properties, appropriate price and high availability will be achieved. TES Ltd would be very interested in exchange fossil-based raw material for disposable bottles with a renewable one, when it will be profitable or imposed by imposed by the law or relevant policy.

Innovation needed to implement technology

The disposable bottles cause a significant problems for environment. In Poland, about 650,000 tons of plastic packages are produced annually. Most of them are disposable bottles. There are several solutions for reducing those numbers or reducing the impact of bottles on environment:

- Using reusable PET bottles
- Recycling and reprocessing of the plastic material
- Replacing disposable PET bottles with reusable glass bottles
- Replacing disposable PET bottles with disposable cartons

Unfortunately, none of these solution is ideal, all have disadvantages. In Poland, reusable PET bottles are not attractive. Already after 2-3 re-uses they are very scratched and become unattractive to the client. There is also a problem with cleaning the bottles, which is a very energy-intensive process, generating large amounts of wastewater and using strong chemistry.

The problem with recycling of plastic bottles is their wall thickness, due to tendency of material use. In the production process, on the other hand, a very high repeatability and accuracy in packaging production is required. Even the smallest deviation in thickness or plasticity of the material can cause the bottle to burst. Sometimes the so-called “re-granules” (granules that is made from recycled PET bottles) are used but unfortunately such use does not guarantee uniformity, repeatability and stability of the properties, which renders the production very difficult. So, to avoid the production problems, it can be only incorporated into the process up to 10% in total amount of the substrate. Although granules and regranules are at a very similar price, manufacturers do not decide to use the second one. It is simply unprofitable due to great difficulties in production without bringing significant savings. The only way out of this situation seems to be legal interference, whether at the national or European level. Policies should regulate the issue of using recycled substrates, increasing the price of granules or applying subsidies for companies using regranules. Nowadays main production from recycled PET bottles is focused on toys, household items (bowls, sweepings) and clothes. These products do not require such a high repeatability and accuracy so re-granules find application there.

Some may think that replacing plastic bottles with glass is a perfect solution. Glass bottles are durable and can be used at least theoretically, several times. Unfortunately, many other aspects are not considered. Firstly, cleaning the glass bottles is environmentally unfriendly process. It needs a lot of chemicals and extensive sewage treatment plant that will handle the waste. Moreover, in a view of Life Cycle Cost (LCC), glass bottles are much more expensive in the financial and an ecological context as well compared to PET bottles, where production of glass bottles requires considerably more energy. Glass bottles are also much heavier than PET bottles, so transporting them consumes more fuel, emitting more greenhouse gases to the atmosphere etc.

The disposable cartons are also not an alternative. The cardboard consists of mainly cellulose, which actually decomposes very quickly. Furthermore, a plastic coating is applied in the carton that protects it against soaking, as well as layer of glue. Currently, it is very difficult to segregate and recycle this material properly.

How the PET bottles are made

The input substrate for the production of blow molded PET packaging is a preform. The preform is made from injection molded PET granulate. The preform has the shape of a threaded tip tube.

PET packaging manufacturing equipment is popularly known as blow molding machines. Preforms (semi-finished products) are delivered to a blow molding machine, in which in the first stage they are heated to a temperature of 90-115°C. Preforms are heated by infrared radiation with a wavelength of 0.8-1.2 μm emitted by lamps. Lamps placed horizontally, usually in the amount of 6-8 pieces are controlled independently, so that you can get different temperature of the preform along its axis. The different temperature distribution along the axis of the preform is one of the factors enabling the control of the plastic distribution (wall thickness) on the packaging during the blow molding process. To achieve an even temperature distribution on the perimeter, the preforms in the heating furnace are also rotating along their own axis.

Preforms after leaving the heating furnace are fed to the blow mold. After closing the mold, the sequence of the whole process begins for the manufacture of PET packaging. First, the preform is mechanically stretched by a stretching rod. In the specified position of the stretching rod, compressed air is applied at a pressure of about 4-10 bar (depending on the shape of the preform and the bottle) and the initial forming of the packaging begins - the so-called pre-blowing. After a certain time, compressed air is applied at a pressure of 30 bar (for bottles of low weight) to 40 bar (for bottles of relatively large weight) - so-called main blow. After forming the bottle, the compressed air is removed from the blow mold. The blow mold is cooled with water at a temperature of 7-10°C, so that the formed bottle is simultaneously cooled when the plastic meets the blow mold. At a later stage, the molded PET packages are automatically delivered to the air conveyor and transported to the bottling line, Figure 13 and Figure 14. All parameters of the blow molding process are regulated with relatively high accuracy and have a significant impact on the quality of PET packaging produced, as well as on the material distribution along the packaging axis.

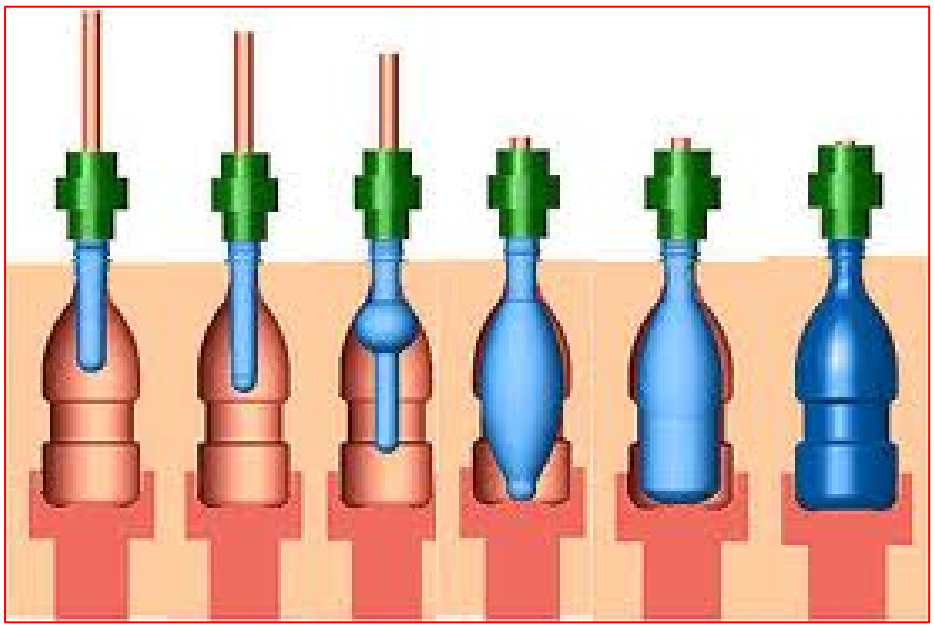

Figure 13. Production technology of PET bottles

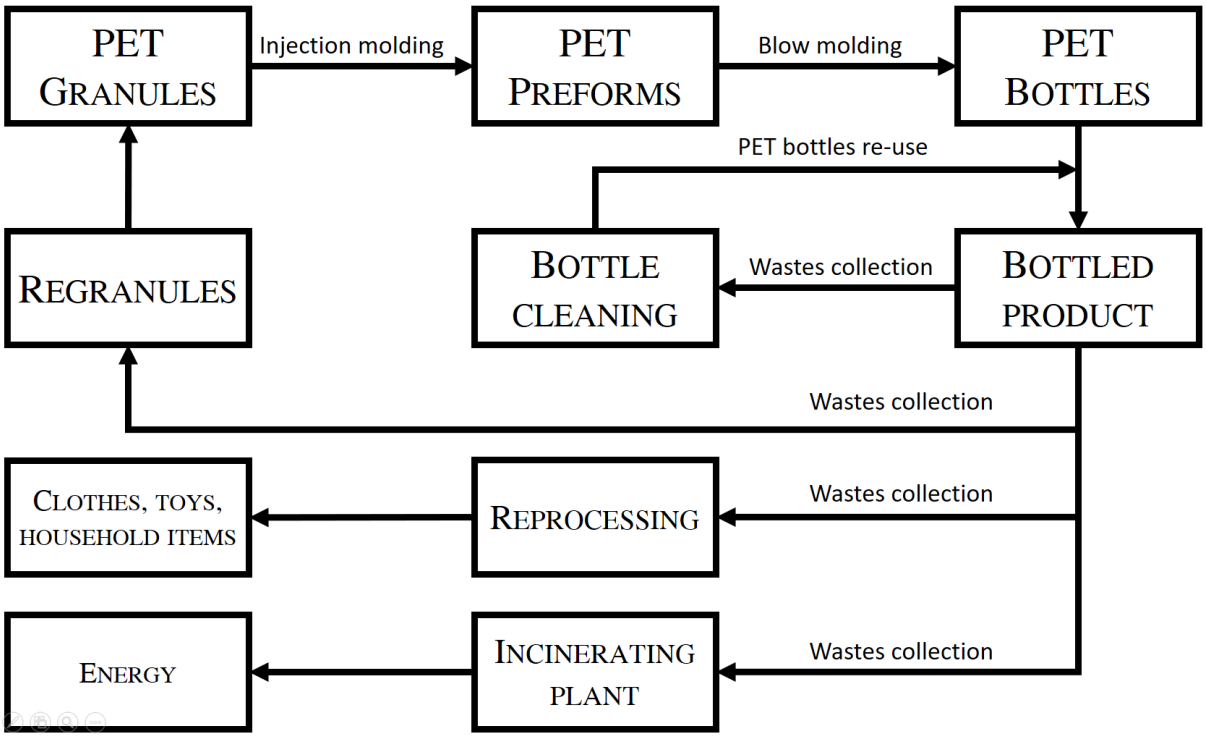

Figure 14. Scheme of PET bottles production including material flow

Circular economy principles applied to a potato value chain

This portrait based on an interview with:
Andrzej Paszota and Michał Paszota at the Gospodarstwo Podole Wielkie farm, in Główczyce, Poland
Interviewers:
Dariusz Mikielewicz, Roksana Bochniak, Aleksandra Gołąbek and Paweł Dąbrowski at GUT

The Podole Wielkie Farm (founded in 1993) is a classic example of a pioneering approach to circular economy in the Pomeranian Voivodship. It consists of three fundamental pillars - a farm growing potatoes, cereals and rape, as well as the cattle farms, and agricultural distilleries. The total area of cultivation is over 600 ha. In order to ensure a permanent sale of its goods, the Farm cooperates with the potato processing factory Farm Frites Poland SA in Lębork and the Frito Lay Poland Sp. z o.o., delivering raw material (potatoes) to them. The farm is also the largest producer of potato spirit in Poland (1.5 million liters per year or 350 l / h). The enterprise also has a production line of unfiltered rapeseed oil on a micro scale (about 1,000 bottles per year). The farm is a classic example of circular bioeconomy – the waste from the Farm Frites factory, which processes potatoes grown by Podole Wielkie, returns to the farm and is the batch product to the distillery. The residues from the distillation of alcohol, characterized by a high content of micronutrients such as potassium or phosphorus, are managed as fertilizer for cultivation or animal feed. The farm tries to maximally use its resources and waste produced during the processes. A novelty in their offer is high-quality alcohol produced from rye and potatoes (production line with a capacity of 30 l / h). The company employs about 25 people.

The concept of bioeconomy according to The Podole Wielkie Farm

From the perspective of Mr. Andrzej Paszota, the founder of the farm and its director, an innovative approach to any production should be carried out in accordance with the fact, that ecology should go hand in hand with economics. Entrepreneurs dealing with biomass

processing are currently in a situation, where general interest in organic products of natural origin and changing regulations require them to apply new, pro-ecological technologies regarding biomaterials, bio-components or re-use of waste. Currently, most of these technologies is still unprofitable. In addition, most of them are supported by various forms of co-financing for pilot installations. Projects of this type require certain periods of durability, during which the financing of installation work is secured. However, at the time when co-financing ends, a large part of the projects is unsuccessful, not giving the expected results. The essence of each enterprise is to achieve operating profit, and therefore it is crucial to develop such paths for companies' development towards biomass management, so that they are profitable for them. It is also important to skilfully support new initiatives and projects in such a way that they are able to function on the market without the need for subsidies.

Influence of small and large stakeholders

The company's owners emphasize the fact that the policy has and will have a big impact on the functioning of the farm. The local governors (mayor, commune head) and their decisions do not have a negative impact on the functioning of the farm, but there is also no counseling on bio-innovation. Founders of Podole Wielkie farm are skilled farmers with higher education in the field of agriculture and biotechnology and also keep up to date with the national and European Union legislation, because they play an important role due to the introduction of numerous restrictions and production limits (for example, the farm cannot expand and cannot acquire additional land due to domestic legislation). The Podole Wielkie farm was for some time a member of the Cluster of Intelligent Specializations of Pomerania.

Farm cooperation with other companies and local entrepreneurs

The Podole Wielkie farm cooperates with large corporations as well as with local farmers. It closely cooperates with the Farm Frites Poland SA factory in Lębork, the recipient of the potatoes yields, being a good example of the circular bioeconomy. While cultivating high-quality potatoes for the needs of the factory, the farm also processes the waste returning from the production line of chips for potato spirit. Own waste (decoction from a distillery) is used as a fertilizer for cultivation or feed for own animals. Part of this fertilizer is also sold at attractive prices to nearby farmers. Potatoes from their fields are also supplied to the chips factory Frito Lay Poland Sp. z o.o. On the other hand, straw, that is waste from growing grains, is the energy source managed within the enterprise. Hence in practice, the farm does not generate waste requiring utilization and is guided by the philosophy of continuous circulation of organic matter and micro- and macro elements. The farm owner states that everything that is taken from the soil in the form of crops returns to it at the end of the processing.

Owners from the beginning employed people from neighboring villages and rely on local human resources. The owners remain in close cooperation with local farmers. It is important for them that their production should be regional, qualitative and small-scale, and that the entire process should take place with the participation of high-quality technologies as well as ingredients.

Farm co-operation with research centers and its introduced innovations

The farm is open to initiatives and innovations which would enhance their production. From the very beginning, it has been trying to introduce environmentally-friendly technologies into the processes taking place onsite. Already in 1994, as the first farm in Poland, they adapted the traditional coal-fired boiler for burning straw, thus in such way giving up fossil fuels. For the purpose of energy production only own resources as well as waste are used. In order to

optimally use their resources, the owners do not use valuable crop products as energy source, in order to not to lose valuable substances and microelements contained in them (for example, they do not burn rancid straw, which has excellent fertilizing properties). The company is constantly looking for improvements in the process of alcohol distillation, as well as in the maximum use of raw materials and goods. It is preparing to launch its own biogas plant, cooperating with the company running the similar installation in Darżyno. Founders are emphasizing that it is an investment extending the energy chain of the raw material and, at the same time, it is a profitable solution for the company. Moreover, waste from biogas plants is still valuable and will be used as a fertilizer for crops, so that the circulation of the stock in the farm will achieve completeness. It is also planned to improve the entire biogas energy production process. One of the ideas is to modify the engine cooling system to allow the generation of additional high-temperature heat in the form of steam, it was estimated that this would reduce the total steam consumption for the technological processes related to distillation by 60%. It is also a major contribution to the green economy.

