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CIRCULAR ECONOMY BioBoosters

BioBoosters Impact Review 2024

Tales of the Circular Bioeconomy Innovation Journeys Launched at the BioBoosters Community

Edited by Anna Aalto & Tuija Manerus

Jamk University of Applied Sciences

BioBoosters Impact Review 2024

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Abstract

Anna Aalto & Tuija Manerus (Editors)
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Bioeconomy business accelerator, BioBoosters by Jamk, and the BioBoosters community around the Baltic Sea Region are employing a business-driven hackathon concept to boost circular transition of the bioeconomy sectors. This publication explores nine innovation journeys of leading bioeconomy companies around the Baltic Sea that shared their challenges at the BioBoosters Hackathons organized in autumn 2023 and spring 2024. With the support of the BioBoosters, these companies apply open innovation to find co-operation partners and solutions for greater circularity, sustainability, and profitability of their operations.

BioBoosters hackathon leverages the networks and knowhow of nine regional bioeconomy innovation systems connecting cross-sectoral and international expertise with open innovation excellence. The nine impact stories highlight the barriers, enablers, and success factors of circular transition in the bioeconomy sectors of the Baltic Sea Region. They also showcase the impact of open innovation and inter-regional co-operation. The lessons learned from the hackathons boosted by the international innovation community are recounted and the conclusion is clear – BioBoosters Hackathon is making an impact!

Keywords: bioeconomy, hackathon, sustainable development, innovations, circular economy, open innovation

Foreword: Boosting Circular Transition with BioBoosters

Anna Aalto, Project manager, Jamk University of Applied Sciences

You are holding a copy of the first ever annual 'BioBoosters Impact Review'. This publication collects innovation journeys of companies that have been employing the open innovation services provided by the Bioeconomy business accelerator, BioBoosters by Jamk, and the BioBoosters community around the Baltic Sea Region.

Our first edition focuses on the business sector experiences with the BioBoosters hackathon concept applied to boost circular transition of the bioeconomy sectors. We follow up with nine innovation journeys of leading bioeconomy companies that shared their challenges at the BioBoosters hackathons organized in autumn 2023 and spring 2024. With the support of the BioBoosters innovation community, these companies have applied open innovation to find co-operation partners and solutions for greater circularity, sustainability, and profitability of their operations.

Transitioning to Sustainable and Circular Bioeconomy

To provide a framework for these stories, let us briefly discuss what circular bioeconomy means and what the circular transition can bring to bioeconomy sectors. In the European context, bioeconomy is promoted as a part of the measures to ensure food and nutrition security as well as sustainability of natural resources. Furthermore, the goals of the bioeconomy strategy aim at reduction of reliance on non-renewable resources, limiting and adapting to climate change as well as strengthen European competitiveness and creating jobs. A circular and sustainable bioeconomy contributes to all dimensions of the European Green Deal guiding the European societies towards climate neutrality via just transition and respect to the planetary boundaries. (European Commission, 2020.)

> *"The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and*

all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. It cuts across these sectors and systems, interlinking them and creating synergies." (European Commission, 2018.)

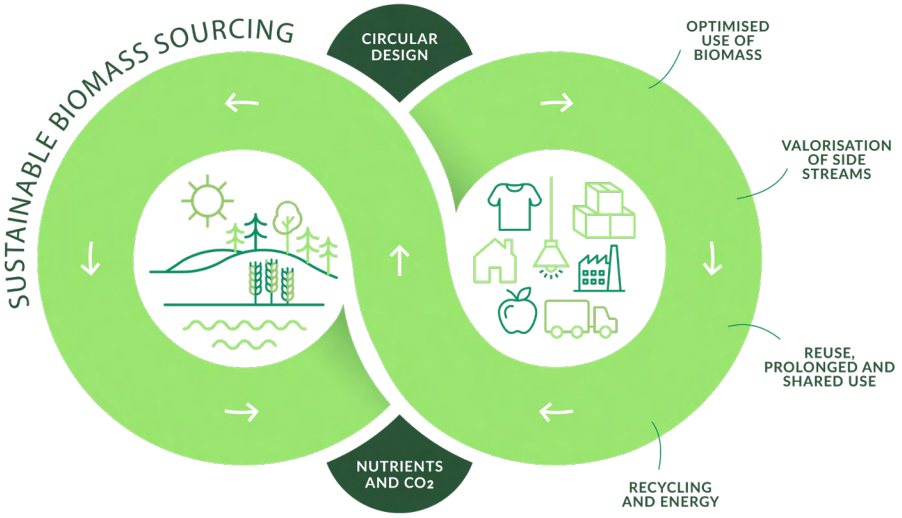
As a renewable source of material and energy, biomass and biobased industries play a key role in meeting the global climate targets. For replacing the finite, fossil feedstock with renewable ones, multiple industries turn their attention to the biomass resources. However, globally and locally, this transition to biobased industries can come with trade-offs and negative impacts including increased pressure on natural ecosystems and competition of land-use. As a response, bioeconomy growth and development should be strongly embedded with circularity and sustainability. Notably, an increasing linkage of circular economy to the bioeconomy strategies in Europe has been observed since the introduction of the EU action plan for Circular Economy in 2015. (Stegmann et al., 2020.). This was followed by the emerging of the circular bioeconomy paradigm. As defined by Stegmann et al. (2020), circular bioeconomy consists of the sustainable, resource-efficient valorisation of biomass in integrated, multi-output production chains (e.g. biorefineries) that make use of residues and wastes with an aim to optimise the value of biomass over time via cascading. Cascading is conducted adhering to the bio-based value pyramid and the waste hierarchy where possible and adequate. (Stegmann et al., 2020.)

In picture 1, the concept of circular bioeconomy is explored as we are approaching it in the BioBoosters innovation community. The image applies the lessons of Stegmann et al. (2020, 4) and the conclusions of their literature review on the concept of the circular bioeconomy and how it has been defined in literature and by the North-West European bioeconomy clusters. Absolutely, the image has also drawn inspiration from the Ellen MacArthur Foundation's butterfly diagram (2019) as a pivotal driver of circular economy concept and knowhow. The core design-driven principles of circular economy introduced by Ellen MacArthur Foundation are highlighted:

- Eliminate waste and pollution;
- Circulate products and materials (at their highest value); &
- Regenerate nature.

Furthermore, the circular bioeconomy concept visualized in picture 1 attempts to highlight the circular transition needs of the bioeconomy sectors in the Baltic Sea Region. As emphasized in the policy area "Bioeconomy" of the

EU Strategy for Baltic Sea Region, bioeconomy should be seen as a strategic framework that builds on circular thinking and the promotion of sustainable production, as well as use of biological resources. PA Bioeconomy advocates smart use of biological resources in combination with the principles of circular economy as an opportunity for productivity, economic benefits and environmental improvement. (European Commission, 2021.)



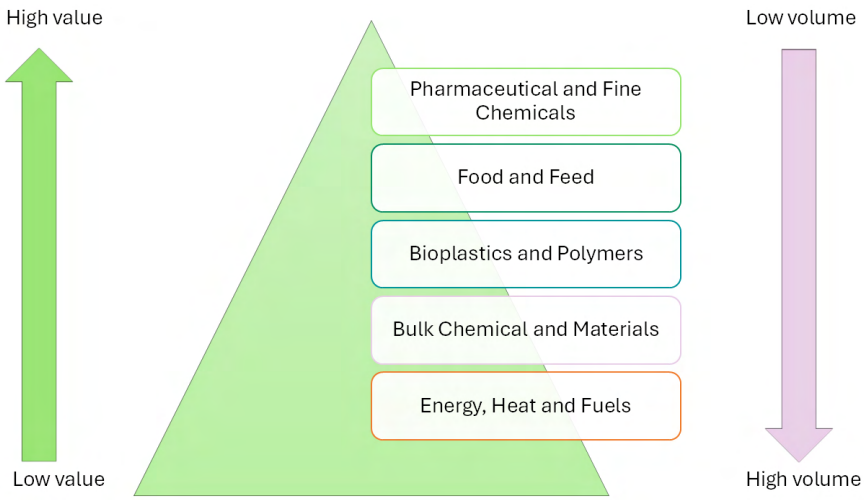
Picture 1. Circular bioeconomy concept adapted from Stegmann et al. (2020, 4) and Ellen MacArthur Foundation (2019)

The left side represents the biomass sourcing from the biological cycles taking place in nature, agriculture, forests and waters in a sustainable manner. This means that the sourcing needs data and knowledge-based management respecting the natural boundaries, supporting biodiversity and ecosystem services, and strengthening or maintaining the natural carbon storage. To support sustainable biomass sourcing, the return of nutrients to the ecosystems is a key area highlighted in picture 1 as reliance on imported mineral fertilizers is not only a concern for soil and water quality, but also a risk to the national food security. For completing the natural nutrient cycle, data-based management of recycled nutrient flows is central.

The right side of the circular bioeconomy concept image focuses on the material and energy flows in the biobased industries and in the human society

(consumers). In order to transform the industries from fossil based to biobased, the flow of material and energy from the natural ecosystems, agriculture, forests and waters needs to be supplemented with circular input of material and energy within the industries as well as with circular design supporting durability, reuse, as well as shared and prolonged use of the products and materials.

In short, a central issue in circular bioeconomy is circular stock management and achieving optimization of the value of biomass over time. Using the biomass to the highest value applications while optimizing the use of side streams and residues along the biobased value pyramid makes sense in terms of economic, social, and environmental sustainability. (Stegmann et al., 2020; Márquez Luzardoa & Venselaar, 2012.)



Picture 2. Biobased value pyramid adapted from Stegmann et al. (2020) and Márquez Luzardoa and Venselaar (2012)

In the root of the pyramid, there is the using the biomass as an energy source. In accordance with the waste hierarchy, material that cannot be recycled as material, can be turned to energy. Although seen as the application for lower quality biomass not suited for the higher value applications, the energy recovery for the biomass is important for the society and industry aiming for climate-neutrality. For example, in Sweden, the supply of biofuels has increased steadily since the 1980s, tripling over the last 40 years and rising

to almost 30 per cent of the energy sources in Sweden in 2022 (Swedish Energy Agency). Overall, the transition to the renewable energy sources is in the core of the circular economy (Ellen MacArthur, 2019). In this transition, the key is to ensure the energy use is not depleting the biomass sources or causing negative externalities – in short, that biomass sourcing for energy use is sustainable.

While the feedstock strategies often receive the most attention in the bioeconomy focused clusters, it is important to note that circular bioeconomy transition can also be driven forward effectively via circular design and business models to prolong the product lifetime and minimize the material input. Circular design with a consideration of the end-of-life of the product (recyclability) should always be an integral part of launching any new biobased products or materials to the market. Whether via sharing, maintaining, reusing, redistributing, refurbishing, remanufacturing, or recycling, the extension and management of the product life cycle is in the heart of the circular bioeconomy. (Ellen MacArthur Foundation, 2019.)

Additionally, the circular bioeconomy is not complete without a bio-based circular carbon economy. As argued by Tan and Lamers (2021, 6), closing the carbon cycle and creating an additional carbon sink capability in the technosphere by circulating biogenic carbon for products and materials is critical. As highlighted by Venkata Mohan et al. (2016, 506 & 517), there is growing emphasis placed on the importance of biological sequestration methods as alternate and viable routes for mitigating climate change while simultaneously synthesizing value-added products that could sustainably fuel the circular bioeconomy. Looking at CO_2 in terms of biorefinery models can open diverse opportunities to convert CO_2 to several valuable products, materials, and fuels, which could help close the carbon cycle. Meanwhile, the carbon sink capacity of the biosphere side can also be enhanced by sustainable forestry and farming practices. (Venkata Mohan et al. 2016, 506 & 517.)

Where does BioBoosters come in the Picture?

The role of the BioBoosters is to help build innovation partnerships that can enhance the circularity via optimization of the biomass use, material flow management, and the value created. Furthermore, the innovation partnerships are vital for minimizing both negative externalities (such as loss of biodiversity) and the systematic outflow of materials, nutrients, CO_2 and energy – in other words, for closing the loops.

The business cases presented in this publication tackle most notably the areas of digitalisation for sustainability (twin transition) and optimization of the value of biomass. The articles featuring Valio, Alojas and Nando highlight the ability of BioBoosters to launch innovation partnerships and identify solutions to boost data-based management of the biomass flows for enhancing sustainability of the biomass sourcing and the optimization of the biomass flows in the biobased production and consumption chains. In the articles featuring Moelven, Targi Kielce and Fibenol, the focus is on discovering and commercializing new biobased ingredients, materials, and products to bring higher value to the biomass and to replace fossil alternatives. Optimization of the value of biomass is also explored in the articles on Holmen, Cosun Beet and Võiste where the challenge has been to create new value chains from side streams and residues.

What is common for all types of challenges, whether digitalisation or the optimization of the value of biomass, is that co-operation and cross-sectoral knowhow is needed. BioBoosters hackathon leverages the networks and knowhow of nine regional bioeconomy innovation systems connecting cross-sectoral and international expertise with open innovation excellence. In the scope of this publication, the nine impact stories highlight the success factors, enablers, and barriers of circular transition in the bioeconomy sectors of the Baltic Sea Region. They also showcase the impact of open innovation and inter-regional co-operation. The lessons learned from the hackathons boosted by the international innovation community are recounted and the conclusion is clear – BioBoosters hackathon is making an impact!

Hope you will enjoy these innovation journeys with us.

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Hackathon Lessons from Trial to Success: Community, Customer Experience and Challenge Owners

Riikka Kumpulainen, Jamk University of Applied Sciences
Anna Aalto, Jamk University of Applied Sciences

The success of the BioBoosters hackathon model has not been a matter of a luck, but a process of trials, errors and a steep learning curve. This article describes phases in the development of the model from inter-regional learning to practice.

In the BioBoosters network, the mission is to boost the bioeconomy sectors competitiveness and sustainability in the Baltic Sea Region. As identified in the regional and macroregional strategies, the rural areas of Baltic Sea region have a great potential for bioeconomy as they have abundant natural resources (European Commission, 2021). However, these regions struggle to grow the bioeconomy sectors, to provide job opportunities, and to tap into global market opportunities due to limited human capital, business networks and innovation capacity. Co-operation between regions is needed in order to connect knowhow, talent, and resources across the Baltic Sea Region. To strengthen the capacity for innovation, we need platforms and processes for business-driven research, development, and innovation co-operation steering digital and green transition of bioeconomy sectors. (Honkanen et al., 2020.)

As showcased in the articles of this publication, the BioBoosters network has been implementing a demand-driven business to business hackathon model with tangible results to boosting the circular transition of the bioeconomy sectors in the Baltic Sea Region. With the support of the Interreg Baltic Sea Region programme, nine regions with a smart specialization focus on bioeconomy are co-designing and piloting an open innovation model, the BioBoosters Hackathon, in an inter-regional co-operation during a 3-year project implemented in 2023–2025. In the course of the BioBoosters project, 18 hackathons will be organized bringing together over 500 specialists from research and industry to launch 20 or more innovation partnerships tackling circular transition challenges of the bioeconomy companies. (Interreg Baltic Sea Region, 2024.)