One of the company's strategic goals is to launch production in the bioplastics area, seeing its huge potential on the market, mainly due to the increasingly restrictive provisions of both national and European laws. According to founders, now is the best moment to develop this sector, as it is in the phase of prototypes and pilot installations. The owners of the farm are considering a few ideas for the production of organic straw dishes. An interesting idea is the use of cellulose acetate, which could be produced from straw (waste after cereal production) and vinegar (by-product of secondary fermentation of alcohol). They also emphasize that it is important to develop a technology of bioplastic production that can be easily replicated at least in other SMEs, as large-scale production is very difficult to implement.

The owners of farms so far were involved in a few biotechnology projects with the Jagiellonian University for optimizing the chain of processes at the potato farm, Figure 15. The farm owners are also interested in cooperating with the Gdańsk University of Technology as part of the BioBIGG project in order to check for new possibilities of using waste or producing energy from the waste. The owners are convinced that the typical average company may have difficulty in combining research work with production and satisfying the market needs, so cooperation with universities can solve this problem and bring real benefits. At the same time, they believe that working on new technologies in the field of ecology is exceptionally perspective and necessary, and therefore they are ready to support and invest in such projects.

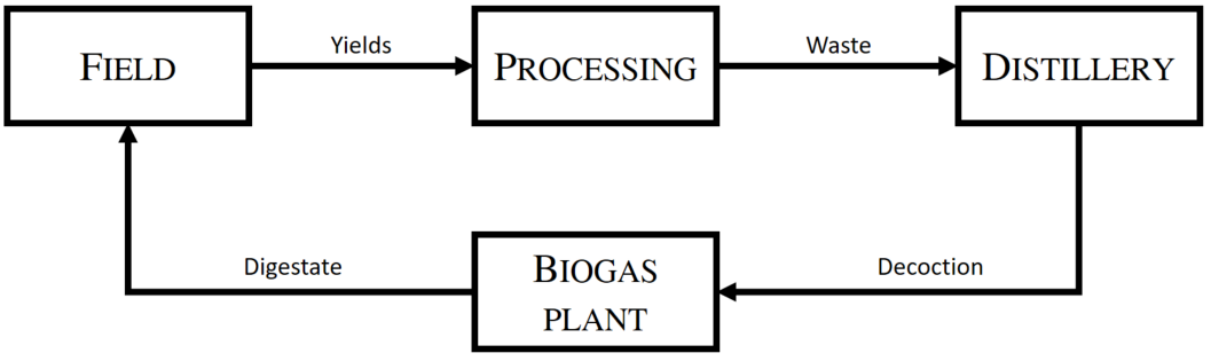

Figure 15. Scheme of circular material flow in the described case

Straw-based mushroom production

This portrait based on an interview with:
Adam Dobrenko at the company Pieczarki Mazurskie sp. z. o. o., in Mrągowo, Poland.
Interviewers:
Rafał Andrzejczyk and Paweł Dąbrowski at GUT

Introduction to the enterprise and the value chain it is part of

Użranki is the small village in the Warmia and Mazury Region, near the city of Mrągowo and 75 km east from Olsztyn (capital of the region). This region is a land with a large amount of lakes and forests (about 30% of the area). Due to a high afforestation rate as well as low urbanization and industrialization, air in Mazury is unpolluted and very clean. The region is known for producing a very good quality food. The company Pieczarki Mazurskie Fedor was established in 1988 as a family company. It is the biggest Polish mushroom producer, which is its main product. The company consist of a few mushroom farms, which cover a producing area of above 19,000 m^2, Figure 16. It should be noted that all production buildings are equipped with air conditioning systems, which enable the control of mushroom growing parameters, such as temperature, humidity, air movement and carbon dioxide. It should also be emphasized that the mushroom farms use compost made in the company's own compost production facility, which is also located on the company premises. At the moment, all mushrooms are harvested by hand, which is not very efficient. The Pieczarki Mazurskie Fedor is working to find a way to automate this process. After harvesting, mushrooms go directly into a vacuum cooling chamber and are cooled to the temperature of 2°C. After three harvesting cycles all the mushroom growing chambers are thermally disinfected and the compost is replaced. In mushroom production farms, the purity of soil, compost and all the facility is essential because of the risk of mushroom infection. The Pieczarki Mazurskie Fedor company works continuously throughout the year. The company has its own straw storage (>10,000 m2) for the production of compost. The maximum amount of stored straw is about 100,000 tons, which is enough for two years of the company's production.

Figure 16. View of Pieczarki Mazurskie sp. z. o. o. factory

Amounts of biomass-based residues including current utilization and costs

The biomass-based residues in Pieczarki Mazurskie Fedor are mainly the spent mushroom substrate. It is a used subsoil, that contains straw and parts of mushrooms. This material is a very good fertilizer containing a lot of minerals. Local farmers buy it very willingly, and there is no problem of selling it. It is a very good quality fertilizer. Awareness that the soil needs mineralization helps the owners to get rid-off that commodity relatively easily. The company produces over 300 tons of spent mushroom substrate weekly which is stored at the company premises, Figure 17. However, there are some difficulties with this biomass-based

residue. It is not possible to handle this waste at the plant because of the risk of infection. As said before, spent mushroom substrate is a perfect fertilizer and for this reason all the fungus, molds, grasses and cereals that are spread around with the wind can easily develop on it. For that reason the mushrooms produced in company can be easily infected, which may result in a complete destruction of a given batch followed by onerous, costly and time-consuming disinfection and cleaning of the entire apparatus. For this reason, the waste is stored a few kilometers from the plant in heaps and would have to be processed there. This situation impede the possibility of pelletisation of spent mushroom substrate for energy purposes. Nevertheless, the company owners are interested in the possibilities of converting the acquired waste into the thermal energy. A few years ago, they give some of their biomass-based residues to the company, who wanted to explore them for the possibility of converting the material into energy, but unfortunately without corresponding success.

Figure 17. Spent mushroom substrate

Perspective of the enterprise on opportunities for valorization of biomass-residues

At the moment the residues from the company are mainly sold to companies from the agricultural and horticultural sector. The company, however, would like to partly convert the residues (spent mushroom substrate) into thermal energy. Some experimental investigations have been done to produce pellet from spent mushroom substrate (Figure 18), but the first attempts have not resulted in good results for use of this kind of fuel.

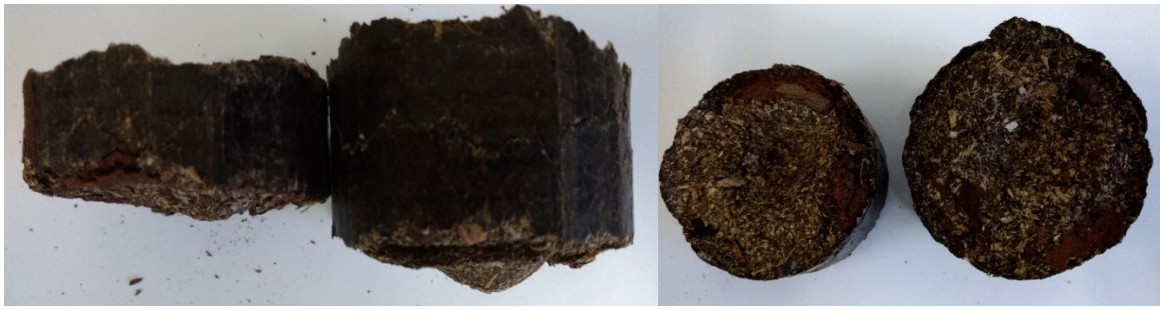

Figure 18. Example of pellet from spent mushroom grain.

The material samples of spent mushroom substrate have been also taken by Gdańsk University of Technology to evaluate possibility to use this material as a fuel. The experimental results have shown a large variability in calorific value due to combustion from various material samples (from 12 kJ/kg to 17 kJ/kg). That variability is a result of the material heterogeneity. The latter issue could be alleviated by modification of the pellet

production technology. On the other hand, the company has no capability to use all the amount of produced waste material for heat production. Another problem is the fact that management of spent mushroom substrate as a fertilizer is difficult in winter due to the low field accessibility via local roads. It seems that the realizable solution is the year-round production of granulate from spent mushroom substrate, which partly could be used as a fuel for meeting local demand for heat (or even possibly electricity production) and partly sold as a fertilizer granulate (Figure 19).

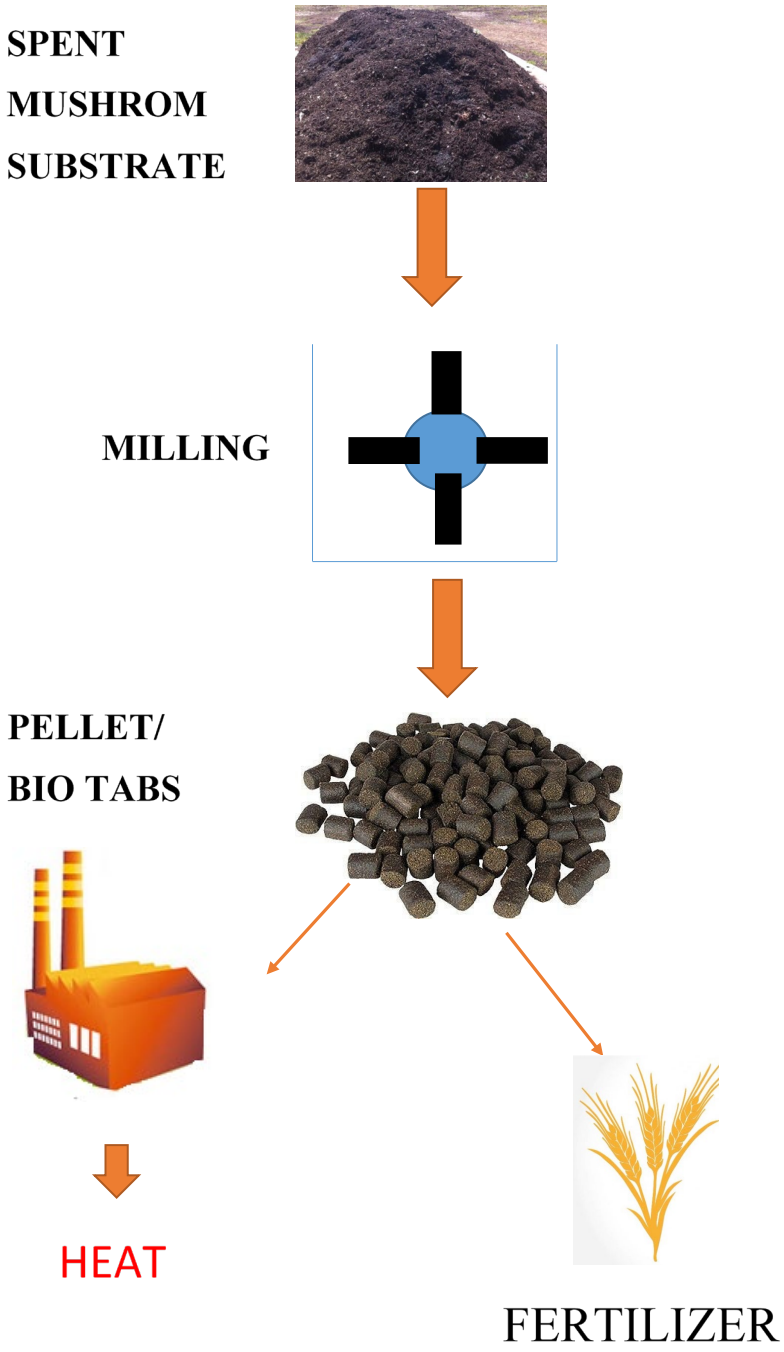

Figure 19. Example of spent mushroom substrate valorization

Innovation needed to implement technology

Although the company does not have its own Research & Innovation center or unit, it puts a lot of emphasis on development and keeping their production technology up to date. The company has the most modern substrate production technology. The company owners place great efforts on its quality and invest a lot of money to be as innovative as possible. Nevertheless, the company wants to continuously develop. In the next 5 years, Pieczarki Mazurskie Fedor plans to implement a new technology in a substrate production, namely composting (pasteurization of 2nd fraction, 3rd fraction overgrowth and mowing).

Moreover, the company will focus on changing the harvesting technology. They are planning to introduce mechanization of the mushroom collection to solve the problem of non-availability of human resources. It is also planned to expand the plant and renovate the existing infrastructure. The company owners also intend to acquire energy-saving technologies and develop the energy recovery installations. The company is very interested in a disposal of its spent mushroom substrate by combustion. At the moment it uses very large quantities of heat, electricity and cold. Energy is one of the largest components of the company's costs. The monthly bills for electricity, which is mainly used to lower the temperature in a mushroom plant, is 150,000 - 160,000 PLN. The increase in electricity prices in the years 2018-2019 was at the level of 63%. The company utilizes heat from the recovery from refrigeration systems, but the amount of it is still not sufficient to cover the demand. The problem is that for the production of mushrooms, it is necessary to ensure appropriate humidity - most often the air needs to be dehumidified. At this point, to dry the air, it is first cooled and then heated, which incurs significant costs.

Currently the labour market shows the deficiency of manual workers. Therefore, it is necessary to undertake actions leading to automate the collection of mushrooms. The entire global mushroom production market is striving to find a solution, namely a robot that would collect mushrooms. On the market there are emerging tests, prototypes and prototype machines. Recently, a Canadian company presented its automatic mushroom harvesting robot at the fair. Unfortunately, it is very slow, as it collects mushrooms one by one. There is also a problem with the accuracy of this device. In addition, it requires a man to service and is very expensive.

How the mushrooms are produced

The production of mushrooms is about 3,000 tons per year, Figure 20. Before sale, mushrooms are packed according to individual customers requirements or in the standard way:

- 3 kg boxes loose
- Box with tray 4 x 500 g
- Box with tray 4 x 400 g
- Box with tray 6 x 250 g

The mushrooms might also be sorted in accordance to different sizes:

- 2 – 4 cm
- 4 – 5 cm
- 5 – 6 cm
- More than 6 cm “Riesen”

The company possesses their own source of heat, two boilers with a 500 kW power each. The boilers are fired with wood pellets. One of the boilers is used to produce technological steam

and the second one is used for hot water production. The company also needs electric energy to cool mushroom growing chambers and for the technological process of compost.

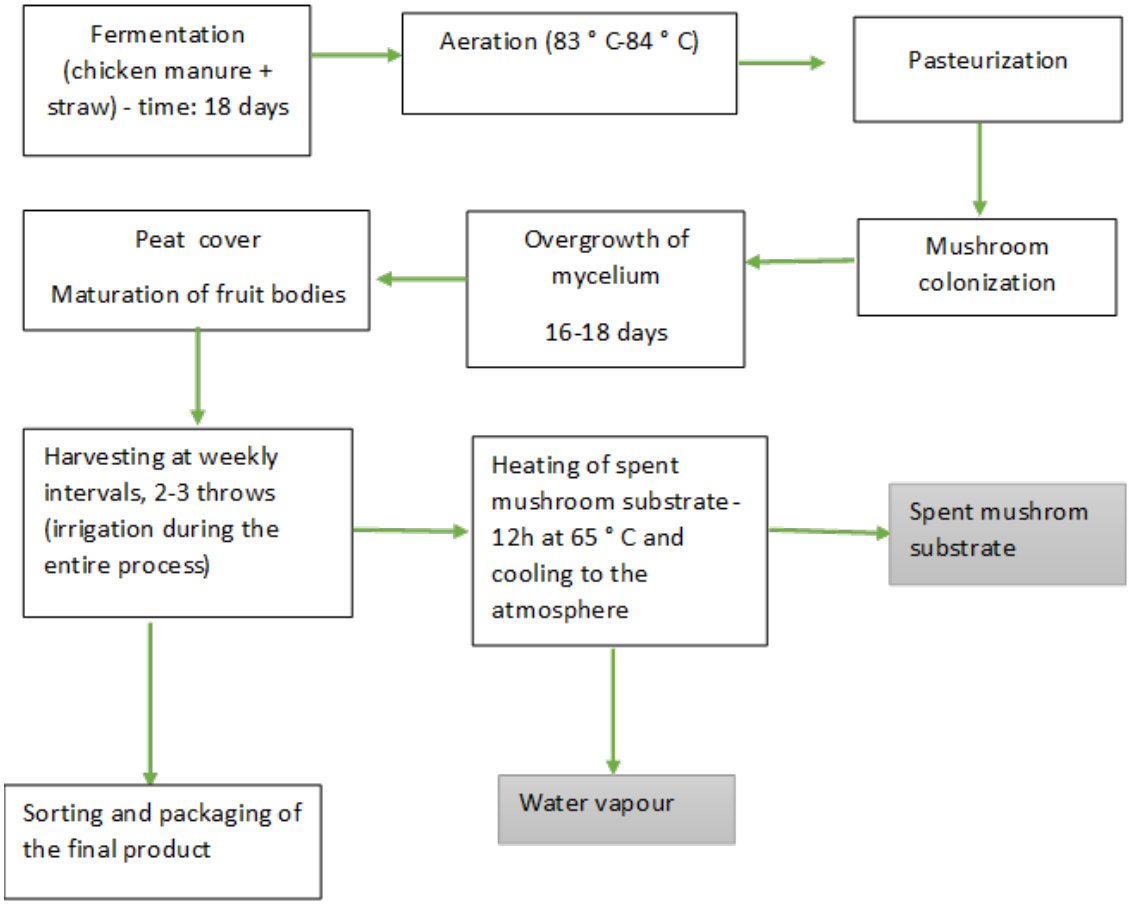

Figure 20. Scheme of mushroom production process

Regional guidance in the bioeconomy

This portrait based on an interview with:
Dr. Adam Mikołajczyk, Head of Department of Economic Development, Pomeranian Region Marshall Office, in Gdańsk, Poland
Interviewers:
Dariusz Mikielewicz, Jan Wajs and Aleksandra Gołąbek at GUT

The Marshal's Office is a representation of the local government. It is a budgetary unit of the voivodship self-government and constitutes an auxiliary unit of the province's management board, enabling it to perform its statutory tasks. The office operates on the basis of the provisions of the act on the self-government of the voivodship and on the basis of its statute. One of the departments of the Marshals Office is the Department of Economic Development, which tasks is amongst the others to support the local bioeconomy initiatives.

Bioeconomy and its development in the Pomeranian Voivodship and in Poland from the point of view of the Marshal's Office of the Pomeranian Voivodship

According to the Director of the Department of Economic Development of the Marshal's Office and its leading collaborators, the region had some experience with the issues related to bioeconomy earlier, however has not been named using that terminology. The definition of

bioeconomy at the level of this organizational unit is a novelty, because it has only been functioning for about a year and in recent months this has led to an increased interest in bioeconomy in the area. The main current of interests among the Office's clients is the so-called circular economy, which is coupled with the terminology of bioeconomy and aims to minimize the waste generated in the enterprise, thanks to the use of residues generated during processes as a raw material for subsequent processes. The interview shows therefore that entrepreneurs in Poland are beginning to be intensely interested in solutions used within the broadly understood bioeconomy. One of the identified limitations that may lock the development of this area is the lack of precise legal regulations in that direction. As an example, by-products from the food processing industry are classified as waste, without detailed specification of their nature, and as a result they should be treatment as, for example, the municipal waste. They cannot be used again in food production, which does not, however, disqualify them from other interests. In order to make these by-products available as feestock for the bioeconomy, regulations on EU-level need to been seen over to not gerenally exclude these valuable by-products.

Perception of Polish enterprises by the Office of the Marshal of the Pomeranian Voivodeship in the context of bio-innovation

The unit perceives some companies in the Pomeranian Voivodeship as bio-innovative. There are identified municipalities and areas in the voivodship in which the circular economy already operates. These areas include, among others, newly created energy clusters (for example, the Baltic Eco-Energy Cluster, or dedicated lobbies for the benefit of prospective energy technologies). Institutions and enterprises in these areas cooperate with each other for the purpose of designing and implementing innovative solutions, also in the field of bioeconomy.

An example is the Kwidzyń Energy Cluster, whose coordinator is Kwidzyński Park Przemysłowo Technologiczny Sp. z o.o., in the framework of which there are developed installations for renewable energy sources and which have investment land with an area of ca. 17 ha, equipped with technical infrastructure. The aim of the cluster is to support the ecological economy and based on the principles of sustainable development, as well as promoting territorial and social cohesion. Its scope of operation includes generation, distribution and reception of electricity and heat by cluster members in their area of operation (6 municipalities: City of Kwidzyn, Kwidzyn Commune, Municipal-Rural Prabuty Commune, Ryjewo Commune, Sadlinki Commune, Gardeja Commune).

The second cluster is the Słupsk Bioenergy Cluster, coordinated by the company Wodociągi Słupsk Sp. z o.o. (Słupsk Water Supply Ltd) and which operates, inter alia, in the area of electricity, heat and fuels production in conventional installations as well as renewable energy, energy storage, scientific research, advisory and educational activities related to generation, distribution, trade and management or optimization of energy and fuel consumption. Its purpose is, among others, to reduce the emission of the economy by supporting the production and distribution of energy from renewable sources, promoting energy efficiency and the use of renewable energy in enterprises, promoting the use of high-efficiency cogeneration of heat and electricity based on the useful heat demand.

The next cluster in the region is Przechlewo Energy Cluster. It includes the following communes of the Człuchów powiat: Przechlewo Commune, Rzeczenica Commune, and Koczała Commune. The cluster's activities aim at balancing energy at the level of the cluster, the distribution system operator and the national power system, activities related to energy efficiency, development of low-emission economy. Within the cluster there are three biogas

plants that have their own distribution grids connecting biogas plants with neighboring agricultural plants and farms.

Another cluster of this type is the Energy Region Gajewo cluster, which covers the area of the rural commune of Malbork. Its coordinator is Ośrodek Hodowli Zarodowej "Gajewo" Sp. z o.o. (Breeding Centre “Gajewo” Ltd) for and FLEXOPACK Polska Sp. z o.o. The cluster's activity focuses on the implementation of investments including, inter alia, the construction of installations based on renewable energy sources, construction of the energy storage facility and the reduction of harmful emissions to the atmosphere. There is also a biogas plant in the cluster.

The last example is the Gniewino Energy Cluster, which operates in the Gniewino commune. Its coordinator is Gniewińskie Przedsiębiorstwo Komunalne Sp. z o.o (Gniewino Municipal Enterprise Ltd). The area of the cluster's activity includes the implementation of the local energy system, which will include 6 solar installations and 2 micro-installations of biomass co-generation.

Communication of the Marshal's Office of the Pomorskie Voivodeship with Pomeranian entities interested in solutions in the field of bioeconomics

The Marshal's Office maintains contact with many enterprises and associations in the voivodship. The entities report on issues related to bioeconomics, but this is often an indirect topic. The purpose of companies' registration is, among others, to receive help in acquiring potential clients for the proposed solutions or to obtain permits and acceptance for the implementation of projects. A formal requirement in such cases is that these projects comply with the provisions of Polish law, because the Marshal of the Pomorskie Voivodeship cannot create their own laws and regulations. The interesting fact is that applicants are not always interested in co-financing initiatives. The institution also uses its network of contacts to advise on issues related to the solutions proposed by the companies and associations that approach them.

The Voivodship Marshal developed in previous years (2014) the so-called Smart Specializations of Pomerania (ISP). Recently, the Council of these specializations has been changed and it is expected that the new one will be the main information channel for the local communities with which the Marshal's Office will closely cooperate. It is anticipated that the Council for Smart Specialization of Pomerania in the area of Eco-Efficient Technologies in the production, transmission, distribution and consumption of energy and fuels and in construction (ISP3) will expand its activities to bioeconomy and to raise public awareness of the bioeconomy. ISP3 associates about 110 entities from the Pomeranian Voivodeship (municipalities, scientific and research centers, institutes, enterprises, clusters, administrative centers), and its task is, inter alia, to identify research and development areas with significant development potential and whose support will contribute to increasing the economic attractiveness countries of the European Union. One of the areas of interest of ISP3 are biocomponents and biofuels whose development has an impact on the broadly understood bioeconomy.

In addition, the Marshal's Office of the Pomeranian Voivodeship actively cooperates with scientific institutions – it is an associated partner of the BioBIGG project, thus supporting the Gdańsk University of Technology in the implementation of the project managed by Roskilde University. The Office supports initiatives aiming at the development of bioeconomy in the Pomeranian Voivodeship, among others by promoting events (conferences, seminars, panel meetings) on the development of the bioeconomy in Poland and Europe.

Forms of support for enterprises wishing to develop within the bioeconomy sectorThere are several forms of support that enterprises seeking to develop bioeconomy can take advantage of as part of their activities. In the initial phase of implementation of the financial perspective 2014-2020, these were even direct grants to investments considered beneficial for the region. Unfortunately, the expected results of this type of solutions have not been achieved. Currently, the so-called profiled loans are favored. They can be obtained by companies that want to implement technologies that reduce energy consumption as well as resources and raw materials. The condition is to show that the applied activities bring the result, and thus such enterprises should make use of the expert knowledge in a given field before deciding to use the loan.

The second form of support is the so-called Renewable Energy Sources Loans offered by Pomorski Fundusz Pożyczkowy Sp. z o.o. (Pomeranian Lending Fund Ltd), and financed from European Fund for Strategic Investments funds and from the state budget. The loan is addressed to investors who are interested in the construction of installations in the Pomeranian Voivodeship, along with the infrastructure allowing to connect the source to the network, producing energy (electricity, heat or both forms in cogeneration) from renewable energy sources (biogas, biomass, solar, geothermal energy and water energy), thereby increasing their installed capacity. Preferred are enterprises that use innovative technologies, are part of municipal documents in the field of low-emission economy or energy supply and ensure the greatest ecological effect in relation to the incurred financial outlays. The maximum loan amount is PLN 15 million, and the maximum repayment period is 15 years from the first launch of the funds. The grace period for repayment of the capital is up to 24 months (depending on the nature of the investment and sources of financing).

Another way to support enterprises is to create the so-called interest groups, among others, various councils through which relationships can be established, for example between an enterprise interested in implementing a given technology from the bioeconomy sector and an enterprise that can provide it or use the same technology and who can share comments on it. One of such groups is the above-mentioned ISP3, which supports projects focused on the development of technologies concerning the areas of interest of specialization. The support includes conducting scientific research as well as development works, and takes place with the participation of research units and enterprises.

In addition, projects that meet the requirements set by ISP3 have priority in accessing EU funds earmarked for supporting research and development projects in the period 2014-2020 (as part of the Regional Operational Program for the Pomeranian Voivodeship). One more scientific and research competition is expected to select further projects for financing. There is also a place for the implementation of projects related to technologies related to the bioeconomy.

The forms of co-financing under ISP3 are also competitions for research and development projects submitted by consortia consisting of scientific units and enterprises in which the scientific unit is the leader. Support is provided by the National Center for Research and Development.

What should be changed from the point of view of the Marshal's Office to develop the bioeconomy sector in the Pomeranian Voivodeship?

Employees of the Marshal's Office draw attention to a significant percentage of projects carried out, which have no positive impact on the economy. Companies should be more willing to cooperate with each other and create and co-finance (together with local

government institutions) research and development centers, thanks to which it would be possible to implement innovative technologies. Partial financing of such a center by enterprises would result in a greater involvement in the process of researching and implementing technologies, but also would reduce the cases in which the proposed projects would not be able to check themselves in real conditions (technical scale). Universities and research institutions should further educate the public on developing sectors, including the bioeconomy sector, and inform about possible directions of its development.

4.2.2 Germany

A Farmer's perspective on bioeconomic developments in the cultivation of sugar beet
This portrait based on an interview with:
Christian Ringenberg, Farm owner, in Alt Negentin, Germany
Interviewer: Max Mittenzwei, UG

The sustainable family farm in the Vorpommern region has been operated for generations. Its central pillar is the agriculture with the cultivation of the typical fruits like barley, rape, wheat and sugar beets. On the grassland, suckler cows with their calves of the breeds Uckermärker and Fleckvieh are kept, which are marketed as fattening and breeding animals. The farm has a cultivation area of about 3000 hectares, 200 of which are sugar beets. The sugar beet itself has been grown since 1991. The main reasons given for growing sugar beet were its status as a staple crop and its function of broadening the crop rotation of otherwise rape, wheat, and barley. Some crop protection products can furthermore only be used in sugar beet cultivation, which is another reason for the cultivation. These would otherwise have adverse effects on the crop. Otherwise, maize or field beans are occasionally sprinkled in as a crop, but this happens rather rarely in comparison.

Mr. Ringenberg himself has been working as a farmer for 13 years. When asked to what extent his activity has changed over the years, he replied that administrative tasks had increased considerably. In the past, these would have accounted for 20-30% of his work, today it instead amounts to 80%. However, this circumstance is also due to the development that various laws and regulations have been introduced over the years, such as fertilizer regulations or plant protection regulations. His work has thus become considerably more complicated, also due to the complete conversion of the farm to precision farming. Data acquisition, processing, and digitization are an enormous time factor.