In the midway milestone, the project has achieved impressive results. The key performance indicators set for the first nine hackathons were matched or exceeded as the partnership celebrated 123 applicants, 64 selected teams,

11 launched innovation co-operations and a LinkedIn community of over 1000 followers. It was evident that the value added from the cross-sectoral and international 'network of networks' had boosted the impact of the Hackathons. (Olesiak et all., 2024; BioBoosters, 2024.)

Apart from the impressive numbers, the feedback surveys for target groups indicated that the value propositions for participants had been achieved. The feedback indicates also that the target group loyalty is high based on both the standardized Net Promoter Score (57) and by asking participants whether they would take part in another BioBoosters Hackathon in near future (96 % challenge providers and mentors; 90% teams reported high likelihood). Reasons for the high loyalty are not hard to find; 96 per cent of challenge providers report that they got a promising solution for solving their challenge; and 95 per cent of the solution providers agree that BioBoosters Hackathon is a good tool for entering into a dialogue with large companies and they have gained knowhow from mentoring. (Olesiak et all., 2024; BioBoosters, 2024.)

Looking at the long-term inter-regional co-operation, it is also essential to note that all organisers anticipate a continuation for their Hackathon service provision after the project. Again, the reasons are not hard to find. In the view of the organisers and mentors:

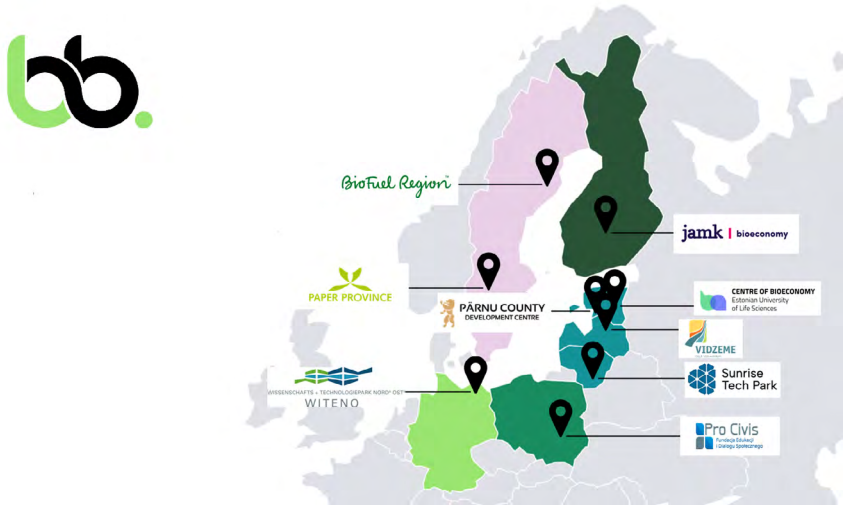
- 91% agree that BioBoosters Hackathon supports green transition in the Baltic Sea Region.
- 89% agree that BioBoosters Hackathon supports growth in bioeconomy sectors in the Baltic Sea Region.
- 84% agree that BioBoosters Hackathon supports exchange and transfer of best practices across the Baltic Sea Region.

All in all, BioBoosters Hackathon has been proven impactful for boosting circular bioeconomy business and co-operation, while also offering an engaging collaborative learning experience for all participants. (Olesiak et all., 2024; BioBoosters, 2024.)

The Long Road of Building Inter-regional Smart Specialization Co-operation

How did we get here? It is important to acknowledge that 'BioBoosters' has long roots. The mission of BioBoosters – strengthening the innovation capacity in the rural bioeconomy regions – was also the mission of a previous Interreg BSR project, Rural RDI Milieus in Transition Towards Smart Bioeconomy

Clusters and Innovation Ecosystems, RDI2CluB, implemented in 2016–2020. RDI2CluB was followed by an extension project, ConnectedByBiobord (2020–2021) to pilot and support uptake to the jointly designed inter-regional innovation co-operation model and platform, Biobord.



Picture 1. BioBoosters has nine partners across the Baltic Sea Region from Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany. (Photo by Moa Jonsson)

ConnectedByBioBord brought new partners to the Biobord network initiated in RDI2CluB, strengthening the network in Sweden and Estonia. New partners, such as Krinova Incubator & Science Park and Paper Province cluster from Sweden, brought valuable insights on management of innovation processes. After the extension, the Biobord network hosts 15 bioeconomy organisations from Finland, Sweden, Norway, Estonia, Latvia and Poland. Many of the Biobord network members are also present in today's BioBoosters activities (i.e. in the BioBoosters project) as featured in picture 1.

BioBoosters partners are:

Jamk University of Applied Sciences, Central Finland
The Paper Province economic association, Sweden
BioFuel Region BFR AB, Sweden
Vidzeme Planning Region, Latvia
Estonian University of Life Sciences, Estonia
Witeno, Germany
Pärnu County Development Centre, Estonia
Foundation for Education and Social Dialogue "PRO CIVIS", Poland
Sunrise Valley Science and Technology Park, Lithuania

Furthermore, the ConnectedByBiobord project team piloted an online hackathon competition, FoodHack. The lessons from FoodHack were valuable when the current demand-driven hackathon model was created by Jamk University of Applied Science's biobusiness accelerator BioBoosters by Jamk. For the Biobord network, FoodHackByBiobord implemented in 2021, was the first step into the business-driven hackathon world. The hackathon was implemented with a demand-based approach and with an aim to attract the participants from companies rather than the student participants normally targeted by Krinova FoodHack.

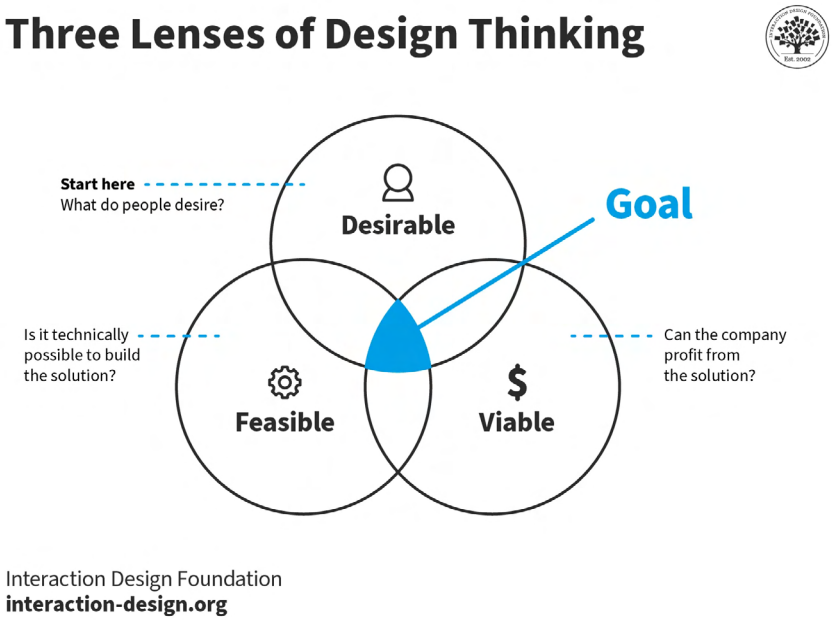
The FoodHackByBiobord introduced five different challenges (share of expertise knowledge, marketing of healthy food, changing the perception of plant-based proteins and insects and exploring new protein sources). Teams were gathered from the networks of the Biobord network, and they were divided into mixed groups based on their interest on the topics. Event attracted 13 startups internationally. (Biotalouskampus, 2021.) Covid-19 brought new elements to original plans as the hackathon was held in a completely online format. In a way, BioBoosters project can thank this pandemic for the gigantic digital leap of open innovation events. Still today, one of the success factors for BioBoosters hackathon (or any inter-regional open innovation platform) is a well-functioning hybrid implementation.

The key takeaways from this initial experience were related to the usability of the results and stakeholder engagement. Since the startups were in mixed teams, the teams were not able to reach highest possible innovation capacity, due to IPR concerns and competition between the companies. Also, the concept had a drawback as there was a lack of ownership for the challenge.

The fact that the challenge represented generalized industry's development needs rather than a challenge from a specific company, manifested as lack of guidelines for evaluation, lack of motivation (on behalf of the competing startups), and lack of follow-up activities to take the solutions further. In short, the lack of a challenge owner resulted in a lack of tangible impact – and a lesson learned.

Hackathon through the Lenses of Design Thinking

Design thinking (picture 2) is one of the core theories behind successful innovations and the current hackathon model. It is a non-linear process that impacts design processes such as service design. The theory rises from the idea of Human Centred Design. Its core idea is to reveal the hidden needs of target groups and formulate the solutions to answer these needs. In practice, designer can utilize the theory by observing its solution from three perspective: desirability, technical feasibility and economic feasibility. When all three boxes are ticked, the solution has success potential. (Interaction Design Foundation 2024.)



Picture 2. Three lenses of Design Thinking (Interaction Design Foundation 2024)

By observing the design thinking model, we may see that the first hackathon trial, FoodHackbyBiobord, did not fulfil all the demands. It was lacking the ”desirability” – the demand, and the challenges did not consider actual business creation possibilities (technical or economic viability). It was merely on the ideation level. Meanwhile, the current demand-driven business hackathon model in BioBoosters ticks all the boxes. There is always the challenge owner (desire) with a real need. Furthermore, expert mentoring during the hackathon days helps to develop the economic viability and the technical feasibility of the proposed solution. When all these elements are in place, it is natural to continue the development work of the solution.

What else did we learn from the first inter-regional Hackathon? Several key improvements have been made to the process based on the initial experiences and feedback of the participants. To avoid IPR issues and enhance collaboration possibility after the Hackathon, the startups, research groups and SMEs can compete with their own selected team members. This creates motivation and trust. Trust is one key factor in open innovation culture. Without it, the most disruptive ideas may never come to surface. Furthermore, the teams are given enough time to develop their ideas. BioBoosters hackathon process is on average 10 weeks long and includes flexible development time for the teams. This way the teams are able to do research, build their team, enhance their knowledge base, and innovate, among their daily tasks. Lastly, the ownership for the idea, helps the teams to adjust their solution better for the actual need and it creates win-win situation for both parties and prevents waste of time.

Intense National Piloting in Finland has been Guiding the Service Design

The lessons from the FoodHackByBiobord were utilized in a regional project called Business Accelerator to Saarijärvi (Yrityskiihdyttämö Saarijärvelle, EDRF, 2019–2022). During this phase the hackathon’s practical processes were fine tuned to ensure best customer experience for the startups and challenge providers (large enterprises etc.). Before launching the BioBoosters hackathons in the network, Jamk had hosted already 15 hackathons. The feedback and experiences from these 15 hackathons were the starting point for defining the value propositions and workflow for the international hackathons. (Aalto et al., 2023, 20.)

The process development work entailed hybrid facilitation development, digital communication platform (Howspace) piloting, and perfecting the workflow of the organizing parties. A clear process mapping of the hackathon

hosting was the most concrete result of this phase, but perhaps the most important finding was how to utilize the existing Biobord network in the team scouting. At this day, the transnational approach is one of the biggest assets for this model since it widens the innovation capacity vastly. Today the same model is being upscaled and further developed with the international BioBoosters network, which entails innovation organisations from all Baltic Sea region's countries except Norway and Denmark. As a summary we may say that the model really works, and the trial-and-error process, which is also a key part of the Design Thinking approach (Han, 2022).

The ongoing BioBoosters project hosts a perfect opportunity for continuous learning to keep improving the open innovation process. As experienced innovation hubs and regional innovation ecosystem connectors, all partners are bringing their knowhow and expertise to the table. Together we can develop our open innovation excellence as well as connect our networks to respond to the innovation challenges from the bioeconomy sectors and industries. The biggest value in the hackathon model is the network (or even community), since the hackathon challenges need outside the box ideas that are not necessarily found from individual region or country. (Aalto & Iso-Ahola, 2023.)

Building a Bioeconomy Innovation Community Responsive to the Industry Needs and Societal Transitions

In many ways, Biobord was the growing round for BioBoosters. In the activities of the Biobord network, we engaged the regional authorities, the research institutes, the business support organisations – we came up with joint actions plans derived from regional bioeconomy profiles featuring the strengths and weaknesses of each region. We designed and piloted a platform for connecting the bioeconomy networks of each region to help find solutions and partners, to share expertise and good practices, to launch new research, development, and innovation projects and so forth. We learned a lot, we made great connections between the regions, we started new co-operations and got new innovation tools. All in all, we build a strong basis for inter-regional teamwork.

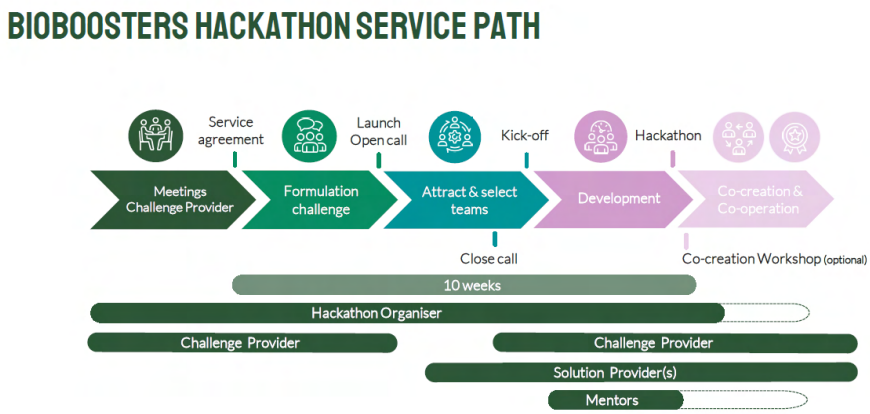
Still, how about the mission of boosting the growth and development of the rural bioeconomy sectors? Did we make an impact for the companies in our region? As is common with inter-regional smart specialization co-operation, Biobord struggled to engage the business sector into the dialogue which naturally hindered initiating business-driven innovation co-operation across the Baltic Sea Region. What we do differently in BioBoosters is that the

process is designed from the business perspective and having the business sector's needs as a starting point. For engaging the business, we simply need to be able to promise a clear return on investment – a better value for their time spent.

In BioBoosters Hackathon, we have a clear value proposition for the companies supported so far by testimonials and numbers from 25 Hackathons run by BioBoosters by Jamk accelerator and the BioBoosters project network. The whole process starts from the business sector need. We design the whole process and engage all players to support solving the challenge from the industry. We offer our client a chance to move forward with their sustainability mission. For example, to cut the carbon emissions in their supply chain, to find a smart digital solution for boosting their resource effectiveness, to find a biobased alternative for products or packaging, to grow value from side streams, from waste. We will connect our client with a variety of potential solutions and partners; we offer them expertise for upgrading these solution proposals to fit their needs, and a process for assessing these alternatives to select the way forward. All in a relatively short time span and with a professionally facilitated open innovation process that offers positive visibility for the company's sustainability mission and enables also the mobilization of external resources to tackle the company challenge. (Aalto et al., 2023,14–15; Myhrén et al., 2023.)