A further reason for the cultivation of sugar beets was that from a business point of view, they generated an excellent yield. However the decreasing demand for sugarbeets due to the 2017 sugar market reform, during which the sugar market got liberated and went from a quota-system to a free-market model, resulted in a considerable price drop. When asked about the extent to which the cultivation of sugar beet has changed over the years, the main factor mentioned was a significant increase in yield. This was primarily due to the breeding performance of the cultivars; the influence of the climate alone was not the decisive factor. In comparison to southern German sugar beet growers, Mr. Ringenberg notes that the yield increases in the northeast are relatively higher and more constant than in the south, due to climatic effects. Despite the current market problems, it is still desired to increase the cultivation of sugar beets. As a result of the imminent bans on crop protection products, they are already working intensively on how they can optimize cultivation. Today, they are working together with their neighbors to cut harvest costs by 20-30 percent. Another topic that will be important in the future is the use of modern harvesting technology to reduce costs during harvesting. The impact of the sugar market reform on the farm itself was estimated to be significant. Whereas in the past it was possible to earn about 27€ inclusive, today it is only

about 20€. From a purely economic point of view, sugar beet should no longer be grown, but various intangible effects, which are difficult to express in mere figures, play a role. For example, it is stated that the fact that sugar beet is a spring fruit leaves more time for other work. This makes the operation more stable, even if the effect cannot be measured economically. The sugar beet should no longer be seen as a "cash crop", but rather as a crop like all others, which is integrated into the crop rotation over the years. Mr. Ringenberg also mentions that, as a farmer, he generally does not consider annual effects but medium-term developments.

Contract farming, originating from the sugar factory, is regarded as a reasonable solution because it is easy to plan and therefore offers a certain degree of planning security. On the other hand, the lack of flexibility is seen as a problem, as in the event of a good harvest and overproduction, the surplus cannot be supplied to the sugar factory. Geographically speaking, the region is disadvantaged compared to southern Germany due to only a small number of biogas plants in which this surplus could be processed. Although one would like to see a better price, the agreement is generally regarded as fair.

A problem that has been identified over the years is the infrastructural disadvantage of the region. Sugar beets are, in comparison, quite voluminous and thus need more significant machinery than wheat or rapeseed. The single fields of cultivation are larger in Vorpommern, the roads are not well developed and often old flat roads exist, while trees and dips block specific ways completely. That means that regular harvest machines are not used, but wheel loaders and cleaning belts instead. A better option could not have been identified yet.

Excellent networking with other farmers was expressed several times during the interview. Private meetings are held regularly, while during the winter season, there are many specialist events. Up to twenty different events are mentioned, to which farmers can voluntarily register and participate, depending on their interests. Much of the input about innovations communicated through these contacts and events, while an independent business consultancy provides further input. These include field inspections, sharing expertise in working groups and critical discussion among each other. Thus it is stated that the company is always up to date regarding new developments and that this also plays a vital role in the future.

The response to what he thinks about sustainability, Mr. Ringenberg answered surprised: *“I always say to people that sustainability is important to me, but I already live it, so do I need sustainability as a broad concept? We have 15-20 employees, three apprentices, leave an edge strip on each field, have over 20 hectares of flowering area and so on. However, I believe that the elderly in comparison like to stick to their structure from the past and just want to earn as much money as comparable jobs without thinking about their footprint. A major point of criticism for me is that we farmers are the players on the land, but far too little is actually done with us players on this land, and far too much is said about it in politics. What I mean to say, then, is that no farmer will resist doing something good for nature if he can because he lives from it. And no farmer pollutes his soil if he has lived off it for generations. And sustainability is what we live for, and I think we would live even better if more support were given to farmers in that respect.”*

Residue-wise, at least during the cultivation of sugar beet, there is not much room for improvement now. Leaves and heads remain shredded in the field after the harvest, these are not used for further processing for feed or other purposes, because the costs would be too high for gathering and transportation. As a rule, the residual by-product is plowed down and wheat cultivation follows as the next crop. The current main task of the residual materials is

to improve the soil structure. Economically, residues are of no importance. Mr. Ringenberg cannot currently imagine a more efficient use of these by-products for the reasons given.

The single most important innovation for the cultivation of sugar beet was the significant progress in breeding, says Mr. Ringenberg. Especially the even spread of the sugar content over the whole beet was mentioned, while harvesting as itself and the whole system have not changed much. When asked about his general attitude towards innovation, Mr. Ringenberg said that he would consider his farm as open.

Although he was familiar with the term bioeconomy, it was only terminologically, which can be seen as an indication of the total failure of politics to communicate the concept of the bioeconomy to the actors most likely to be affected.

The role and perspective of regional farmer associations in the sugar value chain of Mecklenburg-Western Pomerania

This portrait is based on interviews with:
Thies Holtmeier at Anklamer Anbauerverband Zuckkerüben e.V., in Kruckow, Germany and
Frank Schiffner at Bauernverband, in Neubrandenburg, Germany
Interviewer: Max Mittenzwei, UG

The Anklamer Anbauerverband für Zuckerrüben e.V. represents the interests of 366 farmers. They cultivate around 19,000 hectares of sugar beet for the Anklam sugar factory andis organized wholly detached from the sugar factory. It is a registered association and was initiated around 1991/1992 after the fall of the Berlin Wall. At that time, the sugar market was restructured quite extensively. As a result, many of the then small sugar factories were closed, and at the time, under the direction of Danisco, the Anklam site was specifically targeted. It was then very actively developed, including the foundation of the association. The membership is obligatory, i.e., all farmers who deliver sugar beet to the Anklam sugar factory must become members in the association. The main task, according to the statutes, is to negotiate the delivery conditions with the sugar factory for all sugar beet growers. Otherwise, there are regular contacts to the campaign, especially in autumn/winter and otherwise at irregular intervals. As soon as there are any problems or a need for discussion, the discussion is sought. There is however no robust framework that one meets monthly. Not only delivery planning and day-to-day business during the sugar beet campaign are being coordinated, but multi-year contracts are also being negotiated.

The Anklamer Anbauerverband (ABV) sees unequal market access conditions to the sugar market within the EU as a serious problem. The members cannot solve it in their association, because they are restricted by EU law. Improvements can only be made by politicians, especially at the EU level.

The regional sugar company tries not only to produce sugar but also to market the by-products by processing them into biogas or bioethanol. Thus, it has a somewhat broader market position than many other sugar companies, which is considered an advantage. On the other hand, it is, of course, the case that the factory is a purely private-sector one. The breeders thus have no say within the company because there is no shareholder structure. That is different in many other sugar companies.

The framework conditions for the work of the association have changed entirely in the last few years. Until 2016, the sugar beet farmers were operating in a completely isolated market. The sugar market was the last market with an absolute quota. That had two sides. On the one hand, production has always been capped, which has meant an explicit restriction for farmers.

In the new federal states, in particular, the proportion of land used for sugarbeet production is significantly low. With ca 19,000 ha under sugarbeet, this means that the average distance from the plant is very high, which represents a particular disadvantage in terms of costs.

On the other hand, of course, it has also ensured that farmers have or have had stable conditions in the market. At the moment, the complete liberalization of the sugar market has led to dramatic distortions. This overproduction, which prevails within Europe, coincides with a worldwide overproduction, and this naturally leads to chaotic conditions, which the market partners within the EU have underestimated. According to Mr. Holtmeier, the momentum that has developed from this has become partly ruinous at the moment. Besides, the different conditions of competition in cultivation under equal conditions of access to the sugar market are another problem. This is also a problem that urgently needs to be corrected within the EU*: "It is unacceptable that one should collect an area payment at absolutely the same prices for the end product. That does not work at all. As a result, in the end, it is not competition that wins, but political circumstances. So either you want competition, then you have to allow it across the whole area and not cover one of them with your cheese bell. That is not possible somewhere. And that is particularly true of this region."*

Concerning partnerships and cooperations, the association participates in the working group for beet growers in Anklam, which is the direct link to the sugar factory. The Landesforschungsanstalt is the most essential partner besides the sugar factory for the ABV; it has an accompanying function and makes information and knowledge available, which is passed on to the farmers themselves via the ABV. Besides, a close relationship is maintained with the Göttingen-based Institute for Sugar Beet Research. However, ABV has never been a participant in sugar beet research projects.

About the openness of the members towards modern cultivation methods, the answer was that the Anklam region was relatively innovative in terms of sugar, especially in terms of yield development. The expansion of the factory in Anklam towards ethanol and its consequences is mentioned as an influencing factor. Very poor beet prices accompanied it. On the earnings side, it was thus necessary to exhaust everything possible in order to achieve profitability. So anyone who decided to follow this path as a farmer at the time had to be innovative on their own. Otherwise, the process was not profitable for them.

The question of sustainability and what people think of it was answered with a similarly diverse response as in the first interview: *"So, first of all, I find the concept of sustainability completely overloaded at the moment. Everything is sustainable at the moment, but if we look at global development, we are anything but sustainable. We are all on an absolutely ruinous path together. I do not want to exclude myself, the region or the farmers. That is what we all do together. Always according to the motto "do it better," we just try to put on the cloak of sustainability somehow. Something is always brought out that the solution is supposed to bring. I think the way they went in Anklam was to say that we not only produce sugar but also try to use the by-products in a sensible way."*

The factory returns Carbokalk to the farmers. Carbokalk is an earth-moist, crop-compatible lime fertiliser for arable farming, grassland and special crops. Carbolime is produced during the processing of sugar beets. It is a fertilizer approved according to the fertilizer ordinance, and according to the EU organic ordinance also for organic farming. Some of the pressed pulp is also brought back to the farms as animal feed, and some vinasse from bioethanol production is returned to the farmers. With the expansion of the sugar factory, the idea of taking a more active approach to beet soil is currently also being considered. So far, the soil that is collected together with the beets has been on the verge of becoming waste. It is

currently used as a covering material for landfills. In the past, it has gone back to the farmers, where it has been applied in parts as a soil improver. However, returning the soil is connected to high transport costs and cheaper alternatives for improving soils. In future, the beet soil is to be pressed directly at the factory. Mr. Holtmeier finds it very questionable whether it is really sustainable if a lot of energy is used to squeeze the water out of these secondary components of the beet and the soil, and according to him it has not been investigated to the end: "But that is usually the problem with the subject of sustainability".

Further use of the residues on the field is also viewed critically. The current situation, in which the residues are plowed into the field, primarily serves to recycle nutrients. The sugar beet extracts potassium from the soil, which can mostly be returned via the leaves. In addition to the nutrients, the humus balance side is also seen as the primary focus. Withdrawal of the residues would have a negative effect, says Mr. Holtmeier. Compared to other fruits, the current use is considered very reasonable. The direct combustion of the produced raw gas in the factory is seen as great potential. However, there are political reasons against it. The purified and processed gas earns much more money and can be bought back cheaply afterward: "That is the perversion of our economy at the moment. But that is due to the subsidy policy, which leads to such stupid excesses."

The Farmers' Association of Mecklenburg-Western Pomerania (Bauernverband), as the "Association of Associations", is organised in 15 independent regional associations throughout the country. These regional farmers' associations operate independently in the regions. The sizes of the regional associations vary considerably in some cases. The regional association tries to bundle the interests and to be active also in the direction of technical information and consultation for the regional circle federations. The Farmers' Union is a representation of the interests of the agricultural enterprises in political regard in the first place and tries to bring unity into the variety of the enterprises and to let equal treatment prevail. The founding of the Farmers' Union also dates back to the post-reunification period; members of the Farmers' Union currently cover 55-60 percent of the agricultural land in Mecklenburg-Western Pomerania.

In contrast to the ABV, membership in the farmers' association is voluntary. A farmer can also join both associations. The Farmers' Union is also broader and represents the interests of all farmers, not just sugar beet growers. The ABV is also a member of the farmers' association itself.

Farmers can participate in the Farmers' Union in many ways. Specialist committees, such as plant production, animal production, renewable energies, and public relations work, make every effort to ensure that farmers from each region are actively involved in the work of experts in their respective fields. From Mr. Schiffner's point of view, every farmer is also a PR worker and more or less represents his industry.

The Farmers' Union can confirm the good cooperation dynamics between farmers mentioned in the interview above: cooperation on land management, machine replacement, and -sharing or joint accounting are widespread. There is cooperation in daily work, in the division of specialized machines, and also in bookkeeping and accounting. These links are mostly informal and are often based on the principle of good neighborliness and the we-are-all-in-the-same-boat approach. Farmers also can receive help and support from the association. There is help with legal questions, instructions in plant cultivation or animal production, and a large number of support measures are offered to the individual regional associations.

Regarding its cooperation partners, the Farmers' Union is broader than the ABV, not least because of its goal of being publicly and politically active. As far as the innovative ability is

concerned, the Farmers' Union maintains close contact with the Neubrandenburg University of Applied Sciences and with the universities in Rostock and Greifswald, with which various projects have been worked on. However, it is emphasized that the farmers' association is not a university or institute, but a representation of the farmers' interests so that the focus is not on research and development.

One of the problems the farmers association sees in the contact between ABV and the sugar factory is the lack of a partnership-based equal treatment and interaction with each other. Especially after the liberalization of the European sugar market, a partly fierce competitive battle was fought.

Once again, the question of sustainability was answered emotionally: “We work and live on earth, and then we should also be aware of the consequences and question our actions and doings, so to speak. Finally, it's also about resource consumption and that we don't just take, take and take, but also always question our actions and doings.” Whether the term bioeconomy is known or not, was answered with: "I have already heard about it, I have read about it. It's a relatively new term. I've read it, but I'm not so sure."

4.2.3 Denmark

Innovative utilization possibilities for sugarbeets

This portrait is based on interviews with:
John P. Jensen, at the company Nordic Sugar, in Nakskov, Denmark
Interviewer:
Rasmus Nør Hansen, Mark B. Nielsen and Tyge Kjær from RUC

Nordic Sugar operates 13 factories and 3 refineries in Denmark, Sweden, Germany, Poland and Slovakia, where they produce approximately 3 million tons of sugar annually from sugar beets, Figure 21. The company is the second largest sugar producer in Europe and part of the Nordzucker Group (since 2009). The main residuals from the sugar production is molasses and pressed beet pulp used for animal feed.

Figure 21. Nordic Sugar plant

The sugar market development

The European sugar prices have been plummeting to a world market price of around 320€/ton since the liberalization of the European sugar production in September 2017. Due to overproductions in Europe and low market prices, several sugar productions by the competing company Südzucker, has been shut down. A structural development which has reduced the production capacity with approximately 700,000 tons annually, or 5% of the total EU sugar production capacity.

Nordic Sugar is owned by a cooperative of German sugar beet farmers. This can be an strategic advantage, as (1) the organizational structure is responsive to the entire value chain and (2) beet farmers are more focused on long term financial gains, compared to shareholder companies, such as Südzucker. Nevertheless, Nordic sugar still has to reduce their annual costs with approximately 40 million euros in 2019.

Main driver for innovation

According to John Jensen prolonging the harvesting season could potentially increase the sugar beet production with 100,000-200,000 tons in Denmark. Sugar beets have the highest productivity of carbon compared to current crops in Denmark.

An increased yearly production could support new and innovative utilization possibilities for sugar beets and also help mitigate the current market situation. Hereof, he suggests growing sugar beets with a higher fiber content.

The sugar extracted from the sugar beets could potentially be converted into bioplastics for the production of toys, bags etc. According to Jens Jensen, technologies that extract sugar from sugar beets and turn it into polymers, is on a higher developmental stage than technologies extracting cellulose from wood and straw.

In relation to the development of new and innovative production processes, John Jensen also suggest how the overall production principles could be defined through a sugar platform.

The platform would need to be supplied with a steady sugar beet production. When refining the sugar into different products, the concept needs to be flexible. The production capacity should be able to utilize different commodities (both wet and dry) and needs to be able to produce a variety of products/molecules from the same plant. He also stresses that choosing the right building block from sugars is of great importance, as there are many options and developmental pathways.

In order to make the production profitable, the platform needs to be based on a large-scale plant with a turnover of > 50 million euro/annually. In the development of such a commercial plant, a multi-functional pilot-plant should be developed before scaling up. Potentially attached to existing bio-refineries.

Ongoing projects related to beet tops and by-products

According to John Jensen, Nordic Sugar is also interested in the production of innovative products and services from their by-products and beet-tops, if there is a long-term market demand.

Hereof, the development of a sustainable bioeconomy needs to be supported by venture capital and focused research and investments, with participation of the right stakeholders and cross-border open-source collaboration. Nordic Sugar has thereby been involved in several innovation and sustainable projects in the last couple of years, such as SUBLEEM 2.0, STEPS and the ASSEMBLY project.

SUBLEEM 2.0

The SUBLEEM 2.0. project focuses on innovation utilization of green biomass. One of the focus areas of the project, have been valorization of the protein, fibers and other substances in beet tops. By separating the different components, it becomes possible to sell them individually and thereby utilize them in the best way possible.

The protein concentrate can be sold as feed for poultry or pigs, the fibers can be sold as feed for cattle and the liquids from the biorefining process (brown juice) can be us-ed for anaerobic digestion at a biogas plant.

The demo-plant used in the project aims to extract proteins and fibers from grass and beetroot tops, and possibly make the materials consumable for humans in the future. SUBLEEM 2.0 has recently made their first consumable-quality protein, isolated from sugar beet tops.

STEPS

Another project that Nordic Sugar is a part of, is the Swedish project STEPS – Sustai-nable Plastics and Transition Pathways. The project is a research program with a vision of a society in which plastics are sustainably produced, used and recycled in a circular economy.

One of the aims of the STEPS project is to make polyester, fibers, coatings etc. from building blocks produced from renewables feedstocks, such as beet tops. The feedstocks will also be used for productions of copolymers and composites with natural polymers like cellulose and starch.

The project team are currently working on a STEPS 2.0 application, and are looking for companies and partners with tech-knowledge, that would like to participate (Read more about STEPS by following the link in the footnote).

ASSEMBLY project

The ASSEMBLY project is founded by the Danish Innovation fond and focuses on production of sustainable fibers and composites. The aim for the industrial part of the ASSEMBLY project is to utilize the organic side streams from mills and factories to produce building blocks, by using (1) enzyme-mediated processes, (2) spin fibers with nanocellulose as the major component and (3) construct composites and chimeric materials with nanocellulose.

The research activity regarding Nordic Sugar, is mainly concentrated around the sug-arbeet pulp from the sugar production. The intention of the research is adding value to the raw materials aimed for the production of biocomposites.

The main strategic focus is to position the industrial partners as suppliers of materials suited for biocomposites. Thereby increasing the sales price for the organic side stre-ams from different productions. At the present time the ASSEMBLY project has made their first sandwich wrap from nanocellusos from sugar beet pulp (mg/g-scale).

Sustainable Agricultural Initiative

Nordic Sugar is also involved in the Sustainable Agricultural Initiative (SAI), as a member of Nordzucker. SAI is a global non-profit initiative promoting sustainable agricultural practices through collaboration platforms with key stakeholders related to the global food and drink value chain.

Pre-treatment of organic household waste for recycling
This portrait is based on interviews with:
Ole J. Andersen, Head of the energy department, at company Affaldplus, in Næstved, Denmark
Interviewer:
Rasmus Nør Hansen, Mark B. Nielsen and Tyge Kjær from RUC

Affaldplus is a waste handling company owned by 6 municipalities in the Region of Zealand, which consists of approx. 309,000 inhabitants and 30,000 companies, Figure 22. The company owns and operates 2 waste-incineration plants, 1 pre-treatment plant for municipal organic waste, 1 processing plant for garden- and park waste, 1 district heating plant, 2 environmental plants for inert waste, asbestos and temporary storage, 1 recycling terminal for further processing, 20 recycling stations, 10 garden waste centers and 2 second hand stores (re-use).

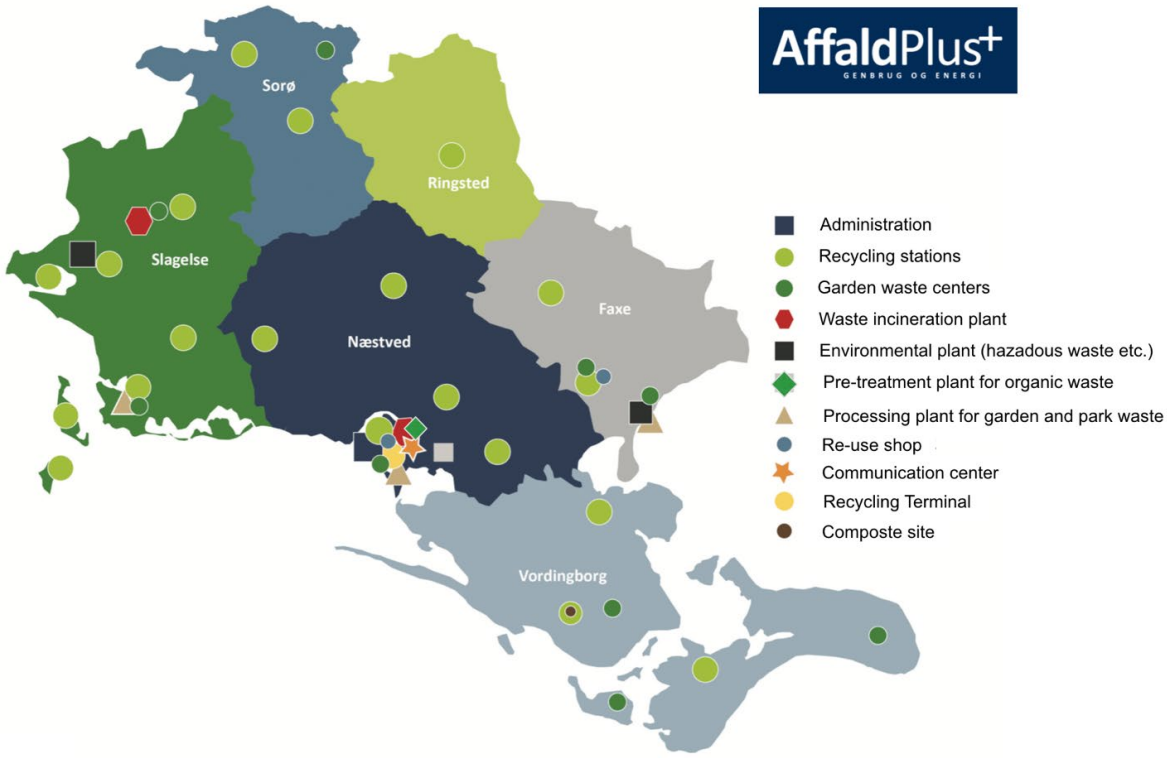

Figure 22. Locations where Affaldplus is situated

The municipal waste is collected through collection schemes organized by each of the six municipalities and transported to the waste handling plants operated by Affaldplus, Figure 23.

Figure 23. Waste incineration plant in Næstved

The company has its own environmental management system continuously harmonised to ISO 14001 standards. This strategy supports a very systematic and transparent approach to waste management within the company. Each year an environmental report is published, entailing environmental goals and the operational data for the companies' waste handling activities. This includes waste-input and output (divided into fractions and residuals), energy consumption, energy production, utilized chemicals and emissions related to operational activities.

Main drivers and barriers for innovation

Affaldplus main driver for innovation is directly related to the requirements in the EU waste directive 2008 and the Danish waste handling strategy. In 2020 the strategy states that 50 % of municipal household waste (Calculated by wet-weight) should be collected for recycling in 2020. Within the last couple of years, the collection of source-separated municipal waste for recycling has increased from 32 % to 48 % by the six municipalities.

In 2018 the calculation procedure for the recycling rate was amended in the waste directive. After 2020 the weight of municipal waste can only be defined as recycled, if it enters into the desired recycling operation after sorting and other preliminary operations (e.g. separating waste materials not subjected to the recycling operation).

Affaldplus is thereby highly focused on optimizing existing pretreatment processes for recycling, implementing new pre-treatment processes and identifying potential new markets for recycled materials.

Recycling of organic household waste

In 2017 – 2018 the company established a pre-treatment plant for organic waste to biogas. The facility was constructed next to the companies' largest incineration plant located in Næstved.

According to Ole Andersen the primary driver for establishing the pre-treatment plant was to increase the amended and collective recycling rate for municipal household waste, as the weight of organic waste is often higher than that of other household waste fractions.

The organic waste is collected in all 6 municipalities and transport to the pre-treatme-nt facility, where the organic part is pulped through a mechanical pulping technology developed by Ecogy. By pumping the pulp through 6 mm sieves, missorted waste (plastic, metal, glass

etc.) is removed from the biopulp. The water content in the reject is pressed out and recirculated back into the consecutive pretreatment process.

The pressed reject is transported by a conveyer belt into the incineration plant and us-ed as waste to energy (WtE). The pumpable biopulp is transported to a nearby biogas plant and utilized for biogas production (Figure 24). The residual fiberrich digestate is recycled as fertilizer on agricultural soil located close to the biogas plant.

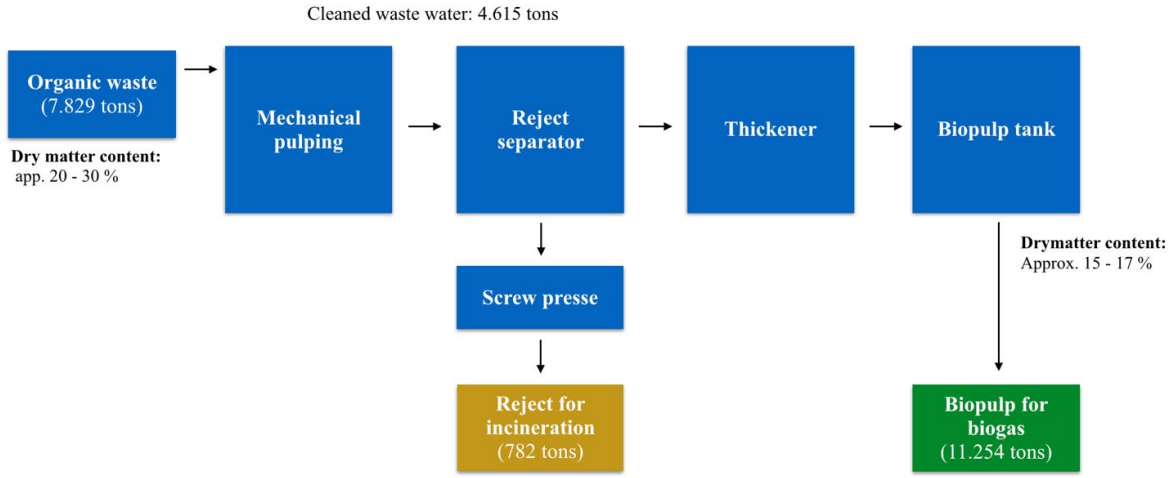

Figure 24. *Material-flow for pre-treatment plant (2018)*

In 2018 the pretreatment facility processed approx. 8,000 tons of municipal organic household waste for recycling. In 2019 the annual tonnage is expected to increase to approx. 19,000 tons, which follows the estimated total potential for or-ganic waste collection within the municipalities.

The facility has a daily operating time of 10 hours, 5 days a week. There are no per-sonnel on site, as it is fully automated and operated through the control room of the incineration plant.

Main barriers for recycling organic waste

According to Ole Andersen, handling physical impurities in the biopulp is one of the main challenges related to the recycling operation. He emphasizes that organic waste collected in biodegradable plastic bags has a tendency to break into small pieces, which is difficult to separate from the biopulp. Furthermore, the municipalities also focus on high purity in the digestate. Mechanical wear, and the related maintenance costs, is also emphasized by Ole Andersen as important process parameters.

When discussing the establishment of the pre-treatment plant, the economic feasibility of the plant was of course also a parameter. Hereof, Ole Andresen stressed that the estimated potential amount of organic household waste, needs to support the feasibility of the plant. He also stated that after the plant was politically projected as feasible, there were limited barriers related to the establishment of the plant.

Nevertheless, he mentioned that some private pre-treatment companies (in another c-ase) tried to affect the political decision-making process related to establishing these types of ownership models, as they believed it was too expensive to establish a pretreatment plant owned by a municipality or municipal waste handling company.

4.2.4 Sweden

Extraction of high-value compounds from biomass side-streams

This portrait is based on interviews with:
Ecevit Yilmaz, CEO, at YLS Consulting, Alnarp, Sweden
Interviewer:
William Newson from SLU

YLS Consulting helps SMEs with their marketing needs, promoting products and finding customers mostly in the bio-based product space. They provide scientific findings making bio-products more sellable in the marketplace. To increase value, YLS Consulting provides separation techniques to purify bio-products, including custom chromatography resins. The managing director, Dr. Yilmaz has an undergraduate degree in Biotechnology and PhD in polymer chemistry, specifically in the application of biomimetic polymers for biomolecules in the clean-up of food, ingredients and pharmaceuticals. He founded YLS Consulting after 15 years specializing in increasing bioeconomy value generation for other companies.

In the area where YLS Consulting operates, the methods used, such as chromatography, are expensive to implement so the products must be high-value and not commodities. Target product areas include nutritional products, flavours, aromas, colorants, proteins/peptides and pharmaceutical ingredients. Custom products that remove contamination in bio-based materials are also provided, such as for taking out toxic compounds from food products. All of these activities are aimed at maximizing the value of bio-products by both collecting and concentrating valuable components or removing components that reduce product value.