As outlined, the open innovation process starts with and builds on a real-life business case. The challenge of an industry-leader in turn represents a growth opportunity for the innovative SME, startup, research spin-off, and innovator. A chance to get the first customer and establish a sales reference, a chance to pilot their solution idea, to establish a proof of concept, a chance to test the waters at a new market cross-sectorally or in a new country. So far, a Win-Win. (Aalto et al., 2023, 14–15; Myhrén et al., 2023.)

Our tip for future hackathon hosts is that always find a challenge with an owner that has capacity to further explore development opportunities with the competing teams, find a tight community that can help you with the idea scouting phase and communication and lastly make the process user friendly.



Picture 3. BioBoosters Hackathon Service Path designed and piloted in inter-regional co-operation. (Myhren, Lehtomäki & Aalto 2023)

There is a value created also for the innovation and business support actor, for the regional authority, for the sectoral agency. As the BioBoosters Hackathon offers a platform connecting the industry challenge and the group of innovative and growth-oriented SMEs and startups, it represents an opportunity to drive the agendas of regional development. For the region, it offers an opportunity to support green transition, digital transition, climate neutrality, circular economy – an opportunity to steer these transitions, and an opportunity to learn about the needs of the companies and the status of the transition in the industry. (Aalto et al. 2023, 14–15; Myhrén et al. 2023.)

All in all, the BioBoosters Hackathon offers a platform for the regional and interregional dialogue where the business interests are in the centre. The WIN-WIN-WIN makes the process interesting for all target groups, and that is the basis for the success of the BioBoosters Hackathon process. It offers a good value for the time spent and a promising return on investment for all target groups engaged in the open innovation process. This is the message highlighted in the articles of this publication – the impact stories across the Baltic Sea.

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Theme 1

Twin transition, digitalisation for sustainability

Data-driven Solution Responds to Valio's Complex Challenge

Eija Iso-Ahola, Jamk University of Applied Sciences
Anna Aalto, Jamk University of Applied Sciences

On the 28 of November 2023, the atmosphere was enthusiastic at the Valio's main office in Helsinki. Swedish Elvenite AB had just been declared the winning team of ValioHackathon with their data model pilot for understanding the factors behind seasonality in milk production. This co-operation would be a first step for establishing a data-driven strategy for levelling the seasonal variation of milk production at farm level and along the Valio supply chains. The data model would help to discover the most resource-effective and impactful ways to address seasonality by analysing the data from farms with high, and farms with low, seasonal variation. The pilot was launched in 2024.

Picture 1. Cows in a field of Alasen tila. (Photographer Kuvauspalvelu Salopino Oy)

Owned by 3,400 Finnish dairy farmers, Valio is a brand leader in Finland and a major player in the international dairy ingredients market. Valio is on a journey towards carbon-neutral milk by 2035. In 2023, the greenhouse gas emissions from Valio's operations in Finland were about 2.16 million carbon dioxide equivalent tons. The carbon-neutral mission entails the whole milk's journey – dairy farms, transportation, factories, and the manufacturing of packaging. In this mission, the biggest steps are taken by e.g. the means of carbon-farming, reducing emissions from agricultural peatlands, production of renewable fuels from manure as well as renewable energy and energy efficiency. Still, the vast transformation calls for optimization of all aspects of the supply chain operations – including optimization of the production capacity. (Valio, 2024a.)

Production Peaks Challenge Profitability both at Farms and Dairy Operations

Why is seasonal variation in milk production a challenge to Valio? Did you know that the difference between milk delivered to dairies varies 250 million litres from peak month in March to the lowest production month in November in Finland? Imagine the effect of the excess capacity needed across the whole production and logistics chains from farms to dairy production plants. As Valio is owned by the farm co-operatives, the company is obliged to buy and process all raw milk that is produced by the owners. Thus, the production needs to adjust for the seasonality, and the capacity needs to be planned and maintained in line with the peak production. Seasonal variation in milk production is a challenge for competitiveness and sustainability that Valio is striving to resolve. Tackling seasonality is a strategic aim for Valio that so far has been difficult to effectively address. (Nokka, 2023.)

In line with the long-term strategic aim, Valio entered contract production from early 2021 due to overproduction of milk, reduced milk consumption, and limited milk powder processing capacity. This meant a change in the pricing system for farm cooperatives seeking to equalize seasonal fluctuations in milk production and discouraging production peaks. (Valio, 2020.) In a thesis study, Klemetti (2021, 51–52) explored factors for improving profitability of the Finnish dairy farms in contract production. The study indicated that the profitability of a dairy business can be developed without increasing of litres of milk. In fact, exceeding the contract amount will reduce the profitability of the company while equalising seasonal fluctuations and developing milk content can improve the profitability according to the data from case study farms.

As a conclusion, active management of the dairy farm operations is a key to increasing profitability and all sustainability areas, including the wellbeing of the animals and farmers themselves. (Klemetti, 2021, 51–52.)

Consistent milk production throughout the year could offer more sustainable and climate-smart milk for consumers, and more sustainable income for the producers. Balancing the seasonal variation would not only lead to sustainable milk production but would also have positive economic impact by making Valio's dairy production operations more efficient. The planning phase in the factories would be more accurate and it would improve cost control in the whole production chain (Nokka, 2023).

Complexity due to a Wide Range of Actors and Variables

There are several factors contributing to the level of milk production, and the seasonal variation. Rinne (2023) highlights, that the milk production peaks are mainly in autumn and spring because of the calving and the Finnish climate. The quantities produced also depend on factors such as the nutrition, heat stress, barn environment, as well as the health and well-being of the cows. Changing the calving time and extending the lactation period (normally 305 days) could be ways to reduce the seasonal variability. (Rinne, 2023.)

Meanwhile, the farm sizes and management practices vary notably as well. The 3,400 dairy farms delivering milk to Valio would need to be motivated and steered to address seasonal variation (Valio, 2024). What was evident from the data collected by Valio, was that some dairy farms were able to balance the seasonality already very effectively while others had very steep variation. This discovery proved that the seasonality could be addressed. Still, it remained unclear what the farms were doing differently. (Nokka, 2023.)

All in all, the challenge presented in the ValioHackathon entailed a lot of complexity which was reflected in the range of the applicants and teams alike. The open call for solutions attracted 18 applications coming from Finland, Poland, Sweden and Denmark. Teams proposed a variation of solutions related to e.g. advisory services to farms, nutrition, health monitoring, management of calvings, reduction of heath stress, and even reducing the water content of the milk before transportation. Teams selected to the Hackathon also represented a wide range of intervention approaches. As stated Sanna Nokka, Development Manager at Valio, the range of the applications was wide and demonstrated a high-level of interest to ValioHackathon. While the applications gave a good overview of the approaches available for tackling the challenge of seasonal variation in milk production, Valio prioritized new,

innovative data-based applications to manage the dairy farm operations and gain more balanced production in their team selection. (Jamk University of Applied Sciences, 2023.)

What did we Learn during the Hackathon?

The teams that got the opportunity to reach the final stage were Anicare Oy, Elvenite AB, Quanturi Oy, Condensed milk, SimHerd A/S, and HAMK Smart Data and Business Analytics team (Valio, 2023). Mentors supporting the teams at the ValioHackathon were from Jamk University of Applied Sciences and Valio with the specialists from ProAgria, Faba, Emovet and the Estonian University of Life Sciences. Hence, the open innovation dialogue bridged knowhow from four countries and connected technology and ICT solution providers, dairy farm advisory specialists, business development and innovation specialists as well as veterinary experts.

The cross-sectoral and international dialogue brough forward some essential discoveries during the Hackathon Days in Helsinki on 27–28 November 2023. In fact, the international dialogue had a notable impact as the comparison of the prevalence of seasonal variation in different countries resulted in a more in-depth dialogue about the root causes. Along the Hackathon, it started to become clear that many teams struggled to explicitly state the impact their solution would have on the seasonal variation of milk production on farm level due to lack of applicable data; it was also difficult to compare or evaluate these solutions in terms of the impact to seasonality. In fact, the solutions were addressing different factors affecting the level of milk production and the exact impact to seasonality could only be roughly estimated. All in all, it was like comparing apples and oranges. (Aalto, 2023.)

One team captured this problem in their proposal. The team wrote three white boards full of notes during the mentoring sessions trying to understand the factors causing seasonal variation. That team was Elvenite AB. The team that won the ValioHackathon.

> *"ValioHackathon was a great experience for us. Especially meeting all the mentors that had very different points of input and different backgrounds has been very valuable. Interacting with all the participants and people with in-depth knowledge on the dairy farm operations was inspirational and gave a lot of insights to the challenge at hand,"* tell **Agnes Lindell** and **Niclas Lovsjö**, Elvenite (Valio, 2023).

The hackathon jury from Valio were impressed about Elvenite's comprehensive data solution, which offered a broad answer to why there is different seasonal variation between farms. Valio Development Manager Hanna Castro explained that it came apparent during the hackathon that there was no thorough understanding of the factors affecting seasonality and why some farms have a steeper seasonality than others. She emphasized that with the comprehensive data analysis and comparison of farms with low and high seasonality, we can get to the bottom of the challenge and understand also what solutions would be the most effective. (Valio, 2023.)

Picture 2. Ulf Jahnsson, Valio's VP of Primary Production and Milk Procurement, and Valio Development Manager Hanna Castro at the Hackathon days after winner's announcement. (Photographer Eija Iso-Ahola)

On the Road to Carbon Neutral Milk Production Chain by 2035

ValioHackathon was an effective launchpad for new co-operation partnerships to tackle a long-term challenge of the challenge provider company, and to make progress with the mission of reaching a carbon-neutral milk production chain by 2035. As the first step, Valio and Elvenite started their co-operation

in pilot scale in 2024. In March 2024, the first activity was to collect data from selected primary production farms. The pilot will use a dataset collected from a representative sample of dairy farms, including farms of high and low seasonality (Van Koch, personal communication 2024, August 6). As announced in October 2024, Elvenite utilized advanced data analysis, artificial intelligence (AI), and machine learning (ML) to analyse and understand the underlying causes of these seasonal variations. By comparing farms with different production patterns, they were able to identify which methods and conditions could potentially contribute to more consistent milk production. Now, it is the time for Valio to apply the lessons learned and consider strategic actions that could lead to a more stable production over time. (Elvenite, 2024.)

After reaching a deeper understanding of the root causes of seasonal variation in milk production, co-operation could be launched with other teams as well. Development Manager Hanna Castro highlighted after the hackathon that Valio had encouraged all participating teams to continue working on their idea and the dialogue with Valio. After completing the pilot with Elvenite, Valio expects to have a better understanding of the factors affecting seasonal variation, we can prioritise the steps and solutions needed. (Valio, 2023.)

Understanding the root causes of a challenge is key to planning the most effective response strategy. The more complex the issue, the more important the data-driven approach becomes. Christian Van Koch, Senior Machine Learning Engineer from Elvenite, highlights the impact data can make.

> *Digital transformation in agriculture requires a continuous and iterative implementation workplan. The co-operation with public and private sectors plays a critical role in breaking down the silos and implementing innovations in technology and new outcomes. Companies need help to combine the data, now it is still quite separate operations. By looking at the previous data, you can predict pinpoint trends and patterns that forecast future behaviour or handle different kind of scenarios beforehand. I hope we can work more in Finland!"* (Van Koch, personal communication 2024, August 6.)

In fact, Elvenite expanded their business to Finland in 2023. It seems the demand for Artificial Intelligence (AI) solutions and data-driven decision making in the agrifood system are on the rise.

Picture 3. Elvenite AB Winning team of Valio Hackathon (Photographer Eija Iso-Ahola)

Digitalisation and Data as Key Drivers for Sustainable and Economical Farming

In a wider perspective, Elvenite represents the digital transition that is seen imperative for sustainable agriculture and the whole agrifood system. Increasingly complex relationships between processes with more reliable, validated and curated data is a premise for developing models to predict trends and the impact of climate change on agricultural production and its environmental footprint. Data management reduces the risks, which is reflected in the ability to build up resilient food systems (Rozenstein et al., 2024). Data analytics bring accurate and correct information in different processes, because without data it is hard to develop the production in a way that avoids waste of resources. Achieving the full potential of data-driven sustainable agriculture requires pooling data from individual farms and the decision to apply a data-based approach. Data-driven agriculture provides the opportunity to deal with not only the usual unpredictable environmental conditions, but also economic problems in a reasonable timeframe.

Many challenges remain in the development and implementation of data-driven sustainable agriculture. Agricultural data are very complex in regard to volume, variety, velocity, veracity and tailoring information to make it relevant in each individual case. Despite the considerable amount of literature and studies dealing with the agriculture sector, the understanding and implementation of data to ensure sustainable food production is still at an early stage (Rozenstein et al., 2024).

Still, digitalisation and agriculture are priority topics for the European Commission. According to the European Union data strategy, a transformative change in the rural areas of Europe is important, and it has been confirmed in the Commission's Common Agricultural Policy (CAP). Digital transformation needs a reliable technological infrastructure, and solutions adapted to different scales and types of farms, without forgetting the importance of investments. The CAP vision framework outlines the strategies for the EU Member States: building capacity and bringing together education, training, technology and targeted advisory bodies. Educators and local administrators are the key forces to speed up knowledge sharing and approach the innovation systems (Barabanova & Krzysztofowicz, 2023, 5–8, 38–39). In short, the transformation is driven by collaborative, mission-driven knowledge building.

'Finnish Future Farm' Project Responding to the Digital Transition Challenges

With the Finnish Future Farm project, the Bioeconomy Campus addresses the need for data-driven transformation securing the profitability and sustainability of agriculture in the Northern Europe. Bioeconomy Campus is developing into a smart farming innovation hub leveraging cutting-edge technologies and collaborative efforts to achieve climate-neutral goals and drive innovation in the agriculture. In collaboration with industry leaders such as Valtra, AGCO Power, and Neste, the project focuses on testing and demonstrating smart agriculture solutions. The initiative is boosted by the expertise of educational institutions, the City of Saarijärvi, local farmers, and various stakeholders, all working towards common sustainability goals. (Jamk University of Applied Sciences, 2024a.)