Barriers to innovation

Dr. Yilmaz sees that some of the observed barriers to innovation faced by YLS Consulting and its clients in the bio-based product space are the required development time, lack of patience from both the customer and supplier side and in some cases lack of investor patience. Dr. Yilmaz suggests it is possible that this can be addressed with increased awareness of the time required for development on all sides of the business. Another barrier for YLS Consulting and its customers is a lack of a surrounding community of specialized expertise and networks to assist in quickly developing products. For many products, regulatory barriers, such as strict food industry regulations, need to be navigated. Dr. Yilmaz sees that these regulations place a high burden on small companies and expertise to assist in this area could also be part of a specialized expertise network, helping everyone in the bio-based product space.

YLS Consulting and its clients also have barriers in accessing feedstock for processing; suppliers of required biomasses may not be not well known to possible users, giving them a low chance of interaction. Dr. Yilmaz notes that unlike grains or oilseeds no platforms exist for trading non-commodity biomass due to their low volume or low international trading flows. An example of making supplier connections in non-commodity feedstock are combined technical and business meetings that YLS Consulting attends. For example, a recent essential oil convention where knowledge was shared and focus is placed on the production stream brought together all parts of the process allowing interaction from feedstock suppliers to industrial users. Dr. Yilmaz suggests similar activities could be used in other areas to facilitate interactions along the production stream.

In terms of industrial customers of YLS Consulting, there is a lack of customer pull on the biomass producers due to a lack of knowledge of what compounds are in the biomass. Dr. Yilmaz points out an example that flavour molecules exist in juice pulp that could be

exploited in other parts of the food industry providing added value for the juice producer, these are compounds that could find value added uses. In many biomasses it has not been defined what may be there, then the lack of knowledge is a barrier to value creation. Dr. Yilmaz sees that components like antioxidants, nutritional compounds, flavours, antibacterials, antifungals or colorants need cataloguing to be targeted for use. For each feedstock the knowledge of its components is needed, e.g. macro vs. micronutrients, positive and negative micro components and active compounds available for recovery in order for YLS Consulting to design separation processes. In this space it is unclear who is analysing the materials and in what detail. In current practice for YLS Consulting and its clients, this is not only the responsibility of the biomass producer, in some cases the user has target compounds where they identify a biomass supply and seek out suppliers, but knowledge of the content of the biomass is needed to connect them. For the clients of YLS Consulting, multiple marketing connection models produce these material flows making for a complex situation.

Motivation for innovation in bioeconomy

For clients of YLS Consulting, motivation for innovation in the bioeconomy area are primarily economic. Dr. Yilmaz notes that anything fossil-based is currently inexpensive for their clients as the real costs are not calculated properly, e.g. the total cost is not internalized, this makes economic competition difficult. A total accounting of real costs of each product would affect cost motivations giving a big push to bio-based solutions, says Dr. Yilmaz. For some products, like complex natural molecules, only nature can make them effectively. Dr. Yilmaz remarks that we have to find which molecules are interesting for industry in targeting products for commercial use.

In Dr. Yilmaz' view the complexity of nature is an advantage but we need to identify sources and users. For example, valerian is popular natural product and is seen as an effective treatment for calming and sleep disorders in Germany. Researchers cannot identify the active compounds in valerian; the products function is believed to be a combined effect of multiple compounds. For Dr. Yilmaz this case highlights how the complexity of nature can provide value compared to the specific compound approach from traditional synthetic chemistry. Identifying these cases can provide commercially relevant targets for development by YLS and its clients.

Feedstock utilization

In terms of feedstock utilization, the way YLS's client companies use bio-based materials depends on the capital cost to develop new technologies and where they sit in regard to the company's existing products. Dr. Yilmaz observes that if significant capital is required or there is risk involved, established companies are likely to pass on their own internal feedstock, looking for external companies to extract the value. In Dr. Yilmaz's experience biomass producers often want to stick to their main business and avoid the distraction of diversification, passing the work to outside companies, like YLS.

For clients of YLS Consulting missing technical expertise and sales networks make sticking to the core business more attractive for these existing enterprises. The first choice is usually selling the feedstock to another company in Dr. Yilmaz' experience. Dr. Yilmaz sees that, from the point of view of a company receiving another's biomass, if there is a single supplier there are risks associated with security of supply - it is best to have multiple suppliers. In the case of a single supplier, when other suppliers see a market they will enter it increasing competition. On the other hand, Dr. Yilmaz notes that if you can produce a unique product some industries may prefer a restricted single source supply chain, as they can use it to

differentiate their products with agreements to give them a marketplace advantage as a sole user e.g. in cosmetics.

Identified obstacles

For YLS Consulting and its customers one of the obstacles to finding valuable bio-based resources is the expense for analytical services. Their clients often stop searching for valuble compounds or looking at new processes because of the cost of analysis. Dr Yilmaz suggests that some form of lower cost service for analysing bio-based substrates would help exploration for new products and processes. In Dr. Yilmaz' experience it could be that new techniques and technologies are not there yet to reduce costs, as has happened in DNA analysis, or new techniques are not being applied.

Dr. Yilmaz sees that in the marketplace consumers/manufacturers want bio-based solutions but do not want to pay for them. For YLS and its clients Dr. Yilmaz estimates that the most effective overall driver in the short term would be legislation; without real price accounting for overall effects of non-bio-based products nothing will change unless bio-based product prices come down or product adoption is driven by legislation. From YLS's experience, real marketplace behaviour is based on price, bio-based as a product attribute often has little real value on their own.

Future opportunities

For Dr. Yilmaz, an area where there are opportunities for bio-based feedstock is in packaging, replacing non-biodegradable products, driven by environmental pollution from plastics resulting in both consumer demand and legislation. Dr. Yilmaz observes that legislation currently drives demand in some areas; carrier bags, straws, microplastic abrasives, once these are banned we need to find a range of replacements. Consumers do not create market pull without price or function advantages comments Dr. Yilmaz; they don't really care enough about environmental impact to pay more. Dr. Yilmaz believes changes need to be legislatively driven as consumer behaviour does not easily drive demand as a market pull.

Climate-positive soil improver and district heat from seed cleaning residues

This portrait is based on interviews with:
Markus Paulson, Environmental director, at Lunds municipality, Lund, Ann-Mari Fransson, Researcher at SLU, Alnarp and Sven-Olof Bernhoff, CEO, at company Skånefrö, Tommarp, all from Sweden.
Interviewer:
Thomas Prade from SLU and Johanna Lund from RISE

Over the past 10 years, Skånefrö and partnering companies have carried out research, development and innovation actions in order to produce a climate-positive energy solution and soil improver from residual agricultural feedstock.

Skånefrö is one of Sweden's seed producing companies with an annual production of 16,000 tonnes of cereal seeds and 3,500 tonnes of grass- and ley crop seeds. We have spoken with Sven-Olof Bernhoff, CEO of Skånefrö, whose grandfather was the founder of the company. The company´s goal is to achieve the highest possible quality throughout the whole value chain offering the best seed material on the market for agriculture and green areas. In the last 15 years, Sven-Olof has within his work at Skånefrö also worked for a large decrease in fossil combustion and CO_2 emissions.

In the 90's Skånefrö had a large share of unutilized residues that they wanted to utilize in some way. Skånefrö started to produce pellets and combust the residues. This is also when Skånefrö got funding for the EU-LIFE project BIOAGRO in which Skånefrö developed a method to decrease the content of sulphur and chlorine in the flue gases. Sven-Olof was project manager for this and many of the following projects. Skånefrö receive a lot of visitors at the Skånefrö site during the LIFE project, from a total of 48 countries. The total project budget was around 5 million €. As a result of the project the company became more and more aware of climate impact and what could be done to avoid it. According to Sven-Olof, climate change is a strong driving force for him and for Skånefrö and for the company´s involvement in different projects.

In 2014, Skånefrö installed a pellet boiler that delivers heat to the district heating system in Simrishamn, a nearby village, to a specific area (Simrishamnsbostäder). During recent years more houses in another village (Hammenhög) were connected to the district heating system. With the help of a 1.7 million € investment grant from the Swedish government in 2017, Skånefrö and their daughter company Bioagro Energy built a 3.1 million € facility to convert their own agricultural residues from seed cleaning to heat for their seed drying facility, district heat and a valuable soil improver, biochar. The value chain uses residues from seed production such as husks and chaff to produce heating pellets. The recipes used reduce acid emissions and minimize sintering during pellet combustion. The pellets are predominantly used in the company´s biochar production unit that also delivers heat to the seed drying facility and district heating services to the local community. The biochar is sold as soil improver for parks and gardens, football grounds, golf courses and in agriculture. The carbon sequestration is commercialized via the partner company Ecoera which sells climate compensation certificates based upon the carbon sink generated.

The current 500 kW biochar production unit is able to convert 1,400 tonnes of residues to produce 300 tonnes of biochar and 1000 MWh of climate-positive heat annually. A second unit, 2-3 times larger than the first, was delivered in April 2019 but is not in operation yet. There were no units available in the size Skånefrö wanted to install so they had to ask the German company, Pyreg, to build a unit that was 3 times as big as Pyreg´s biggest plant available. The biochar furnace is the latest component in a unique value chain that starts with the by-products from seed material production that is the core business for Skånefrö. Heart of the facility is the 13 silos for separate collection of agricultural residues such as straw residues, hulls, chaff and seed rejects. A small-scale and a large-scale pellet production line are established and residue mixtures recipes have been optimized for reduced acid emissions and minimized sintering during pellet combustion. Besides the biochar furnace, conventional pellets boilers use the pellets to produce heat for the local district heating system. Besides private homes, heat is also delivered to companies such as SimrisAlg and Lantmännen.

Leadership

Sven-Olof who has acted as project leader for most projects Skånefrö was involved in regard to residue use, is an enthusiast and entrepreneur who is motivated by leaving the world a better place by fighting climate change and lowering the environmental impact. For instance, Sven-Olof did not settle for just decreasing the combustion emissions from Skånefrö´s pellets, but more environmental advantages were possible and worth striving for! Sven-Olof is not interested in acquiring different certificates (ISO as an example), but rather in making things happen. So in the case when the biochar furnace manufacturer required a 10-14 day maintenance schedule. In long negotiations Sven-Olof asked the technician to break down the problem piece by piece. The manufacturer agreed to remodel the furnace resulting in maintenance intervals of 3-4 months.

Little of the project work would have happened without Sven-Olof, who sees himself as a positive and innovative person, acting as the driving force. And this force, he admits with a smile, is only limited by his time available.

Economic sustainability

Skånefrö and especially Sven-Olof have invested many hours in the development of the biochar value chain over the last 15 years. With the pellet and biochar facilities up and running, the Skånefrö board of directors sees no financial gain from the biochar production and indeed profit margins for the heat and biochar system are small. Both biochar sales and heat sales are needed for the company´s economic sustainability. Still, Sven-Olof sees that also the company´s core business of seed production has received a positive impact from the biochar investment including a positive image for their brand with climate-smart production, increased sales and new concepts e.g. for football lawns combining the use of high quality seeds and biochar. A fair bit of luck was that heat demand in the local district heating system had increased when the company planned to invest into a pellet furnace. Also the way to the existing pellet and biochar plant was not straight, according to Sven-Olof the well-quoted two steps ahead one step backward-rule applies.

Funding

In Sven-Olof´s experience funding for development and investment projects is difficult to attract and some of his earlier applications were rejected. But he has also had negative experiences with fund managers and stresses that acquiring funding requires personal engagement and proactive negotiations.

Ongoing development

Currently, Skånefrö is involved in the Rest-till-Bäst project funded by Sweden´s Innovation Agency. This project investigates the suitability of sludge, park and garden residues, algae, seaweed and horse manure as biochar feedstock. A specific focus here is the removal of cadmium from the biochar process during pyrolysis. Further development will also include finding new uses and markets for biochar. Sven-Olof is sure that agriculture could be such a new market, but admits that more field experiments are needed to convince farmers of the positive effect of biochar on crop yields as demonstrated by Skånefrö´s and Ecoera´s own large-scale field experiments starting in 2009. But also other applications such as in field borders for reduced nutrient leakage, on green roofs, urban tree beds and natural grass football lawns for increased water holding capacity and in rain collection beds with cleaning effect seem to be promising. Besides biochar, Sven-Olof continues his quest for emission reduction. The latest project involves a switch from diesel-driven to electric forklifts.

Table 2. Company history

2006-2009	SKÅNEFRÖ leads the award-winning EU-LIFE project BIOAGRO about innovative methods for reduction of emissions of greenhouse gases and waste from the agricultural sector. The companies BIOAGRO Energy (pellets) and ECOERA (biochar) are formed.
2009	Small-scale field experiments with biochar are carried out in Halland.
2010	Large-scale field experiments with biochar are carried out in Halland.
2011	Study tour to Germany to investigate biochar furnaces
2017	The Swedish Environmental Protection Agency issues a 17 million SEK investment grant to Skånefrö for the installation of a biochar furnace for climate-positive district heating and biochar production.
2018-2020	Rest-till-Bäst VINNOVA (Sweden's Innovation Agency) project about biochar as product and solution in the circular society, with SKÅNEFRÖ and ECOERA as two of 14 project partners in total. New feedstocks such as park- and garden residues, sludge, algae and seaweed are to be tested for biochar production.

Development of sustainable bio-based products – focus on sustainable milk replacement based on Swedish oats

This portrait is based on interviews with:
Carina Tollmar, one of five sustainability managers, at company Oatly, in Landskrona, Sweden.
Interviewers:
Sven-Erik Svensson and Thomas Prade, SLU

Company´s history and development

A group of researchers from Lund University were carrying out research on a non-milk drink. The original idea of Oatly was to provide alternative products to people with milk allergies or a dislike for cow milk. The main development included a patented process where oat grains as the raw material are fermented to a milk-like drink while keeping soluble fibres for nutritional purposes. The number of employees was below 15 people for the first fifteen years, but then increased exponentially to above 300 in 2019. Likewise, the production volume grew from 6 million litres in 2003 to about 80 million litres in 2018, while sales rose over 8-fold in the recent decade.

Today, Oatly products are produced in Sweden, The Netherlands and the USA and sold in about 20 countries. Sales are mostly limited due to bottlenecks in production, which is currently backed up by production being licensed to other companies with fermenting equipment.Hinders and barriers to development.

Market placement

A large part of the company growth was related to a change in market placement. The company´s oat-based drinks were initially sold in the health market in the UK. Contract production of oat drinks for a large food retailer in Sweden increased market size, but first the development of the Oatly brand and market placement as non-speciality milk replacement brought a breakthrough in sales.

Image development

Promoting the oat-based beverages as sustainable alternative to milk proved successful and explains the further development of the brand and the associated sustainability work behind it. The company has produced and published LCA-based sustainability assessments of their products and uses it to sell the products to environmentally aware customers. In parallel, work has been done on removing hotspots identified from the sustainability assessments, such as replacing natural gas with biogas and use of environmentally certified electricity.

Organic production

Most of the Oatly products are currently based on conventionally grown oat. These products are enriched with vitamins (D, riboflavin, B_{12}) and calcium to the same extent as in cow milk. However, enrichment is not allowed in organic products as defined in the EU rules for organic production. Organic cow milk on the other side can be enriched by adding the vitamins to the cow feed. Without the labelling as organic product, switching to organic oat was deemed less profitable and is not pursued.

Lack of influence (oat production)

Oatly supplies its Swedish production facility with Swedish oat bought from an agricultural cooperative, but with increased production volumes may also import oat for its production. After switching to renewable energy in the Swedish production facilities, a large part of the remaining environmental impact originates from oat cultivation and harvest. To decrease environmental impact further, Oatly says that the company will commit to focus sustainability work on the primary production part. Currently, the oat acquired fulfils the Nature+ requirements, which lead to a 20% reduction of GHG in the cultivation part. The reduction is achieved by implementing measures such as optimized nitrogen fertilisation, avoidance of straw-shortening substances and eco-driving. In comparison to other food producers, Oatly is not a large buyer and claims to have too little impact on the grain traders to actively work with improving the environmental footprint further. A potential way to go is to build up a network of directly contracted oat farmers where Oatly could directly control environmental work in the grain production.

Conclusions

Drivers for developing biobased products do not necessarily originate from the desire to replace non-renewable products, but to improve all three pillars of sustainability, where advantages regarding health issues, low production cost and high retail prices leading to high profits and low carbon footprints are used for promoting products and securing an environmentally aware consumer group.
Barriers in the regulatory frameworks for organic production have been pointed out as hinders for a switch to further improve sustainability, i.e. by switching to organically produced oat.

5. SMEs point of view assessment

5.1 Identified interest and obstacles of companies

Accessing biobased feedstock for processing and reduce waste

One identified barrier was in accessing biobased feedstock for processing. For grains or oilseeds there are platforms for trading today, but this is lacking for several other biomasses due to their low volume or low international trading flows. Companies are interested in making supplier connections in non-commodity feedstock by combined technical and business meetings. In parallel to the transition from fossil to biobased raw materials it is also

essential to reduce the wastage. This can be conducted through new thinking along the value chain, for an example from the grower to the production. Better planning of the cultivation with communication along the value chain in combination with innovative storage solutions are example of activities that can reduce the waste and at the same time reduce climate and environmental impact.

Need for development time, specialized expertise and networks

Another identified barrier was a lack of a surrounding community of specialized expertise network to assist in quickly developing biobased products. It was also observed that in the bio-based product space a long development time was required which created lack of patience from both the customer and supplier side and in some cases lack of investor patience. That is the reason for the need for collaboration of entrepreneurs with universities and research institutes. It is hard for SMEs which do not have their own R&D department usually to develop a new idea in the field of the bioeconomy. Well-educated and experienced in conducting experiments scientists would bring many benefits and reduce the development time. On the other hand, scientists would focus on real-life problems and challenges that are brought to them by entrepreneurs.

Regulatory barriers

For many biobased products regulatory barriers need to be navigated and adjusted. These regulations sometimes place a high burden on small companies. The most effective overall driver in the short term would be legislation. It is also important to skilfully support new initiatives and projects in such a way that they can function on the market without the need for subsidies.

Profitability

When it comes to profitability there are several things that effect it in a negative way when it comes to biobased products. The high price is one problem for some products, as one example PLA is 30 – 40 % more expensive by than known and widely used PET. At the same time anything fossil based is currently inexpensive. One of the identified obstacles in finding valuable bio-based resources was the expense for analytical services. Companies often stop searching for valuble compounds or looking at new processes because of the cost of analysis. The companies are interested in some form of lower cost service for analysing bio-based substrates that would help exploration for new products and processes. It is also a problem that currently, most of these technologies are still unprofitable and most of them are supported by various forms of co-financing for pilot installations.

The interest of several companies is that ecology should go hand in hand with economics. One company could see that the company´s core business has received a positive impact from the biobased investment including a positive image for their brand with climate-smart production and increased sales.

One company stated that the development of a sustainable bioeconomy needs to be supported by (1) venture capital and (2) focused research and investments, with participation of the right stakeholders and cross-border open-source collaboration.

5.2 Barriers to innovation

One of the significant barriers against innovation in the bioeconomic context is the lack of profitability. Often, following the fossil-based way is more profitable than the new, innovative way. Companies need to generate income, and as long as it is not profitable to transition from a fossil- to a bio-based process, they won’t do it. It is crucial to develop the

possibility for firms to use modern, bio-based solutions, without them running the risk of losing money. While subsidies can be used as a band-aid for individual development, supporting initiatives and projects in such a way that they can function on the market without need for them is much more favorable. Anything fossil-based is currently inexpensive, at least on the first look, as the real costs are not calculated correctly, thus making economic competition difficult. The concept of the bioeconomy is still very new to many actors, and it does not help that there is a considerable lack of precise legal regulations, blocking innovative pathways completely. A missing infrastructure for the bioeconomy is a huge problem; firms lack flexibility and are often locked into a standard process. This locked-in state is a problem in general, as well. The global economy at this point is locked-in into fossil-based production, and it will be a long way for transition to a bio-based one. In this current state, some actors tend to do business as usual and shut themselves off to possible innovative scenarios, because they do not see the need or the advantages. This is even true at times, because of the lacking spread of information about the bioeconomy as well as not-given profitability. Innovations in the bioeconomy tend to require a higher than usual development time, and the lack of patience from the customer and the supplier (and in some cases from the inventor as well) is regarded as another barrier.

Isolated companies or actors tend to have a hard time as well, as they do not have the surrounding community of specialized expertise or a network to assist them. Regulatory barriers play a significant role as well and need to be navigated in the future; they place a high burden on small and medium-sized companies. Furthermore, there are various blockages on the feedstock side, as well. First of all, not all suppliers of required biomass are well known to possible users, thus giving them a low chance of interaction. This is partly due to the circumstance that the bioeconomy is not a wide-known concept yet. This problem can be tackled by creating meetings with actors to get them to know one another, for example. Then, the supplier may not be in the condition to provide the needed amount of biomass each year, as it is dependent on weather and climate. Large companies would require large amounts of biomass for solutions to be profitable due to scaling effects, and suppliers can struggle to provide these amounts. For industrial customers, there seems to be also a lack of customer pull on the biomass producers, due to a lack of knowledge of what components are in the biomass. Consumers and manufacturers want bio-based solutions, but do not want to pay for them at the moment. Real marketplace behavior will always be based on price; “bio-based” as a product attribute has little value on their own. For companies, analytical R&D is frequently an expensive endeavor and is stopped in many instances early and does not result in positive outcomes.

Another barrier or challenge for innovation is the fact, that bioeconomy is a heavily multi-disciplinary branch of industry. To develop new ideas in this field, there is a need for experts from chemistry, biology, agriculture sciences, mechanical engineers and economists. It is hard to create innovative ideas alone. Networks that would associate experts from mentioned fields, as well as stakeholders and decision-makers, will be highly appreciated.

5.3 Motivations for innovation

The interviews also showed various circumstances that bolster innovation activities. First of all, a direct link to the scientific world, for example through a former position at a university or a precedent study, can lead to a keen sense for R&D and development inside a company as well as a certain mindset and openness towards innovative activities and other initiatives. Taking part in conferences and seminars, staying up-to-date on recent activities with reports, magazines and scientific articles as well as visiting technical exhibitions helps to build a network with other companies. Networks are said to primarily bolster innovation by formal

and informal linkages between actors, thus being part of one can always be seen as a decisive factor. Keeping up with the national and European legislation is another critical factor, because of the introduction of restrictions and production limits. Besides that, getting to know more than their market, through international cooperation or trade linkages, for example, can play a favorable role as well. They are broadening the horizon on what other countries and companies can lead to adopting specific processes into their own company.

Eager managing staff, ready for change towards the bioeconomy and following a precise vision can be seen as quite influential, as well. These people will sculpt the company after the ideal they desire and are prime innovators by nature. The idea or concept of the circular economy can be regarded as another motivation. Trying to use resources and residues during the process to its maximum, leaving no waste, often stays in connection with innovation that allows firms to do so. Cooperation in itself with large corporations as well as with local farmers is, as indicated earlier, a significant factor. Through cooperation companies can receive knowledge on various topics from their partners and also give certain information to them. These linkages help to spread knowledge in both directions and can help firms that lack experience in certain, relevant fields. If a company has difficulties reconciling research work, cooperation with a university may bring the solution. A general openness towards innovation is, as also already stated, a factor in itself. If the company is too small to have its R&D unit, a certain openness towards development and keeping their technology up to date is a lifesaver. Often, companies innovate out of sheer commercial needs. If it is difficult for a company to find manual workers to do a particular job, the automation of it may be innovative in itself. Building a council or a single interest group that spreads information and acts as a kind of forum for them, can have positive effects, as well.

Moreover, support in general is a big topic. Especially monetary support can play a decent role in boosting innovation activities, as it allows companies to have enormous scope. Current market problems can act as motivation as well. Trying to come up with more effective or efficient methods often means innovating something as well. It also can bolster cooperation efforts, as firms seek help from other firms, which is another decisive factor. Legislation may play an essential role in the future, as it can provide specific funding and financial aid for innovative ideas. Lastly, promoting the bioeconomy as a sharp image on the market might have fruitful effects, as well. The customer side may react in creating a certain pull-effect, and fulfilling companies may need to adapt their production to match the need, thus innovating.

The motivation for the companies could also be a regional policy – it should be based on supporting and promoting innovative projects related to bioeconomy and helping other enterprises, which still looking for these solutions. Introducing such solutions should be attractive and might be motivating due to the competitiveness of enterprises – an aware consumer should willingly choose products and services that are offered by these companies, which, for example, are based on circular economy and cooperate with local farmers. It is also important to share the knowledge with people from different countries and regions – some innovative ideas in one place are well-known solutions in another place. Therefore, it can be easier to introduce some improvements when, at the start, there are known possible problems, which might occur.

5.4 Opportunities for biobased feedstock

Residues from cereal production

One example that was highlighted in the interview was chaff from cereal production that can be utilized for biochar and heat production. The biochar can be sold as soil improver for

parks and gardens, football grounds, in agriculture and as climate compensation certificates based upon the carbon sink generated. When it comes to the utilization of biochar in agriculture more field experiments are needed.

Another example of possible utilization of residues from the cereal chain was the opportunity to produce organic straw dishes. An interesting idea is the use of cellulose acetate, which could be produced from straw and vinegar (by-product of secondary fermentation of alcohol). Straw can also be an energy resource in an enterprise.

Residues from sugar industry

One of the interviewed sugar industries is involved in an ongoing project that focuses on innovative utilization of green biomass, such as beet tops. The main target of the project is to extract proteins and other components for food applications. Protein from beet tops has already been isolated for food applications at the projects pilot plant. In another project the focus is to make polyesters, fibers, coatings etc. from building blocks, that are produced from renewables feedstocks, such as beet tops. The other interviewed sugar industry tries not only to produce sugar but also to market the by-products relatively well via processing them into biogas or bioethanol.

New packaging solutions

Several companies mention that they are interested in developing, new packaging solutions with lower environmental impact, this can be done in collaboration with other stakeholders. The opportunities for bio-based feedstock in packaging are in replacing non-biodegradable products and this is driven by environmental pollution from plastics resulting in both consumer demand and legislation. One opportunity that was identified in the interviews was the replacement of PET with PLA, made from fermented plant starch such as from corn or sugar beet pulp etc. One of the interviewed companies emphasized that it is important to develop a technology of bioplastic production that can be easily replicated at least in other SME, as large-scale production is very difficult to implement.

Plant Protein and other products from Green Leaves

Process waste from leafy green horticultural production can be diverted to systems under development where the material is fractionated into multiple streams; fibre, green protein, white protein and residual juice. SLU is developing such a system known as the Plant Protein Factory and other projects are active at other institutions. Where the leafy feedstock is of food grade some of the products can go into the food system, while others can be used for phytochemical extraction and or biogas production. With non-food feedstocks such as fodder legumes, leafy cover crops and leaves of crops like sugar beet that are normally plowed into the field there is an opportunity to turn these resources into animal feed and biogas substrate with the possiblility of recovering phytochemicas and possibly as human food if regulatory barriers can be overcome.

Farm-based Biorefinery

One example from potatoes shows the possibility to utilize it in a biorefinery concept on farm level. While cultivating high-quality potatoes for the needs of the factory, it also processes the waste coming back from the production of French fries for potato spirit. Own waste (a decoction from a distillery) is used as a fertilizer for cultivation or feed for own animals. Part of this fertilizer is sold at attractive prices to nearby farmers.

5.5 Examples of market pull or market push

The search for new solutions and trends are examples of a market push strategy applied by most companies with innovative products. Choosing a market push strategy is based in the need to create a need amongst consumers to purchase an often innovative product. But innovations can also be used to develop a market pull strategy, i.e. to win loyal customers and to increase long-term sales. This is probably true for most product-improving innovations and companies working with such an aim are usually characterised by holding key patents in their product field.

With respect to the bioeconomy development, product improvements could e.g. include reduction of energy and material use, possibilities to include renewable energies and materials in the technical processes and reduction of energy and material losses in production. The need for more sustainable products is a major driver for product development and many companies use this trend for developing a market pull strategy. Although the need for sustainable products is widely acknowledged and despite good intentions in developing such products, the market situation looks meek. Biobased products competing in a fossil-based market have a difficult stand. In the marketplace, consumers want bio-based solutions but at a comparable price level. Unfortunately, bio-based as a product attribute has little real value when it comes to customers economics. Therefore, consumers will not create market pull when there is no price or function advantage with a biobased product.

An internalization of the total costs for any fossil-based product would increase economic competition of biobased products. This also underlines the importance of driving changes legislatively as consumer behaviour does not easily drive demand as a market pull. Future development needs therefore to develop aligned policies on EU, national, regional and local levels.

With a lack of legislative changes, this often means, that companies are working hard with decreasing costs for conventional products and only secondary with implementing renewable solutions. For implementing renewable solution, ecology should go hand in hand with economics. A switch to renewable feedstock often means the implementation of technologies that can handle new materials, especially if raw materials involve biomass. Technology availability and readiness is often a critical for the development of innovative renewable products. However, many entrepreneurs acknowledge that renewable solutions are the future goal for many companies, or are at least expected to be implemented as a result to changed legal requirements.

In terms of industrial customers, it is mainly the lack of customer pull on the biomass producers that hinders further development. This is often caused by a lack of knowledge of what compounds are in the biomass and how the feedstock could be made available.
It is important to increase consumer awareness about supporting entrepreneurs that are not only selling bio-based products, but are also ensuring that the entire production process is sustainable. Public education on the production of sustainable and ecologically friendly products is extremely important. Such educational actions may prompt the community to buy biomass-based products, despite the higher price of the product.