Organiser of ValioHackathon, the BioBoosters by Jamk is a central player in the ecosystem of the Bioeconomy Campus. BioBoosters is building an ecosystem that fosters a startup community dedicated to sustainable business innovations in smart agriculture. The BioBoosters accelerator programme, launched in August 2024, has selected 10 startups from a competitive pool

of applicants from 24 countries. This international programme, a collaboration between Jamk University of Applied Sciences, Valtra, AGCO Power, Neste, and Innovestor, supports co-operation between agritech and bioeconomy startups, corporations, investors, and end-users. The 2024 startup cohort concentrates on smart farming, data management, robotics, soil and water management, sustainability, and reducing the carbon footprint in the food value chain. The focus ensures that the selected startups are aligned with the latest trends and challenges in the digital transition of the agrifood sector. (Jamk University of Applied Sciences, 2024b.)

Info box: ValioHackathon	
Challenge	More profitable and responsible milk production by levelling seasonal variation
Target groups	Dairy farmers, data analytics solutions, farm consulting and guidance organisations, research groups, equipment suppliers, students
Organiser	Jamk University of Applied Sciences, BioBoosters by Jamk Business accelerator, Central Finland BioBoosters by Jamk is a business accelerator that inspires and supports companies to generate new business and develop globally significant solutions to battle the challenges of climate change. The core mission of BioBoosters is to promote business focused on bioeconomy and agritech, create sustainable innovations, utilise digitalisation, develop know-how, and strengthen business networks.
Mentors	Valio (Finland) ProAgria (Finland) Emovet and Faba (Finland) Estonian University of Life Sciences (Estonia) Institute of Bioeconomy, Jamk University of Applied Sciences (Finland) Kasvu Open (Finland)
Hackathon days	27–28 November 2023, in Helsinki, Valio Main Office
Applicants	18 applications 12 from Finland, 2 from Sweden, 2 from Poland, 2 from Denmark
Selected teams	6 teams 4 from Finland, 1 from Sweden, 1 from Denmark
Winner	Elvenite AB (Sweden)
Impact	Valio is owned by 3,400 dairy farms that can directly and indirectly benefit from the results of the ValioHackathon due to increased profitability at their farm and at the level of Valio's operations (Valio, 2024b). 

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Towards more Sustainable Production with Smart CMMS for Aloja Starkelsen

Inguna Kucina, Vidzeme Planning Region, Latvia
Marta Riekstiņa, Vidzeme Planning Region, Latvia

One of the leading Latvian food processing companies, Aloja Starkelsen, had outgrown the maintenance management system developed in-house and was ready to discover the innovative solutions available across the Baltic Sea. Here starts the story of Aloja Starkelsen Hackathon – CMMS system improvements!

Aloja Starkelsen, the Company Driving the Latvian Food and Bioeconomy Cluster

The first joint venture in the Latvian food industry, Aloja Starkelsen was established in 1991 between the employee cooperative ”ALOJA” and the Swedish farming cooperative SSF. Over the years, Aloja Starkelsen has become the largest producer of potato starch in the Baltic states, as well as one of the largest producers of organic potato starch globally. Aloja Starkelsen has also started processing organic brown peas and fava beans, thus expanding its range of gluten free, vegan and organic food raw materials. (Alojas, 2021.)

As a value-based enterprise, Aloja Starkelsen has developed vertically integrated from farm to fork leveraging excellent relations with his partners in agriculture, food processing and retail chains (Alojas, 2021). In 2021 Latvian based company IRLMD Food Solutions acquired the majority stake in *Aloja Starkelsen*, nevertheless Alojas headquarters stayed in Latvia and raw materials, potato, pea, and fava bean for production needs are sourced within a 600-km radius of the factory (Alojas, 2024a). Approximately 80 per cent of the output is exported to countries of the European Union, Asia, and the USA (Alojas, 2021).

Picture 1. Alojas factory in Vidzeme region processes locally sourced raw materials, potato, pea, and fava bean into food ingredients such as starches, flours, and other specialty products (Photo by Alojas Starkelsen)

Sustainability is at the core of Aloja Starkelsen Ltd. and its business – the company is built on the commitment to continuously strive to be more sustainable in every aspect (Alojas, 2024b). It bases its activity not only on long-term development, but also on the improvement of operational daily processes, as this can significantly affect how predictably and continuously things happen in the company. For manufacturing companies, unscheduled downtime is a major issue, leading to delays, missed deadlines, and higher costs. It can cause significant changes in the production process, which in turn creates an avalanche effect of issues in, for example, planning, warehouse and logistics departments.

To be able to predict the necessary line maintenance and repair needs, Aloja Starkelsen Ltd. uses a basic Computerised Maintenance Management System (CMMS) developed in-house, which still requires a lot of manual work and does not ensure full and timely information flow. Considering that Aloja Starkelsen Ltd. is not a large, global corporation, it currently does not have the financial means to purchase internationally developed and expensive IT solutions (Vidzeme Planning Region, 2023a). Nevertheless, the pace of the company's development is fast enough, and it has grown out of its existing solution.

The challenge set by Aloja Starkelsen was quite complicated (Vidzeme Planning Region, 2023a.):

- finding a predictable and preventive maintenance system that includes the company's buildings and infrastructure objects in the new system;
- linking equipment to external service providers and spare parts suppliers;
- ensuring fast response time and solutions for specific service tasks; and
- collecting statistics and visualisations of various processes.

The race to find the best solution provider was on!

Picture 2. Visit to the production facilities of Aloja Starkelsen on the Hackathon days (Photographer Rita Merca)

CMMS: Four Letters for Efficiency Boost. How does it Work?

A production company relies heavily on its machinery and equipment. A Computerised Maintenance Management System (CMMS) is a software tool used by maintenance planners, schedulers, and technicians to manage maintenance activities and increase the lifespan of equipment (SAP, 2024). At the core of a CMMS is a database, which centralises all maintenance information in one place (IBM, 2024). Production companies often manage large volumes of assets, ranging from heavy machinery to smaller tools. A CMMS provides a centralised platform to track and manage these assets, documenting their history, performance, and maintenance needs (IBM, 2024). It helps companies know where each asset is, its condition, and when it needs servicing.

A CMMS is essential for production companies because it centralises and automates maintenance processes, helping them reduce downtime, optimise productivity, and extend equipment lifespan (BasuMallick, 2024). In the high-paced, equipment-intensive environments of manufacturing and production, a CMMS offers numerous advantages by improving efficiency, safety, and cost-effectiveness. It provides real-time data on equipment conditions and helps detect issues before they result in costly breakdowns (SAP, 2024).

One of the most significant advantages of a CMMS is its ability to generate reports and analyse data. Production companies can use this data to make informed decisions, such as identifying patterns in equipment failure, optimising maintenance schedules, and improving overall operational efficiency. CMMS platforms often provide tools for real-time communication, facilitating the sharing of information across teams, including external partners like third-party maintenance providers or R&D teams (IBM, 2024).

The value of the CMMS is easy to see, but how to adapt it to a food production company's needs, which are not included in the standard offer of software systems? That is where the story of Aloja Starkelsen Ltd. and the five teams begins.

Driving Cost and Resource Efficiency Innovations

A blizzard, snow plough lights and completely snow-covered fields – that is probably how the morning is recalled by those who were on their way to the Aloja Business support centre SALA on 30 November 2023. Although snow is not unusual in Latvia in November, it was a quite memorable "warm-up" adventure for the teams and mentors who took on the challenge of the Aloja Starkelsen hackathon.

A total of nine software teams applied, from which five teams were selected:

- from Latvia: VITCAKE Ltd., SIA 7Lines, AllDevice official representative in Latvia SIA Filter;
- from Finland: Pinja Digital Oy; and
- from Germany: Fraunhofer IGP.

They continued their intensive work for two days, aiming to create the most suitable CMMS adapted to the needs of Aloja Starkelsen Ltd. (Vidzeme Planning Region, 2023b).

From cloud-based CMMS solutions to modular digital twin and development of a unique software – the teams came prepared, offering their own ideas and solutions to be adapted to Aloja Starkelsen's needs. The selection process was certainly not easy for the company: the market feasibility study had already given Aloja an idea of the CMMS capabilities and the resources it requires, but this time the company encouraged the teams to be creative and focus not so much on selling an existing solution, and more on delivering fresh ideas. For example, why not try to adapt a CMMS solution applied in the shipping industry to a food production company?

Mentors from Vidzeme Planning Region, Jamk University of Applied Sciences, and Cēsis Digital Centre, with expertise and background in sustainability, business development and supply chains, played an essential and integral role in the selection process. Working with the teams, they pointed out aspects that could affect the development of a successful solution: Does Aloja have enough raw data to create the basis of the CMMS database? What is the expected implementation time of the solution? Does the company have enough human resources to devote enough time to the software developer in the implementation phase? Each of these questions brought the teams closer to a successful result or made them take a step back for a moment and evaluate the necessary improvements.

Pinja Digital Oy has it!

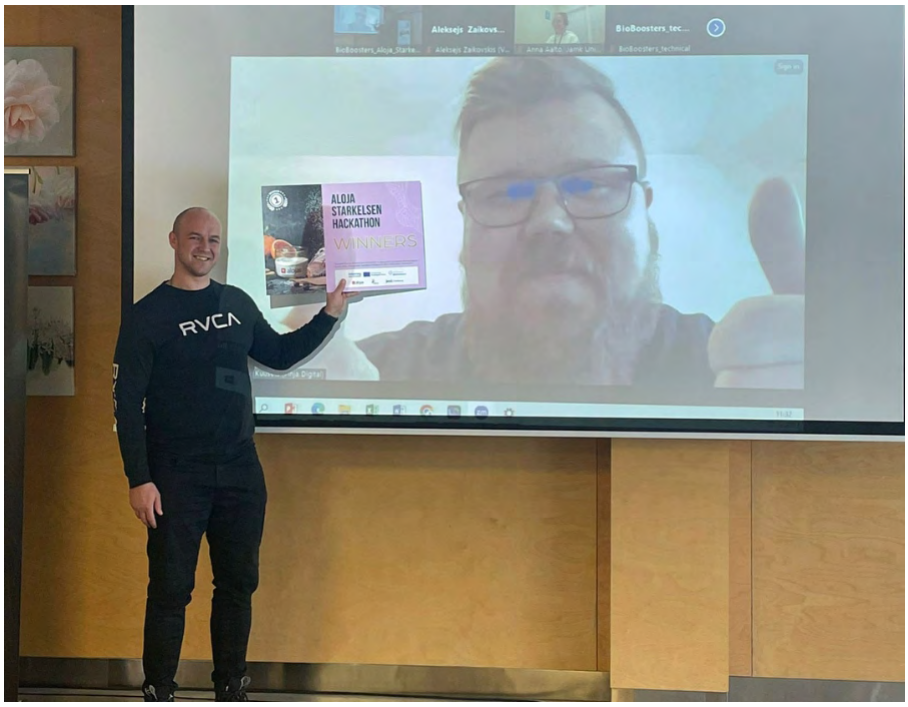
After careful evaluation and intense discussions, the solution offered by Pinja Digital Oy, Novi maintenance system, was recognised as the best and the most relevant to the set criteria: the most efficient solution in terms of resources (natural, human and financial) vs performance. The system's independence of industry, scalability for both small and large businesses, and ease to use

and modification became key selling points as Aloja was looking for a solution that was affordable in terms of both cost and easy implementation. What makes Pinja Digital Oy's winning story even more special? They were one of the teams that participated online in the hackathon.

> *"First, I would like to thank the great professional mentors for their feedback and help during the hackathon. We know that we can offer Aloja Starkelsen Ltd. a great product-based solution to address their challenges, as well as partner with their leadership for building state-of-the art maintenance operations. It seems that they have very ambitious, skilled and co-creative people working in the company, which is a good start for common successful CMMS journey. We are excited about our victory of the hackathon, and we are honoured to onboard Aloja Starkelsen Ltd. to our group of international customers already served in 30 countries across the world,"* said Eppu Kuusela, Sales and Key Account Manager of Pinja Digital Oy (Vidzeme Planning Region, 2023b).

Co-creator of the Aloja hackathon challenge and Technical Director of Aloja Starkelsen Ltd. Jānis Blaumanis did not hide his satisfaction with the positive experience, the progress of the hackathon and the solution obtained. On the conclusion of the hackathon day, Mr. Blaumanis highlighted the creativity of the teams as well as the learning and networking opportunity that the hackathon provides to all participants. According to him, the winning team, Pinja Digital Oy, presented the most suitable solution that demonstrated a deep understanding of the problem. (Vidzeme Planning Region, 2023b.)

Although one winner was officially announced, both Aloja Starkelsen Ltd. and the teams of the solution providers acknowledged that the hackathon had enabled new collaborations that were not even closely related to the primary need for a CMMS. Jānis Grīslis, CEO of start-up company SIA 7Lines (previously Ecommerce Technologies) asserted that the BioBoosters hackathon served as a bridge for service providers to reach company management and decision-makers. Outside of a hackathon, business discussions can take up to several months and still not come to a concrete result, while a hackathon allows for faster and more efficient work. International competition is good sales pitch training – you must be able to distinguish yourself not only in the local market. It is a new experience and forces you to step outside the box, outside the usual co-operation model. (Kucina, 2023.)



Picture 3. The Winning Team Pinja Digital Oy on the virtual stage (Photographer Krista Blūma)

What Happens after the Hackathon?

Following a hackathon, the enthusiasm and energy generated often pave the way for remarkable collaborative opportunities. However, a lingering question remains: what truly unfolds after the hackathon? How feasible is it to foster ongoing co-operation, and what possibilities might emerge?

We have promising news; in the case of Aloja Starkelsen Hackathon participating in a hackathon is just the beginning, serving as a gateway to deeper collaboration. This narrative highlights the journey of Pinja Digital Oy and Aloja Starkelsen over the past year. While the solution developed by Pinja Oy has yet to be implemented and the existing system continues to support daily operations, both companies value their ongoing dialogue. Regular meetings and workshops have become essential tools in progressing toward their shared objectives. Currently, the teams are focused on developing a robust business case and financial justification, which will pave the way for

advancing to a Computerized Maintenance Management System (CMMS). This system aims to enhance efficiency in daily operations, marking a significant step forward in their collaboration. In a personal communication Eppu Kuusela, Sales and Key Account Manager of Pinja Digital Oy confirms that the negotiations with Alojas have continued, and dialogue is progressing towards a commercial agreement.

Sustainability is a Journey

Cultivating innovation is crucial, involving the creation of a culture that encourages creativity, provides resources for experimentation, and establishes systems to bring ideas from concept to reality (MicroMain Corp, 2024). In the evolving fields of bioeconomy and food production, both open innovation and CMMS play pivotal roles in driving efficiency, sustainability, and innovation. While open innovation fosters collaboration between diverse stakeholders, CMMS enhances operational efficiency by ensuring that equipment and processes run smoothly, enabling innovation and long-term sustainability. Together, they significantly contribute to advancing these fields. This collaborative approach accelerates the development of sustainable solutions, improves resource efficiency, reduces input costs and ensures that resources are used efficiently, thereby driving both environmental and economic sustainability.