5.6 Future possibilities

The customer profile of innovative companies is often characterized by a high degree of international customers, and customers shaping and leading market developments. This is also reflected in the many countries for which the products are conform to legal requirements

and policies. Due to the economic risks of implementing new production lines based on renewable feedstock and the partial lack of technology at a high readiness level, supportive funding for pilot plants and innovation project is considered elementary by many entrepreneurs. This also includes a change of expectations in the line with that only few pilot plants result in directly marketable processes and production lines. Instead, multiple pilot projects may be required to achieve the technology readiness level necessary for production implementation.

Farmers are suppliers of primary (purpose-grown) and secondary biomass (residues) to the bioeconomy. However, farmers are dependent on having a buyer for their feedstock either by contract farming or contracted delivery. However, in the case of residues, the yearly variations in residues may present at problem for buyers also wanting to rely of steady feedstock deliveries. This is also relevant for surplus yields, where contracted farming is limited to certain delivery volumes. Biogas plants are often regarded as a possible customer for excess crops and residues, but few plants are equipped to handle e.g. sugar beets or straw-like biomass. Residues and many non-food crops are non-commodities, hindering development of the utilization of theses feedstocks. In order to have a stable feedstock delivery into a bioeconomic application, new logistical solutions may of a business opportunity for companies matching a supply of feedstock varying in volume and quality with the more constant feedstock demand. This goes hand in hand with the problem that biomass producers often rather stick to their main business and do not desire or have the possibilities to drive development of heavy investment technical solutions to implement further utilization of these feedstocks.

An important aspect is the strengthening of cooperation between large biomass processing plants and farmers. Large plants can afford such cooperation without significant losses, and such stabilization is often crucial for smaller units.

Ways forward

- A strong involvement of research and development agents such as universities and research facilities is generally seen not only as an advantage but as a requisite for the development of sustainable production processes.
- Close cooperation among several companies can help to develop specific solutions that will increase resource and energy efficiency and help implementation of renewable and sustainable production solutions. Within such industrial symbioses, shared risk handling and trust are main components for a productive development. But an industrial symbiosis can also bring local and regional actors together to develop regionally produced high-quality products that are innovative while closing important nutrient and energy loops.
- Technology scale is of importance, not least due to the economy of scale. However, for limited markets of specific products, an SME approach to a medium scale production seems advantageous for innovative products such as bioplastics. Also in farming, economy of scale is often sought in cooperation with other farmers in the region, decreasing production costs in e.g. machinery investments etc. At the same time, administration of production has increased to a large share of the time used in production and is often regarded as barrier rather than a production support.
- Much of the innovation work currently carried out at many companies in the biomass-treating sector is driven by the desire to better use by-products and residues formerly considered waste. Additional income while increasing resource efficiency is the main driver for this development. However, the trend is supported by increasing treatment

costs for organic residues. Bioenergy solutions often occur in companies that have energy-intense processes resulting in high energy costs.

- Long-term stability in regulations and support for bioeconomy solutions is regarded as necessary for the increased investment in sustainable production systems. This includes issues such as the policy for handling biomass residues which sometimes classifies these as waste, disabling a further use in subsequent production processes. Many countries offer profile loans that can be used for investments, but that often require success, which not always is possible to achieve and do not result investment security as production guaranties such as feed-in-tariffs in the energy sector would offer. Venture capital and focused research and investments, with participation of the right stakeholders and cross-border open-source collaboration, is regarded as necessary to gain momentum within the bioeconomy development. Not the least, the acknowledgement that development of innovative products requires a long-term commitment from all actors included in the value chain.
- New networks that will associate experts from many fields of science/industry such as chemistry, biology, agricultural sciences, mechanical engineering, the bioeconomy should be created. Those networks should be focused on finding new possibilities for innovation and making local-market connections where entrepreneurs would be able to find a solution for their problems.
- It is important to start building infrastructure for bioeconomy early. For biomass processing, transport and logistics often play a key role. The expansion of the biogas plant network is key, as is the strategic location of the factories close to the biomass source.

6. Appendix

6.1 Survey questions

biobigg → base 22.11.2019, 10:38

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Introduction

The BioBIGG project aims to identify attractive business opportunities concerning the production of innovative products and services in small and medium enterprises, based on regionally available biomass-based resources and innovation potentials. Learn more about the project at biobigg.ruc.dk/

This questionnaire is used to gather data on bioeconomy development, especially in the areas of innovation, residues and new business opportunities. Its focus lies on the perspective of these companies on topics related to the development of a sustainable and circular bioeconomy.

We want to assure you that your responses will be completely anonymous and that the responses cannot be traced back to you in any way. No personally identifiable information is captured unless you voluntarily provide the information in the comment fields during the survey. Additionally, your responses will be compiled with those of many others and summarized in a report to further protect your anonymity.

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Firm characteristics

1. What is the name of your company?

2. How many people does your company employ within your Region?

○ <10 employees ○ 10-49 employees ○ 50-249 employees ○ >250 employees

3. In which economic sectors is your company currently active?

Mark all that apply:

- [ ] Crop farming
- [ ] Animal production
- [ ] Mixed farming
- [ ] Forestry and logging
- [ ] Aquaculture
- [ ] Fishing
- [ ] Other agricultural related activities
- [ ] Mining and quarrying
- [ ] Manufacture of food products
- [ ] Manufacture of beverages
- [ ] Manufacture of tobacco products
- [ ] Manufacture of textiles
- [ ] Manufacture of wearing apparelclothing
- [ ] Manufacture of leather and related products
- [ ] Manufacture of wood and of products of wood and cork products (not including, except furniture); manufacture of articles of straw-based products and plaiting materials
- [ ] Manufacture of paper and paper products
- [ ] Printing and reproduction of recorded media
- [ ] Manufacture of coke and refined petroleum products
- [ ] Manufacture of chemicals and chemical products
- [ ] Manufacture of basic pharmaceutical products and pharmaceutical preparations
- [ ] Manufacture of rubber and plastic products
- [ ] Manufacture of other non-metallic mineral products
- [ ] Manufacture of basic metals
- [ ] Manufacture of fabricated metal products, except (not including machinery and equipment)
- [ ] Manufacture of computer, electronic and optical products
- [ ] Manufacture of electrical equipment
- [ ] Manufacture of machinery and equipment
- [ ] Manufacture of motor vehicles, trailers and semi-trailers
- [ ] Manufacture of other transport equipment
- [ ] Manufacture of furniture
- [ ] Other manufacturing
- [ ] Repair and installation of machinery and equipment
- [ ] Electricity, gas, steam and air conditioning supply
- [ ] Water supply; sewerage, waste management and remediation activities
- [ ] Professional, scientific and technical activities
- [ ] Other:

4. Please give the name of your main product or service:

5. Which parts of the production chain does your company cover?

Mark all that apply:

- [ ] Primary production / raw material production
- [ ] Processsing
- [ ] Manufacturing
- [ ] Research, development and design
- [ ] Equipment manufacturing
- [ ] Distribution
- [ ] Retail and wholesale companies
- [ ] Waste handling
- [ ] Other:

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Use of biomass or biomass-based raw materials

Biomass and biomass-based raw materials include:

- Crops from agriculture (field crops and greenhouse production), forestry or aquatic production
- By-products from agriculture, forestry and aquatic production
- Animals and animal by-products
- Microbial biomass

Biomass-based raw materials are partly processed materials based on the above sources.

6. Does your company currently handle any biomass in your production?

- ○ Yes
- ○ No

3 Active Filter(s)

Filter A202/F1
If any of the following options is selected: **1**
Then display question/text **A204** placed later in the questionnaire (otherwise hide)

Filter A202/F2
If any of the following options is selected: **1**
Then display question/text **A205** placed later in the questionnaire (otherwise hide)

Filter A202/F3
If any of the following options is selected: **2**
Then display question/text **A203** placed later in the questionnaire (otherwise hide)

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7. What would motivate your company to include biomass or biomass-based raw materials in the future?

Mark any that apply:

- [ ] Improved sustainability of products
- [ ] Better quality of final product
- [ ] Positive Image
- [ ] Possibility of innovative products
- [ ] Increased profitability over fossil raw materials
- [ ] Other:

8. Why does your company use biomass or biomass-based raw materials?

Mark any that apply:

- ☐ Improved sustainability of products
- ☐ Better quality of final product
- ☐ Positive Image
- ☐ Long history of use
- ☐ Possibility of innovative products
- ☐ Increased profitability over fossil raw materials
- ☐ Other: _____

9. How do you assess your company in terms of your use of bio-based raw materials?

○ Frontrunner ○ Fast follower ○ Average firm ○ Straggler

Bioeconomy Principles and Sustainability

10. Does your company generate waste, residues or by-products from biomass?

○ Yes ○ No

If yes, please provide information below.

Please fill in the boxes below:

Type of resource: _____ Present utilisation: _____ Treatment before utilisation: _____ Location of utilisation: _____ Amount in tons/year: _____

Type of resource: _____ Present utilisation: _____ Treatment before utilisation: _____ Location of utilisation: _____ Amount in tons/year: _____

Type of resource: _____ Present utilisation: _____ Treatment before utilisation: _____ Location of utilisation: _____ Amount in tons/year: _____

Type of resource: _____ Present utilisation: _____ Treatment before utilisation: _____ Location of utilisation: _____ Amount in tons/year: _____

Type of resource: _____ Present utilisation: _____ Treatment before utilisation: _____ Location of utilisation: _____ Amount in tons/year: _____

11. Do you expect that your current utilization of residues, by-products or wastes will change?

If yes, please specify why you think so.

- ○ Yes
- ○ No

12. What would motivate you to transition to a more intesive or innovative utilization of your company's by-products?

Mark any that apply:

- ☐ Demand for more sustainable products
- ☐ Increasing the economic contribution margin from the input materials into the company
- ☐ Decreased price of the main product
- ☐ Decreased demand for current utilization
- ☐ Increased energy prices
- ☐ Increased price on raw material
- ☐ Falling demand for animal feed
- ☐ Political regulation
- ☐ Following the general market standards
- ☐ Other:

13. How do you assess your company in terms of innovative waste treatment, recycling, re-use of residues, by-products and waste?

○ Frontrunner ○ Fast follower ○ Average firm ○ Straggler

Knowledge and innovation

14. Has your company conducted any structured research and development in the last three years?

- ○ Yes, in a dedicated R&D unit
- ○ Yes, in other ways
- ○ No

15. Did this R&D include wastes, residues or by-products?

○ Yes ○ No

16. Which partners does your company cooperate with in innovation activities?

Mark all that apply:

- ☐ University/research institute
- ☐ Consultancy
- ☐ Association
- ☐ Customer
- ☐ Supplier
- ☐ Competitor
- ☐ Does not apply
- ☐ Other:

17. Which term describes the innovation pressure for your company best – technology-push or market-pull?

Technology Push is when research and development in new technology drives the development of new products.

Market Pull refers to the need/requirement for a new product or a solution to a problem. The "pull" comes from the market.

- ○ Technological push (upstream)
- ○ Market pull (downstream)

18. Where are your cooperation-partners located?

Mark all that apply:

- ☐ same region
- ☐ same country
- ☐ Northern Europe
- ☐ Rest of Europe
- ☐ Rest of the World
- ☐ Does not apply

19. Has your company introduced any new bio-based products in the market in the last three years?

- ○ Yes
- ○ No

20. Has your company started using any new form of bio-based raw material in the last three years?

- ○ Yes
- ○ No

21. Has your company introduced any new processes for treating waste, residues and by-products in the last three years?

- ○ Yes
- ○ No

22. What are the main reasons for innovation in your company?

Mark all that apply:

- ☐ Staff costs
- ☐ High input material costs
- ☐ Falling price contribution margin for main product
- ☐ Regulation
- ☐ Energy consumption
- ☐ Corporate Social Responsibility (CSR)
- ☐ Price of handling waste and residues
- ☐ Willingness to improve the company's competitiveness
- ☐ Does not apply
- ☐ Other: _____

23. From where do you get knowledge about innovation opportunities?

Mark all that apply:

- [ ] Conferences and seminars
- [ ] Technical exhibitions
- [ ] Networks
- [ ] Day to day cooperation with people in the industry
- [ ] Reports or magazines
- [ ] Scientific articles
- [ ] Governmental agencies
- [ ] Analysis of patent data
- [ ] Other:

24. Who gives input about innovation in your company?

Mark all that apply:

- [ ] Subcontractors
- [ ] Internal development department
- [ ] Universities and research institutes
- [ ] Development consultants
- [ ] Other:

Strategy and market

25. Does your company have any kind of a sustainability strategy?

- ○ Yes
- ○ No

26. Does this strategy include the use of by-products, residues, wastes?

- ○ Yes
- ○ No

27. If you use fossil-based raw material, would your company be interested in exchanging it with a renewable one, if it was profitable?

- ○ Yes
- ○ No

28. Have you heard the term "Bioeconomy" before taking this questionnaire?

- ○ Yes
- ○ No

29. Which of the following utilization opportunities do you see as the most promising when it comes to adding value to the main biomass-based residues, by-products or wastes from your company?

New food and beverage products

Not promising	Possibly promising	Very promising	*Does not apply*

Animal feed

Not promising	Possibly promising	Very promising	*Does not apply*

Ingredients and proteins

Not promising	Possibly promising	Very promising	*Does not apply*

Chemicals or enzymes

Not promising	Possibly promising	Very promising	*Does not apply*

Biomass-based materials

Not promising	Possibly promising	Very promising	*Does not apply*

Building materials

Not promising	Possibly promising	Very promising	*Does not apply*

Energy utilization-recovery (Biogas)

Not promising	Possibly promising	Very promising	*Does not apply*

Energy utilization-recovery (Incineration)

Not promising	Possibly promising	Very promising	*Does not apply*

Fertilizer

Not promising	Possibly promising	Very promising	*Does not apply*

Soil improvement

Not promising	Possibly promising	Very promising	*Does not apply*

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Networks

30. Are you a member of a network related to the bioeconomy?

If yes, in which one?

- ○ Yes: _____
- ○ No

31. What is the best incentive for companies to participate in such a network from your point of view?

- ○ sharing knowledge
- ○ Receiving updates on sector developments
- ○ Finding inspiration from success stories shared within the network
- ○ Finding others having the same challenges
- ○ Other: _____

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32. In which country is your company located?

- ○ Denmark
- ○ Sweden
- ○ Germany
- ○ Poland

33. Are you interested in receiving a summary report of the survey results?

- ○ Yes
- ○ No

Please provide your email address: _____

This information will be kept separately from the answers to the survey.

Last Page

Thank you for completing this questionnaire!

We would like to thank you very much for helping us.

Your answers were transmitted, you may close the browser window or tab now.