For Aloja Starkelsen Ltd., sustainability is a journey, and the network of external partners opens a world of possibilities (Alojas, 2024). The Aloja Starkelsen hackathon provided an opportunity to build at least five new, productive collaborations.

Picture 4. Winner was announced on 1.12.2024 at the Aloja Business Support Centre SALA, Ungurpils, Latvia (Photographer Krista Blūma)

Info box: Alojas Starkelsen Hackathon	
Challenge	CMMS system improvements
Target groups	Start-ups, SMEs, technology companies, IT product managers and planners, logistics, warehouse and production equipment service and planning specialists, student teams and researchers.
Organiser	Vidzeme Planning Region, Latvia Vidzeme Planning Region is the Vidzeme development management organisation that represents interests of all Vidzeme residents and based on the development program implements initiatives and projects important for the development of the region.
Mentors	Aloja Starkelsen (Latvia) Vidzeme Planning Region (Latvia) Cēsis Digital Centre (Latvia) Jamk University of Applied Sciences, Institute of New Industry (Finland)
Hackathon days	30.11.–01.12.2023, in Aloja Business Support Centre SALA, Ungurpils, Latvia
Applicants	9 applications 4 from Latvia, 2 from Finland, 2 from Poland, 1 from Germany
Selected teams	5 teams 3 from Latvia, 1 from Finland, 1 from Germany
Winner	Software company Pinja Digital Oy (Finland) with Novy by Pinja CMMS system – modern maintenance management and development. It digitalises data for the management and development of industrial maintenance.
Impact	Alojas factory in Vidzeme region processes locally sourced raw materials, potato, pea, and fava bean into food ingredients such as starches, flours, and other specialty products (Alojas 2024a). Alojas Starkelsen is one of the key Latvian agrifood companies that is supporting development of organic, plant-based and innovative food industry and supply chains (EIT Food 2022). Alojas Starkelsen is also the 5th largest organic potato starch producer in the world (Industry Research & Forecast Reports 2024). 

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Experimenting Sustainable Farming Solutions with NANDO Hackathon

Lina Stanionytė, Sunrise Tech Park, Lithuania
Antanas Popiera, Sunrise Tech Park, Lithuania

Is it possible for a student team to develop a solution for a persistent problem in Europe and receive backing from an internationally operating company? Can students help farmers save costs and contribute to sustainability? NANDO Hackathon proves it is possible.

Picture 1. Drone crop-spraying reduces environmental impact (Photographer Simas Mukauskas)

NANDO is a biotechnology firm rooted in Lithuania, specializing in high-value microbiological products and chemical additives for agriculture and industry. By integrating advances in biotechnology, chemistry, and engineering, NANDO develops biostimulants, surfactants, and chemical solutions that boost crop and animal production while optimizing industrial processes. The company prioritizes sustainability, focusing on creating products and technologies that enhance environmental health. (Nando, n.d.)

One of the key challenges in European agriculture is the widespread issue of overfertilization and its detrimental effects on the environment. To tackle this challenge NANDO in co-operation with Sunrise Tech Park joined BioBoosters hackathons series in the spring 2024, inviting innovators to devise solutions aimed at refining fertilizer application practices. Business and research teams from Lithuania and all over Europe responded to the challenge by offering diverse solutions and alternatives to existing practices, providing a fresh perspective on the problem. Days rich with creativity and innovation ultimately led to the remarkable victory of the Lithuanian student team from Kaunas Tech University.

Tackling Overfertilization for a Healthier Future

Food, water, biodiversity, and thus life depend on healthy soils. Overuse of fertilizers, particularly nitrogen and phosphates, leads to problems like water pollution from runoff, which contaminates water bodies and causes eutrophication. This process depletes oxygen in aquatic ecosystems, harming aquatic life and deteriorating water quality. Furthermore, nitrate contamination of drinking water poses health risks, particularly to vulnerable populations. Overfertilization also disrupts soil health, causing soil degradation, erosion, and declining fertility, which threatens the long-term agricultural productivity (Mockeviciene et all, 2024). It disrupts biodiversity by altering plant species and weakening ecosystem resilience.

More than 60 per cent of European soils are in poor condition (European Commission, 2020), and scientific evidence (EEA, 2019) indicates that they are continuing to degrade due to unsustainable land management practices, sealing, contamination, and overexploitation. One of the key objectives of EU Soil Mission launched under the European Horizon programme is improving soil health. The mission aims to improve soil health on at least 75 per cent of all soils in the EU by 2030 (European Union, 2021). This involves reversing soil degradation, enhancing soil fertility, and promoting practices that sustain soil ecosystems. It's a complex and challenging task that requires collaboration and efforts from all stakeholders, including policymakers, farmers, researchers, industry leaders, and local communities, to ensure the sustainable management and restoration of Europe's soils.

Lithuanian company NANDO is committed to respond to Europe's urgent environmental challenges by focusing on the development of sustainable innovations, including biostimulants, surfactants, and environmentally friendly chemical products. These alternatives aim to minimize the environmental

impact of fertilizers while supporting the long-term health of both ecosystems and communities. Jonas Ignatavičius, Head of Innovation at NANDO and mentor of the hackathon revealed that NANDO has observed a pressing issue regarding the excessive use of mineral fertilizers in agriculture. Therefore, they posed to uptake the challenge of optimizing the use of mineral fertilizers in agriculture and replacing them with harmless alternatives with the hackathon. (BioBoosters, 2024a.)

NANDO's approach aligns with the circular bioeconomy by promoting the development and use of innovative products and practices that enhance nutrient efficiency and support soil health. Sunrise Tech Park was excited to play a role in this important mission launching an open innovation process and sharing the challenge with broad innovation networks.

NANDO Hackathon Driving Innovation for Sustainable Farming

Sunrise Tech Park – Lithuania's innovation hub for cleantech and climate-friendly solutions, was thrilled to host the NANDO hackathon, dedicated to healthier soils and a sustainable future. The hackathon call attracted 14 teams from startups, universities, and research institutes from 8 countries, all focused on developing innovative solutions for sustainable soil cultivation. Participation of multidisciplinary teams from different countries created the perfect environment for creativity and cutting-edge ideas. According to Justinas Taruška, CEO of NANDO and member of the jury, the company was pleasantly surprised by the active participation of both Lithuanian and foreign teams (BioBoosters, 2024b.)

Six teams hailing from Lithuania, Denmark, Spain, Sweden and India were selected to present their solutions and to work with mentors during the hackathon days on 24–25 of April, in Vilnius. Teams presented diverse solutions including advanced technologies like drone-based crop analysis, software for precise fertilizer planning, intelligent systems for nutrient separation, continuous soil monitoring sensors, and analytical tools for assessing soil composition. Together, these ideas aimed to optimize nutrient use, enhance soil health, and reduce environmental impact. (BioBoosters, 2024b.)

The teams improved their solutions with the help of mentors from NANDO, Sunrise Tech Park, JAMK University of Applied Sciences, Estonian University of Life Sciences, and the Lithuanian Research Council. These experienced professionals provided valuable guidance, helping participants enhance both their ideas and presentations.

"It is amazing what you can achieve when you drive teams with diverse backgrounds towards a common goal. Magic happens!" said Juan Gutierrez Canseco, Co-founder and CTO of Agrolinera, a Spanish DairyTech firm and solution provider.

All teams demonstrated a deep understanding of the problem, expertise, and innovative approaches to tackling the challenge from different perspectives. The jury ultimately opted for the solution devised by young innovators from Kaunas Tech University in Lithuania, GreenFly, as it seamlessly integrates with NANDO's initiatives by utilizing drone technology to scan fields, optimize fertilization, and reduce environmental impact.

Picture 2. International NANDO Hackathon teams, mentors, and organisers at Sunrise Tech Park (Photograher Agnė Popierė)

The Winning Solution – GreenFly

GreenFly team of four students from Kaunas Tech University blended their knowledge on electronic engineering, chemistry, programming and drone piloting to develop the winning solution. GreenFly solution leverages cutting-edge drone technology to improve monitoring and fertilization practices. By

equipping farmers with drones capable of capturing high-resolution images of their fields, GreenFly enables precise monitoring and assessment of soil and crop conditions. These images are uploaded to the cloud, where the GreenFly AI model analyses them to detect plant diseases, insect populations, and various vegetation indexes. Based on this analysis, farmers receive detailed reports with recommendations for optimal fertilization and pesticide use, allowing them to adjust their spray rates with high accuracy. This precision in fertilization not only minimizes overuse but also ensures that crops receive exactly what they need, thereby reducing environmental impact and fostering more sustainable farming practices.

GreenFly's solution promotes sustainability by directly addressing the environmental challenges associated with traditional fertilization practices. By using real-time field data, GreenFly optimizes fertilization, preventing nutrient runoff, reducing the risk of eutrophication, and protecting aquatic ecosystems. Its drone technology ensures precise application, minimizing waste and supporting the circular bioeconomy by efficiently using resources. This innovation helps transition agriculture toward more sustainable practices and a reduced environmental impact.

Picture 3. GreenFly – the winning team (Photographer Agnė Popierė)

Co-operation with GreenFly has Taken off

NANDO Hackathon opened quite a few co-operation opportunities. The co-operation between the GreenFly Team and NANDO's drone division is highly promising, given the complementary nature of their technologies and goals. GreenFly's innovative drone technology, designed to scan fields and optimize fertilization while minimizing environmental impact, aligns seamlessly with NANDO's existing services, which include drone-based spraying, spreading, and fertilizing. By integrating GreenFly's advanced field scanning and variable rate mapping capabilities with NANDO's expertise in agricultural drone services, they could develop a comprehensive solution that not only enhances precision in fertilization but also significantly reduces the environmental footprint of agricultural practices.

After the hackathon NANDO supported GreenFly in refining the solution by providing advisory support, which includes soil assessment, crop management and advice on the use of agricultural products. Nando Droid provided the necessary equipment, including multispectral camera drones, and supported field testing and communication with farmers. This collaboration continues in exploring the market opportunities, demonstrating drones, and gathering information about farmers' needs and interests in this type of service.

In summer, 2024 GreenFly team was testing their solution. They carried out over 800 ha of scans with a multispectral drone, the obtained data were processed by assessing the viability of crops before and after the use of technologies. The team visited five farms, cultivating different crops. The possibilities of artificial intelligence were analysed in calculating the number of plants, biomass, flowers and predicted yield potential. Before harvest, the same crops were scanned to evaluate predictions and actual results. Using the collected data, farmers saved an average of 15 per cent of fertilizer. The resulting scans helped farmers see a more realistic view of their fields. Farmers used the processed data for fertilization, thus saving tens of thousands of euros.

Picture 4. NANDO drone for crop testing (Photographer Simas Mukauskas)

Unlocking Collaborative Innovation

Following the Hackathon, NANDO has extended collaboration beyond the winning team to other promising solution providers – DeepScientific & VakeWorks (Lithuania, Sweden, India) and Agrolinera (Spain). They received NANDO's products for testing, along with consultations on potential applications and partnerships in conducting research and evaluating outcomes. Deep Scientific, which proposed a solution incorporating advanced analytical tools for assessing nutritional values and soil composition through sensors, started measuring the impact of NANDO's biostimulants on vegetable growth. As explained by Aušra Baradokė, CEO of Deep Scientific, a solution provider, tomatoes treated with the biostimulants have shown visible improvements, growing larger than those cultivated under standard conditions.

Joining Forces for Sustainable Future

The BioBoosters hackathon created new opportunities for collaboration for the Lithuanian Cleantech Cluster, bridging international expertise in ICT, biotechnology, cleantech, agritech, and bioeconomy. As summarised by Laima Balčiūnė, CEO of Sunrise Tech Park and coordinator of Cleantech Cluster, the members of the cluster can outsource solutions and expertise to pressing

environmental challenges but also gain international visibility as advocates for sustainability by engaging in the hackathon activities.

Conclusions from the organisers included that addressing real-world problems with practical implications attracts motivated participants and produces implementable solutions. Furthermore, providing strong mentorship from experienced professionals helps participants refine their ideas and presentations – even without an established company, a team can go a long way with the mentoring support. Meanwhile, encouraging diverse participation from various backgrounds and regions was definitely a key factor fostering creativity and innovation in the Nando Hackathon. (Popiera, 2024.)

In conclusion, the NANDO Hackathon exemplified how collaborative innovation can address critical challenges in agriculture, such as over-fertilization and its environmental impact. The synergy between GreenFly's advanced data-driven solution and NANDO's expertise in agricultural services highlights the promising potential of this partnership. All NANDO Hackathon solutions contribute to the broader goal of sustainable agriculture by reducing environmental footprints and fostering more efficient resource use. Newly launched collaborations underline the importance of integrating technology and sustainability to shape the future of farming.

Info box: NandoHackathon	
Challenge	Reducing Overfertilisation by Innovative Solutions
Target groups	Startups, established companies, research institutes, educational organisations, and students with solution ideas for reducing overfertilization.
Organiser	Sunrise Tech Park, Vilnius, Lithuania Sunrise Valley Science and Technology Park is a business support organisation encouraging establishment and development of innovative, knowledge-driven business.
Mentors	NANDO (Lithuania) Sunrise Tech Park (Lithuania) Jamk University of Applied Sciences, BioBoosters by Jamk bioeconomy business accelerator (Finland) Estonian University of Life Sciences (Estonia) Lithuanian Research Council (Lithuania)
Hackathon days	24–25 of April, 2024, Vilnius, Sunrise Tech Park
Applicants	14 applications 5 from Lithuania, 2 from Denmark, 2 from Germany, 2 from Spain, 1 from Finland, 1 from Latvia, and 1 co-operative team from Lithuania, Sweden and India.
Selected teams	6 teams 2 teams from Lithuania, 1 from Denmark, 2 from Spain, and 1 co-operative team from Lithuania, Sweden and India.
Winner	GreenFly Team (Lithuania) with drone technology to scan fields and optimize fertilization
Impact	Based on initial tests of the GreenFly solution, which analysed data from five farms, the AI's ability to predict crop yield potential and optimize resource usage enabled farmers to potentially reduce fertilizer usage by 15 %. This reduction not only led to significant cost savings but also promoted more efficient and sustainable farming practices. Environmentally, the reduced use of fertilizers contributed to lower chemical runoff, improving soil health and reducing the risk of water contamination. 

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Theme 2

Transition to biobased industries, materials & ingredients

Innovative Packaging Solution from Moelven Hackathon

Malin Hildén, Paper Province, Sweden
Per Myhrén, Paper Province, Sweden
Magnus Persson, Paper Province, Sweden

In December 2023, Moelven Wood celebrated a successful hackathon. They entered the hackathon searching for a new, sustainable packaging solution for their wooden interior panels. It was a challenge that attracted 22 innovative solution ideas, out of which five were presented in the hackathon days — to develop a packaging solution that would reduce Moelven Woods's use of fossil-based plastics. The outcome was exactly what Moelven hoped for.

> *"We sought innovation, and thanks to the hackathon, we have seen the extent of the market and the opportunities out there. We have gained a lot of knowledge about packaging that we didn't have before, and we are very grateful to all the suppliers that participated." stated Tjalling Chaudron, Moelven Wood (BioBoosters, 2023b).*

Picture 1. The Moelven wooden interior panels that they want to find a new packaging solution for. (Photographer: Malin Hildén)

The Urgent Need for Sustainable Packaging

According to the European Environmental Agency (2024), total global production capacities of biobased plastics reached 2.2 Mt in 2022 which is less than 1 per cent of global plastics production. The European Environmental Agency advises that biobased, biodegradable materials alternative to plastics should be used where the risk of dispersion into the ecosystem is high, such as lubricants, materials subject to wear and tear, and disposable products (European Environmental Agency, 2018.) As explained by Matthias Andersson, Senior Researcher at Rise at the Moelven Launch webinar: ”Out of the plastic, 44 percent is used to produce various kinds of packaging; 18 per cent goes to building and construction, 8 per cent to automotive, 7 per cent to electrical and electrics, 7 per cent to household goods, leisure and sports, 4 per cent to agriculture, farming and gardening, and the rest are split into other markets. Out of all this plastic, 35 per cent are recycled, 42 per cent are used for energy recovery and 23 per cent are landfilled. (Andersson, 2023). Another important factor for the need to lower the use of fossil-based plastics is its resilience to decompose – it can take up to 500 years (Nyström, 2023).

The Swedish climate policy aims to reach a zero net emission of greenhouse gases into the atmosphere by 2045 putting increased pressure on companies to make changes (Government Office of Sweden, 2017). Another is regulations from the EU Parliament regarding Packaging and Packaging Waste, stating that plastic packaging is to be reduced by 10 per cent by 2030, 15 per cent by 2035, and 20 per cent by 2040 (EU Parliament, 2023).

For companies like Moelven Wood, which sells one million packages of interior panels annually, finding a sustainable alternative to fossil-based shrink plastic is not just a goal but a necessity. At the moment, Moelven uses a polythene film made from 95 per cent recycled plastic as cover packaging. In 2019, the total plastic packaging consumed by Moelven was 1,651 tonnes. (Moelven 2024.) Moelven Wood is striving to set an example and be a pioneer in finding a new, more sustainable, packaging solution. They also aim to annually reduce carbon dioxide emissions by five percent. Making a new packaging solution a way to help reach the goal. (BioBoosters 2023a; Chaudron, 2023; Moelven 2024)

Finding a new packaging solution

Like most production companies Moelven rely on plastic for protecting and packaging their goods. Replacing the packaging with one that is bio-based,

made of recycled plastic, or a combination of both would contribute to reaching the annual goal of reducing their carbon footprint by 5 per cent. It would also help Moelven meet the requirements of the Swedish Government and EU.

Each year one million packages of the panels are sold in bundles containing three to ten panels. These are up to 5.4 meters long and 24.5 centimetres wide and packed in fossil-based shrink wrap, labelled with information about the panels. The bundles are stored under a second cover of plastic. However, Moelven Woods's challenge focuses on the first layer of packaging designed to ensure the wood remains safe and even until installation.

In the hackathon, Moelven was looking for a sustainable solution that can meet the requirements for protection, moisture regulation, and visual presentation that is also cost-effective and scalable. Apart from ready-to-use solutions, the company was willing to launch a partnership to jointly bring an innovation to the markets. (BioBoosters 2023a.)

The Choice of Material

One of the most, if not the most, important factor in this hackathon is the material. However, choosing the right packaging material is a complex issue that involves several factors, including environmental impact, cost-effectiveness, and functionality. Moelven Hackathon focused on plastic, bioplastics, recycled plastic, fibre, and different kinds of blends of these materials. Each material has advantages and disadvantages depending on the area of use and environmental requirements. The key criteria of the new solution (Paper Province, 2023):

- Endure cold storage.
- Suitable for stacks up to 60 bundles in height and 90 in width.
- Possible to store for three years.
- Made for transportation and recycling.
- Protection from dust, moisture, and mechanical impact.
- Prevent bending and damage to the surface by friction.
- Ensure good acclimatization and product identification.

Locking at plastic, it is one of the most widely used packaging materials due to its low cost, flexibility, and durability. It is an ideal material for many types of packaging, especially in the food industry. A major advantage of plastic is that it can protect products effectively and extend shelf life, which in turn helps reduce food waste. However, the downside of plastic is its negative

environmental impact, as plastic can take hundreds of years to break down and often ends up in nature and the oceans, causing significant harm to ecosystems. (Johansson, 2017.)

Bioplastics are an alternative derived from renewable sources, such as corn starch or sugarcane, and have the potential to be a more environmentally friendly option than traditional plastics. According to a study by Svensson (2020), bioplastics help reduce carbon emissions compared to fossil-based plastics and can, in some cases, be biodegradable. The benefits of bioplastics are clear, but Svensson (2020) points out that bioplastic production still requires large amounts of energy and water, and not all bioplastics decompose under natural conditions. Additionally, the production of bioplastics competes with food production as it uses agricultural land and crops that could otherwise feed people.

In the collection of plastic, there is also recycled plastic. It is considered an important step towards a circular economy, where materials are reused instead of being discarded. According to Nilsson and Persson (2018), using recycled plastic can significantly reduce energy consumption and carbon emissions compared to newly produced plastic. Recycled plastic, therefore, offers environmental benefits by reducing the need for new plastic production. However, one of the downsides is that recycled plastic often has inferior mechanical properties, which can limit its use to specific types of packaging. Moreover, the recycling process for plastic is both costly and complicated, which can hinder large-scale implementation (Nilsson & Persson, 2018).

Unlike plastic fibre, used for cardboard and paper, is a renewable material. It has gained increasing attention as an environmentally friendly alternative to plastic. One advantage of fibre is that it is biodegradable and can be recycled several times without losing its structure and functionality. According to research by Andersson and Eriksson (2019), fibre-based materials also have a lower carbon footprint compared to plastic. However, a significant disadvantage is their limited durability and resistance to liquids, making them less suitable for food packaging where long shelf life is important (Andersson & Eriksson, 2019).

A growing trend in the packaging industry is the use of blended materials, where fibre is mixed with plastic to improve durability and protection against moisture. This can, for example, include cardboard with a thin plastic coating that allows it to be used for liquid packaging. A study by Berglund (2016) shows that these combinations offer a balance between environmental sustainability and functionality, but they also create challenges in recycling. Because the materials are so tightly bonded, they become difficult to separate, which

means that mixed materials often cannot be recycled and thus end up in landfills (Berglund, 2016).

The choice of packaging material involves trade-offs between environmental and practical benefits. Fibre-based materials are environmentally friendly but have limitations in terms of durability and resistance to liquids. Plastic is efficient and cost-effective but has significant negative environmental effects. Bioplastics are presented as a greener solution but come with their own ecological and economic challenges. Recycled plastic offers a way to reduce reliance on new plastic production but suffers from technical limitations. Finally, material blends offer a practical solution but create problems for recycling. In conclusion, there is no single packaging material that is ideal for all situations, and the choice must be made based on a balance between environmental requirements, product-specific needs, and economic conditions. (Berg et al., 2020)

Two Tracks to Go

During Moelven Hackathon the different kinds of packaging materials were presented as solutions. The open call attracted 22 solutions from 19 companies. Out of them Ahlstrom, Billerud, Boxon, T-Emballage, and Lignin Industries, participated in the hackathon. Out of them, two presented fibre-based solutions with different properties. The rest of the solutions were based on different kinds of plastics (biobased and/or recycled plastics). For example, Lignin Industries presented a brown wrapping to the panels made of lignin. It is a natural material extracted from trees and a side-stream in the pulp- and paper industry. The other solutions contained recycled plastic and different kinds of plastic blends, such as recycled plastic mixed with biomaterial. (BioBoosters, 2023b.)

Based on the materials Moelven Wood divided the solutions into two tracks: one plastic and one fibre. Both possess different pros and cons specific to this case. For example, plastic solutions have a shorter sprint to the market, some being ready to use right away or after a shorter development period. While fibre-based solutions would take considerably longer to develop, the solution would be one of a kind and entirely made of renewable material. In differ to the new plastic solutions the fibre-based will also demand an investment in new or modified equipment. (Chaudron, 2023.)

Picture 2. The winners from Billerud and the jury members showing a prototype of Moelven Woods new packaging for interior panels. (Photographer: Fredrik Karlsson, Solsta Foto)

Billerud: A Key Player in Sustainable Packaging

Among the participants, Billerud stood out with its packaging solution of fibre. They are a world-leading company in high-performing paper and packaging materials, passionately committed to sustainability, quality, and customer value making it their mission to create new fibre solutions (Billerud, 2024). Billerud's approach was both innovative and grounded in practicality. They proposed a fibre-based packaging solution that not only met Moelven's requirements but also aligned with their long-term sustainability goals. The solution was designed to be durable, cost-effective, and environmentally friendly, making it an ideal choice for Moelven's needs. And that was why they were announced the winner. In short, Moelven was convinced that, together with Billerud, they would be able to develop a package with good technical properties that add value to our products and get a feasible implementation in the factory. (BioBoosters, 2023b.)

A Win-Win Situation

The collaboration between Moelven Wood and Billerud began in January 2024. The journey to develop a new packaging solution is not without its challenges. The idea and the material exist, but the real challenge is to find a way to seal the ends and replace the effect of the existing shrink-wrap. These are challenges Moelven Wood and Billerud are taking on together.

In spring of 2024 they made the first test print of the packaging. However, the collaboration is a dynamic and ongoing process, with both companies working closely to refine and perfect the solution. Regular meetings, brainstorming sessions, and prototype testing are all part of the journey towards creating a viable and sustainable packaging solution. The result, the collaboration, and the development of a cutting-edge packaging solution are a testament to the power of the BioBoosterss hackathon. It provided a platform for developing new solutions and fostered valuable connections and knowledge sharing. For Moelven Wood it was a great opportunity to find a packaging solution that helps lower their carbon footprint. For Billerud, it was an opportunity to showcase their innovative capabilities and contribute to a more sustainable future.

For Moelven Wood, the hackathon presented a fast track to finding a solution. Instead of searching for solutions, the solutions came to them. Moelven Wood achieved the goal of finding a new sustainable packaging. They chose the fibre-based alternative despite knowing the development face would be longer and entail a joint development. It is a testament to their proactiveness and willingness to go the extra mile for the environment. We believe Moelven's och Billerud's new packaging has the potential to make a change for the entire industry by demonstrating a more sustainable solution.

Looking at the gains of the hackathon, even the companies that did not win, had much to gain from the process and were glad they joined. Based on the communication with the participant, the hackathon offered a chance to make new contacts, refine their ideas, and promote solutions. To sum up the conclusions of organisers, the gains for participants were:

- Wider network of companies and specialists with interest in the same field.
- The possibility to test an idea with feedback from a potential client and discover how to fit the solution to the needs of end-users.
- Develop the commercialization potential of an idea and discover new business opportunities with expert mentors' support.

- Get international recognition and visibility through nine regions' social media platforms.
- Inspiration from the innovation process and new learnings.
- Promotion through Paper Province network.

Picture 3. Moelven Hackathon participants on 12 December 2023. (Photographer: Fredrik Karlsson, Solsta Foto)

Info box: MoelvenHackathon	
Challenge	Sustainable packaging for sustainable wood
Target groups	Innovators, startups, companies, and researchers focused on sustainable packaging solutions.
Organiser	Paper Province, Värmland, Sweden Cluster organisation, Paper Province has been driving forest-based bioeconomy in Sweden for 25 years. Paper Province has about 120 member companies and at least as many partners. We bring together large and small companies, consultants, start-ups, test facilities, municipalities, the region, research, and academia.
Mentors	Moelven Wood AB (Sweden) Paper Province (Sweden) Karlstad University (Sweden) Almi (Sweden) Karlstad Innovation Park (Sweden) Poznań University (Poland) Biofuel Region (Sweden)
Hackathon days	11–12 December 2023, at Innovation Park in Karlstad, Värmland, Sweden.
Applicants	19 applicants 13 from Sweden, 2 from Poland, 1 from Finland, 1 from Germany, 1 from Estonia and 1 from Sweden/Netherlands
Selected teams	10 teams 7 from Sweden, 1 from Sweden/Netherlands, 1 from Germany, and 1 from Finland
Winner	Billerud (Sweden)
Impact	Moelven uses a polythene film made from 95 per cent recycled plastic as cover packaging. In 2019, the total plastic packaging consumed by Moelven was 1,651 tonnes. (Moelven 2024.) This material can be replaced with the biobased alternative as a result of the partnership with Billerud. 

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Re-covering Trade Fairs with Targi Kielce Hackathon

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Targi Kielce with 90 thousand square meters of exhibition space is one of the leading trade fairs exhibition centres in Central-Eastern Europe (Targi Kielce). However, behind this success story stands a significant problem. Each year thousands of people walk through large halls to see new products, technologies and services. Maybe it is not visible at first sight, but they are literarily standing on the problem – carpets and other textile floor coverings.

Picture 1. Targi Kielce Trade Centre (Photographer: Jaroslaw Brzoza, CC BY-SA 4.0)

Re-thinking the Single-use Carpets

The trade fair business is constantly evolving, innovating and trying not to miss on the green transition wave. Current global trends show that exhibition industry is constantly searching for new raw materials and recycling technologies that could be used to build exposition venues, exhibition stands and small architecture. Another area is development of technologies and solutions that

could decrease the carbon footprint and increase the circularity (infuture. institute, 2022).

Targi Kielce is part of the Sustainable Development Working Group of The Global Association of the Exhibition Industry (UFI). Waste management is one of the key issues addressed by this working group since significant types and volumes of waste are generated in the exhibition industry. UFI has taken the initiative to collect good practices to tackle the waste management challenges of the exhibition industry. The findings of the UFI working group identify focus areas to address. These include reducing waste to zero with circular economy models or development of sustainable materials. (UFI 2020, 4 & 20.)

With the BioBoosters Hackathon challenge 'ReCover Approved by Nature', Targi Kielce was taking these plans into practice and started looking for solutions to replace or recycle the single-use carpets. Most of the carpets are only single use because of the pressure and intensity of exploitation. As a result, the company needs to handle almost 300 containers of textile wastes yearly (Pro Civis, 2024). And this is a problem not only confined to Targi Kielce, but also to all other trade fairs and exhibition centres in Europe and across the globe.

In fact, the exhibition and event industry is zooming into the issue of single-used carpets on a wider front. Launched in 2021, the Net Zero Carbon Events initiative aims to bringing the global events industry together on a common journey to Net Zero by 2050. Together with 400 plus organisations from 55 countries a roadmap has been developed to reach this aim. (Net Zero Carbon Events 2022, 4.) According to the roadmap, the use of single-use carpets should be eliminated in medium-term, 2025–2035 (Net Zero Carbon Events 2022, 25). Event organisers are advised to choose a carpet free event or to switch to completely reusable or recyclable carpet solutions (Net Zero Carbon Events 2023, 10).

However, the question remains – are these solutions available in the market?

On a Search to Close the Loop for Annual 1.6 Million Tons of Carpet Waste in EU

Targi Kielce team wanted to make a real change in their waste management policy. They were also aware that the problem with used carpets is a typical problem in the trade fairs industry that already struggles with post-COVID negative impact on this sector. Solving this challenge would address few crucial issues at the same time: high costs of waste utilization, environmental

impact, finding new ways to transform the whole industry. The company had also an ambition to make room for circularity in this challenge.

The key questions that Targi Kielce was focused on was how to turn the problem to benefits. The challenge was presented as an open call for innovative and more environmentally friendly product or technological solutions for covering the floor surfaces at the trade fairs industry, implementing the principles of circular economy at the same time. The solutions could bring either new bio-circular product – a bio-based substitute with functional and aesthetic potential to replace polypropylene carpets or provide recycling technologies of carpets which would lead to obtaining new products to be used by Targi Kielce or other entities (BioBoosters, 2024a; Pro Civis, 2024).

The scale of the challenge is noteworthy as around 1.6 million tons of carpet waste are generated annually in the European Union alone. Currently, it is mostly burned because carpets are made of composite materials – including polypropylene. For example, at Targi Kielce, the carpet is a mix of polypropylene with a bottom layer of rubber, glue and PVAC (Pro Civis 2024). Still, some promising signals for recycling opportunities are emerging. In 2021, it was reported that Fraunhofer Institute for Building Physics IBP had developed an innovative process to recover polypropylene from carpet waste in the highest quality for the first time. By using a novel solvent, the researcher team supported by a Horizon 2020 project, ISOPREP, had carried out a successful process in a large laboratory scale and was looking to take the next step to pilot scale. (Schwab, 2021.)

Meanwhile, there are several companies that are developing market ready construction materials using the composite carpets as a feedstock. Few of these companies were also attracted to the Targi Kielce Hackathon. For example, one of the international solution providers that joined the Hackathon, Greenful, started commercial production of sustainable construction panels in Netherlands in the first quarter of 2024. Production is utilizing first 5,000 tons of textile waste, while the capacity is to be upgraded to 50,000 tons by the end of 2026. Company expects to use 500,000 tons of textile waste annually in EU countries by 2030. (Greenful, 2024.)

The textile-to-construction loop is an interesting cross-industrial circular economy model with extensive potential to alleviate sustainability issues of both industries. As the EU generates 12.6 million tons of textile waste per year with only 22 per cent of post-consumer textile waste re-used or recycled, these innovative solutions are in great demand. Moving forward in line with the EU strategy for sustainable and circular textiles, the aim is to increase recycled fibres in textiles. (European Commission, 2023.) However, as the

proportion of synthetic and blended fibres in textiles is high and due to the presence of dyes, the technological and economic feasibility of textile-to-textile recycling is still limited. Meanwhile, there is an urgency of closing the textile loops due to scale of the waste issue (Ellen MacArthur Foundation, 2017, 18). Therefore, it can make sense to look beyond the textile-to-textile recycling to discover market-ready and game-changing ways to close the textile loops. (Vasileff, 2024.)

Solution Ideas Offered Circularity – but no Biobased Alternatives

Despite the rigorous efforts, there were no solutions put forward in terms of bio-circular product innovation with the potential to replace polypropylene carpets commonly used in the exhibition industry. Maybe this was just too ambitious. But the innovative proposals of recycling technologies for the floor coverings made up for this. And what proposals they were! And what fantastic results of recycling do they envisage!

The challenge grabbed the attention of various innovators – solutions providers from Poland and beyond. After publishing the call for applications at the official hackathon website seven teams have applied: six from Poland, one from Finland. It was a very interesting mixture of SMEs, startups, large companies and a business-science consortium. During internal meetings, the Targi Kielce team was pleasantly surprised by the initial innovative proposals submitted by different entities. The Targi Kielce team had no previous experience in open innovation methods like hackathons, but they had huge experience in business. That is why they have applied a business-driven approach to the selection of teams. All of the solutions were interesting but if the idea did not have the potential to be implemented in Targi Kielce they decided not to waste the time of the teams that have applied.

Finally, five teams were selected to the Targi Kielce Hackathon Days that took place on April 10th – 11th 2024 in Kielce as a side event for EKOTECH trade fairs event (BioBoosters, 2024b; Targi Kielce, 2024). As outlined, all the teams had chosen the recycling path to solve the problem. The solutions addressed the issue in different ways. Some of the solutions were focused on recycling technologies that would lead to obtain innovative construction materials that could be used by Targi Kielce to build small architecture or exhibition stands. The others were aiming at using recycled carpets for creating thermal insulating and soundproofing materials to be sold as a new product. Teams either already had developed technology to tackle the problem of textile

wastes or had ideas in various stages of technology readiness. Furthermore, there was also one team, Lindström Group, that proposed a new business model for Targi Kielce based on renting the carpets and service them after each exhibition – a true circular bioeconomy business model already on the market (Lindström, n.d.).

Picture 2. Mentors are sharing their remarks with the Lindstrom team. On the table few examples of carpets – possible solution to the challenge. (Photographer: Kateryna Radkovets)

And the Winner is .... VIVE Texcellence!

This tight race played out generally between solutions proposing further usage of polypropylene fibres as an innovative thermal insulation material in construction and the ones proposing utilizing the coverings as an input to the production of panels. The second option finally prevailed and the VIVE Texcellence technology proposed by Kielce based ”VIVE Innovation” has been announced as the winner (BioBoosters, 2024b).

Utilizing up to 60 per cent of recycled textile components the technology allows for the production of composite boards, structural elements and various

types of fittings ideal for small architecture, garden furniture and applications in direct contact with soil or water. You may of course ask yourself – how does these panels fit the purposes of a trade fair organiser? The answer will be – exhibition stands, stages, storage shelves, fenders at parking area and small architecture (benches, flowerpots, trash bins) at resting areas outside and inside the exhibition venues. All this constitutes important functional and esthetical components of sustainable oriented trade fair centre.

The characteristics and distinctive features of the winning technology could not be better. The base material is 100 per cent recyclable. Thanks to the use of textile fibres, the VIVE Texcellence textile composite is much more durable than equivalent products made only from plastic recyclables. It does not require any complicated processes using dangerous chemicals. And finally – compared to waste incineration, production of VIVE Texcellence composite reduces the CO2 emission up to 8 times. One can say – it is just a perfect fit for all ESG schemes!

Picture 3. Member of VIVE Innovation team pitching their solution. (Photographer: Kateryna Radkovets)

Searching for a Solution? Try Next Door

In every journey it is worth to have a right guide that will lead to success. PRO CIVIS Foundation supported Targi Kielce from the initial step of naming and describing the challenge. Both dedicated teams worked to set a selection criteria for future solutions providers. Concrete actions were taken to write an invitation, create a hackathon website and to promote the call for applications.

The hackathon was supported by ten mentors from Poland, Finland and Estonia. Most of them were the representatives of Targi Kielce and had necessary industrial perspective on the problem and solutions. Others had provided the teams with experience and knowledge on ESG, trade fairs industry, business development, circular economy, engineering.

Targi Kielce team had been part of the process all along. It was their first experience with open innovation method nevertheless they have learned a lot about the challenge itself. As it has already been said, the challenge is a common problem in other exhibitions centres. During the publicly open stages of the hackathon process other exhibition centres marked their appearance and expressed their interests in the final outcomes. It showed Targi Kielce teams that finding a solution could really pave the way for green transition in the whole industry. Regarding the bioproducts that could substitute carpets in trade fairs industry it turned out that the solutions available on the market are not ready to be implemented yet on the industrial scale. There were no applications mentioning this path of solving the challenge. However, the textile-to-construction loops offer promising and commercially ready paths for the circular transition of the trade fairs.

What was most surprising is that winning solution was provided by VIVE Innovations – a company located in the same city as challenge provider. Open innovation process allowed Targi Kielce to find a perfect match located just next door.

Enthusiasts in Action!

Targi Kielce are passionate about making trade fairs, exhibition and congresses. And with more than 60 events annually and more than 300 000 exhibitors and visitors annually – they really need to be. The company is also very important for the region. The Trade Fair and congress industry is a part of the smart specialization strategy in Świętokrzyskie Voivodeship, and as such included also in the Regional Innovation Strategy 2030+ (Marshall Office of the Świętokrzyskie Region Investment and Development Department Innovation

and Knowledge Transfer Unit, 2016). But they are also very fortunate. As they started embarking on the circular and green path – they have met neighbours passionate about recycling and sustainability.

VIVE Innovation is namely part of the VIVE Textile Recycling Group, with the main purpose of activity being the use of second-hand clothes segregated every day in the number of hundreds of tons. The Group was recently characterised by the Forbes magazine as a pioneer and forerunner of innovative and previously unknown uses of textile waste. (Vive Textile Recycling, 2021a.) And there is no doubt, VIVE Innovation lives up to this characteristic. The proposed technology enjoys the feature of a global scale innovation. The products are being preferred due to their pro-ecological origin, exceptional durability and versatility, as well as complete maintenance-free and unique aesthetic values. Main markets are in Western Europe and Scandinavia. But the Company does not stop there. The intensive R&D works on the further development on textile composite technology continue. The potential business partnership with trade fair business may give it just another important boost.

> *"All the ideas which were presented were very interesting for us and I'm sure that we could cooperate with the winner in the future. It will be very good for Targi Kielce and maybe for another trade centres to solve the problem with the wastes (…) they have similar problems with textile wastes after the exhibitions.* – Joanna Marcjan, Deputy Director of the trade fair department at Targi Kielce (BioBoosters, 2024b.)*"*

It looks like thanks to this BioBoosters hackathon we struck a perfect match; and we at the PRO CIVIS Foundation are just passionate about delivering the BioBoosters hackathons!

Local Partnership for International Impact

The first substantive meeting on co-operation between Targi Kielce and the Hackathon's winner took place in May 2024 at the VIVE Innovation premises in Kielce. For the trade fair organiser, it was an opportunity to see the composite production site and the sorting facility. VIVE Innovation also presented a catalogue of products made from composite they are currently delivering ready-made products.

The parties have started working towards formalizing their co-operation. The first threshold to overcome is to achieve a code consistency between textile waste codes generated by Targi Kielce and waste codes in the waste

treatment permit obtained by VIVE Innovation. The next step is the purchase of a waste compactor which is necessary to prepare the waste for further processing. VIVE Innovation declared the willingness to provide support to Targi Kielce in this choice. Both parties strive for a successful co-operation. Targi Kielce is also willing to further cooperate with PRO CIVIS Foundation and encourage Trade Fair exhibitors, visitors and other business entities for participation in future hackathons. The first BioBoosters Challenge Provider is more than ready to share gained experiences and strongly advocate for the method.

In the meantime, Targi Kielce has undertaken several activities in terms of their sustainability mission: replacement of lighting with energy-efficient lighting; water feeders with filters directly connected to the water supply; and tree planting. In their investments plans for the near future, the thermal modernization of the exhibition hall, photovoltaics and energy storage facilities are very important endeavours.

Picture 4. Group photograph of all Targi Kielce Hackathon participants. (Photographer: Kateryna Radkovets)

Takeaways of the First-time Organisers: The Change of Mindset Starts the Transition

The BioBoosters project aim is to boost the green transition in Baltic states by using hackathon method – an open innovation tool that gathers innovators to tackle sustainability problems. The journey always begins with naming the problem and realizing that there is an area for improvement in terms of lowering the impact of certain economic activities on climate and environment. It is clear that having a business means also having lots of problems and everyday challenges to overcome. Whatever the business or sector we are referring to.

Looking at the exciting, shared journey of Targi Kielce and PRO CIVIS Foundation – the true value of open innovation process and hackathons can clearly be seen. Regarding the co-operation with Targi Kielce, a big and initial step forward was to name the problem and to describe it. In every case, the crucial step is also to find a guide that could provide professional support and set up a plan that will lead to finding a solution. That kick-starts the open innovation process which will help to share the challenge with the community of innovators. By opening the door for solution providers from different countries and sectors, Targi Kielce got unique opportunity to gain new different perspectives and knowledge that could be implemented.

It has to be highlighted that the outcome and way forward would not be as promising if Targi Kielce would have only focused on the diagnosed problem without readiness to seek for support outside of their organisation. After weeks of preparation and an intensive process during hackathon days the winner was selected. This was a true milestone for solving the problem and hopefully, sparks the green transition in the whole exhibition industry.

The first step to real change starts at the moment when the company decides to take part in a hackathon. It is a sign of changing mindset and focusing on solving a challenge, not only on having a problem. This is where the green or any other transition begins. Always, it is needed to take one step towards more openness. The second step: of the change is the naming of issue at hand – not problem but challenge. The word ”challenge” has strong connection and a promise of development: business, income, co-operation, networking and broadening the horizons.

Targi Kielce was guided by PRO CIVIS Foundation and supported to make the first steps towards taking a concrete action. Taking up the actions will always be the right way to make the transitions happen. Not only for this particular company but for the whole trade fair and exhibition industry.

Info box: Targi Kielce Hackathon	
Challenge	TRADE FAIR EVENTS ON THE WAY TO GREEN TRANSFORMATION The challenge is to propose innovative and more environmentally friendly product and/or technological solutions for covering the surface of various types of floors for the trade fairs industry, implementing the principles of circular economy.
Target groups	Individuals, Entrepreneurs, Scientific entities, Research entities, Academic/student entities with either material recycling solutions or biobased floor covering solutions applicable to the trade fairs.
Organiser	Foundation of Education and Social Dialogue "PRO CIVIS", Świętokrzyskie, Poland The PRO CIVIS Foundation is an independent, non-governmental, non-profit organisation that has been working for the integration and dialogue of science and business for almost 20 years. PRO CIVIS implements projects related to innovation and raising awareness of the bioeconomy.
Mentors	Targi Kielce (Poland) PRO CIVIS Foundation (Poland) Jamk University of Applied Sciences, Institute of New Industry (Finland) Grant Thorthon (Poland) Wroclaw Technical University (Poland) Kielce City Hall (Poland) Cracow Economic University (Poland)
Hackathon days	10–11 April, 2024, at Targi Kielce, Kielce, Poland
Applicants	7 applications 6 from Poland and 1 from Finland
Selected teams	5 teams 4 teams from Poland, 1 from Finland
Winner	VIVE Innovation, creating composites from textile waste fibres
Impact	Valorisation of 100.000 square meters of polypropylene carpet waste annually at the Targi Kielce operations. 

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Estonian' Flagship Fibenol Empowered Innovation at 'Wood to Food' Hackathon

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Anna Aalto, Jamk University of Applied Sciences

Imagine enjoying a delicious wood-based dinner or a dessert tonight. Fibenol Hackathon organised by the Estonian University of Applied Sciences in partnership with BioBoosters took us on a journey to discover the novel foods and ingredients from wood.

Picture 1. BioBoosters hackathon started at the Fibenol plant on 25 April 2024 (Photographer Tago Kalbri, Morrowshoots OÜ)

Unique Flagship for Circular Bioeconomy

Estonian Fibenol is a biotech innovator driving the chemicals and materials industry towards sustainability, by offering solutions to replace fossil-based materials with biomaterials Lignova lignin, wood sugars and specialty cellulose. Fibenol products can be applied in construction materials for interior, buildings and roads, packaging, bioplastics, home care, cosmetics and alternative proteins. (Fibenol, 2024b.)

The Fibenol plant in Imavere has been fully functional since 2023. With the wood to useful products conversion of more than 90 per cent and working on 100 per cent renewable energy, the plant utilizes a unique Sunburst pre-processing technology that fractionates biomass into bio-components faster and more efficiently than any other technology available on the market. The feedstock is sustainable hardwood biomass and the annual production capacity around 6500 t/a of different lignin grades and 20 000 t/a cellulosic wood sugars. (Fibenol, 2024b.)

Since its opening, the Imavere plant has been the destination of choice for many high-level delegations. The company is actively engaging in international co-operation and effectively leveraging funding from the Bio-based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme. The Imavere plant itself has been supported by the SWEETWOODS project. (Fibenol, 2024a.)

> *"An industrial revolution based on fossil materials must be followed by a bio-industrial revolution. We and Fibenol are playing an integral role in this. We are in the process of revolutionizing the wood industry on a global scale so that wood-based materials can move into the value chains of the chemical-material industry as we know it today to create a completely new perspective for the future of wood valorisation."* Chief Development Officer of Fibenol, Peep Pitk. (Fibenol, 2023.)

To capitalize the potential created by the unique pre-processing technology, Fibenol R&D team is engaging in various product development and testing activities to convert wood into different materials more efficiently and with higher quality (Fibenol, 2023). Many R&D activities are supported by Horizon 2020 research and innovation programme. For example, REDYSIGN focuses on creating sustainable fibre-based packaging from the whole product portfolio (MCC, lignin, cellulosic sugars) and COUNTLESS project, the focus is on lignin to produce platform chemicals and demonstrate their applicability and cost-effectiveness in a variety of end-use cases from bulk to specialty applications. (Fibenol, 2024a.)

With the successful demonstration and strong R&D portfolio supporting commercial partnerships, the commercial scale biorefinery is on the way. In August 2024, the news was out – Fibenol plans to develop a biorefinery in Valmiera Industrial Park, Vidzeme Region. No doubt, the Latvian commercial biorefinery will also be a flagship for the Latvian forest-based bioeconomy. In fact, the project has received strong endorsement from the national government as the project contributes to EU Green Deal objectives, including REPowerEU, the Net Zero Industry Act, and the EU biotech and biomanufacturing initiative. A Memorandum of Understanding has been signed between Fibenol and the Ministries of Economy, Finance, Agriculture, Climate and Energy of Latvian Government and the Investment and Development Agency of Latvia (LIAA). (Sillasoo, 2024.)

Cross-over from Wood to Food

The cross-over from wood to food has already long roots. Cellulose has been a common food additive used since the mid-1900s. Particularly in the form of microcrystalline cellulose, it is widely used in the food industry for its functional properties, such as acting as a food thickener and emulsifier. It is also commonly used in low-fat or diet foods. (Mäntyranta, 2020.)

One may wonder why we should further promote the use of wood in the food supply chain. On global scale, the world is facing the great challenge of meeting the growing demand for a sustainable production of food for the estimated population of 8.5 billion people by 2030 while improving the quality of the food supply and tackling the sustainability crises. Global demand for animal protein (fish, meat and milk) is increasing rapidly, driven by growing world population and rising standards of living. Decreasing the environmental impact of protein supply is vital to securing biodiversity and climate change mitigation. In the EU, an additional supply chain challenge is at stake, since about 75 per cent of the protein sources are imported. This raises a concern over food security in the wake of global market turmoil. (World Food Programme, 2024.)

As the global demand for tackling food insecurity is growing, also in regional and country level alternatives in food sector are urgently needed. The forest covers around 50 per cent of Estonia and the forestry sector exports about 50 per cent of its raw materials, resulting in an added value of approximately €35,000 per worker. But for example, in Finland, this figure is significantly higher, exceeding €200,000 per worker (Metsäteollisuus, 2023).

To add more value to local resources Fibenol's announced a challenge to discover high-value applications for valorising cellulosic sugars, lignin,

and specialty cellulose in food and feed production. To launch the open call for solutions to Fibenol Hackathon, Katrin Jõgi, Fibenol's sustainability manager, encouraged all the possible solution providers to join the open innovation process seeking to harness the power of woody biomass to create new innovative high-quality bio-products, alternative proteins, food or feed additives, novel foods. (EestiMaaulikool 2024).

Picture 2. Fibenol factory tour at Imavere on 25 April 2024 (Photographer Tago Kalbri, Morrowshoots OÜ)

'Sky is the Limit'

Possibilities to tackle the Fibenol challenge were indeed numerous. Several startups are already leveraging cellulosic sugars in the food sector as a substitute for palm oil (ÄIO, 2024) and in alternative protein production (FUNKI, 2024), to name a few. But still cellulosic sugars, lignin and specialty cellulose could offer more possibilities in the feed and food sectors. For example, lignin possesses natural antioxidant properties, enhancing the overall quality of food products. Additionally, it can serve as a valuable fibre component in food. Furthermore, in animal feed production, innovations in

biochemical production are utilizing these materials to create nutrient-rich feed that has positive impact for a greener future. Cellulosic sugars, being highly fermentable, make an ideal feedstock for ethanol or alternative protein production, positioning them as attractive ingredients for tomorrow's delicious and nutritious novel foods.

To highlight the scale of the opportunities, let us consider another flagship pilot plant for circular bioeconomy, Arbiom in France that was connected to the Fibenol Hackathon via mentor involvement. The Arbiom plant is due to produce annually 10.000 tons of protein-rich ingredients by yeast fermentation for the food and feed markets. This flagship plant is geared to meet the growing demand for natural, high-quality, and sustainable food products in the market. Fibenol's role in the concept of Arbiom, developed in the SylPlant project, is to deliver a sustainable feedstock of wood-based by-products. (Sylplant, 2024.) The project supports Fibenol's aims to demonstrate that non-food competing wood sugars, with a low CO2 footprint, are a suitable alternative for producing protein-rich ingredients.

And this is just the beginning of sustainable biotech era!

Picture 3. Winning team, NovelYeast, announced on 26 April 2024 (Photographer Tago Kalbri, Morrowshoots OÜ)

Unlocking Success – Open Innovation for Interdisciplinary Solutions

Driven by the need for innovation and science-based solutions, the BioBoosters Fibenol Hackathon launched an international challenge to add more value to woody biomass. The hackathon theme attracted in total seven teams: two from Sweden, three from Estonia, one from Switzerland, and one from Belgium. Six of these teams advanced to the final hackathon days at the Estonian University of Life Sciences in Tartu, Estonia. This event brought together highly motivated, startup-minded international scientists, forming an international platform for ideation. This open innovation approach also attracted esteemed mentors from France and Finland, significantly enriching the entire process.

There is no single winner in open innovation process. As Karl Peebo, Fibenol's product manager and mentor, eloquently stated during the hackathon's award ceremony, "Everybody is a winner." For students, the hackathon provided invaluable experience, while scientists and experts gained practical insights into their fields.

The team announced as the winner, Novel Yeast from Belgium, proposed a solution to valorise C5 sugars derived from Fibenol's residual wood into xylitol using genetically modified and patented yeast strains. Novel Yeast was able to tackle a difficult sugar stream into an ingredient widely used in toothpastes, chewing gums, pharmaceuticals, and the food industry. Based on the hackathon, Fibenol and Novel Yeast started to explore mutual funding opportunity under the Circular Bio-based Europe Joint Undertaking programme. (BioBoosters, 2024.)

Ultimately, the biggest winner was the challenge provider, who forged connections with leading experts in the field expanding and strengthening the innovation partnerships essential for their continuous growth and success. In a remarkable outcome, the overall winner also signed a memorandum of understanding to enhance strategic collaboration with the RISE institution in Sweden, where one of the participating teams hailed from.

> *"This partnership is an excellent match for several reasons, with a shared target for impact and sustainability. Fibenol is transforming biomass into high-value materials, leveraging its proprietary technology. RISE brings extensive innovation and applied science capabilities to help optimize and scale Fibenol's processes and products, " says Henrik Bagewitz, VP of Research & Business Development at RISE Research Institutes of Sweden (Fibenol LinkedIn, 2024).*

Picture 4. Karl Peebo and Katrin Jõgi from Fibenol at the Hackathon Days in the Centre of Bioeconomy of the Estonian University of Life Sciences (Photographer Tago Kalbri, Morrowshoots OÜ)

This hackathon, ”Wood to Food”, is one of the examples of how open innovation can drive interdisciplinary solutions, fostering collaboration and creating opportunities for all involved. Open innovation requires a collaborative capacity and drive from the challenge provider. As stated by Katrin Kepp (2024), Head of the Centre of Bioeconomy at Estonian University of Applied Sciences, the success of the Fibenol Hackathon began with the company itself – their commitment to innovative, research-based sustainable solutions that utilize local resources and add higher value at the local level. Fibenol was open to discussion and welcomed the participants to their demo plant in Imavere showing the entire process and providing a deeper explanation of their challenge on-site. (Kepp, 2024).

Info box: Fibenol Hackathon	
Challenge	Wood to Food: new high value applications for valorising our cellulosic sugars, lignin and specialty cellulose for food or feed production.
Target groups	Entrepreneurs, scientific entities, research entities, academic/ student entities
Organiser	Centre of Bioeconomy (BioMAK), Estonian University of Life Sciences, Tartu, Estonia BioMAK serves as the Estonian Bioeconomy HUB (BIOEAST), focusing on initiating and coordinating interdisciplinary research and the development of innovative technologies. BioMAK facilitates the exchange of multiple stakeholders, fosters innovation, organizes seminars, international conferences, public discussions, and other scientific events in the field of circular bioeconomy.
Mentors	Fibenol (Estonia) Estonian University of Life Sciences (Estonia) Arbiom (France) Elomatic (Finland) Estonian Business and Innovation Agency (Estonia) Jamk University of Applied Sciences, Institute of Bioeconomy (Finland) Tehnopol (Estonia) University of Tartu (Estonia)
Hackathon days	25–26 April, 2024, at the Estonian University of Life Sciences, Tartu, Estonia
Applicants	7 applicants 3 from Estonia, 2 from Sweden, 1 from Belgium and 1 from Switzerland
Selected teams	6 teams 2 from Estonia, 2 from Sweden, 1 from Belgium and 1 from Switzerland
Winner	Novel Yeast from Belgium with a solution to valorise C5 sugars derived from Fibenol's residual wood into xylitol using genetically modified and patented yeast strains. Xylitol is widely used in toothpastes, chewing gums, pharmaceuticals, and the food industry.
Impact	Fibenol pilot plant annual production capacity is 6,5 kton lignin, 20 kton of cellulosic sugars and specialty cellulose at ton scale. 

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Theme 3

Valorisation of biobased sidestreams

From Ash to Assets with Holmen Hackathon

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In the summer of 2023, BioFuel Region found their first challenge provider for a BioBoosters Hackathon in Holmen, one of Sweden's largest forest owners, with forest holdings of 1,3 million hectares (Holmen, 2024). Their challenge was the ash that remain after drying sawn timber in two of their sawmills in the County of Västerbotten, in Northern Sweden. According to Jonsson, A. (2024), the ash is not a part of the business of Holmen, and it is currently costing them to remove or deposit this potential resource. This challenge was the starting point for the first BioBoosters hackathon for BioFuel Region to organize and the first open innovation process for Holmen to partake. This learning journey titled 'Holmen Hackathon – Ash to Assets' was implemented between September-December in 2023.

Picture 1. The challenge provider gives a bouquet to the winning team (Photographer: Samuel Pettersson, CC BY-SA 4.0)

How could Ash be a Part of Holmen's Business Model?

Holmen's extensive forest holdings are the foundation of their business. The growing trees are refined into everything from wood for climate-smart building to renewable packaging, magazines and books. Forestry as a whole face a lot of new challenges connected to the climate change and biodiversity issues. As a forest company, Holmen is at the core of the bioeconomy and most of the residual streams in the forest and industries are included in their business. The ash however is not. Society demands that more of the residual streams should be incorporated in the biological loop and charges for depositing material as ash (Naturvårdsverket, 2024). According to Johsson (2024), the deposit tax is 725 SEK per ton which is added on top of the actual cost for depositing which is around 1200 SEK. Since the ash contains certain elements e.g. K, Ca, P (Pettersson & Björnsson, 2019) and hold properties that have proven to beneficial to several industries, Holmen wanted to see if they could turn this resource from waste to wonder.

Ash in a Scandinavian Perspective

Biomass is widely used in energy production in Scandinavian countries, especially in Sweden and Finland. One third of the total energy consumption in Finland is based on wood. Around 41 per cent of that are solid wood fuels. Combustion processes produce more than 300,000 m^3 (240 Kton) ash originated from wood material (Bioenergia, 2024). The share of bioenergy is at the same level in Sweden, and absolute amount even higher, corresponding up to 145 TWh energy (Swedish Society for Nature Conservation, 2022). Approximately 200,000 tonnes of spreadable bio-ash is produced annually, but only about a quarter is returned to the forest (Enström, 2019).

Utilization possibilities depend very much on the quality of ash. Fuels used in combustion are the main factor for the content of ashes. Combustion process and collection points of ashes impact also to the quality of ash. Typical combustion processes in wood processing industry result in both, bottom ash collected from the bottom of the combustion chamber, and fly ash, received from the flue gas cleaning system. Fuel is typically clean wood hence further use of ash is easier than using ashes originated from mixed fuels or various other sources. Still, especially fly ash is regarded as hazardous material, due to its relatively high heavy metal contents (Pettersson, 2020).

Traditionally wood-based ashes, mainly bottom ash, are used in both countries for land construction, in cement production, and as a fertilizer in

forestry, especially at peatlands. Still, a large part of ashes ends up in landfills. In Finland, where one fourth of the land area is covered by peatlands, wood-based ashes are used for fertilizing peatland forests. The fertilized area has been around 10,000 hectares annually, but the potential can be seen at least six times higher. Ash has shown its excellence there; growth impact has usually been very good and long lasting, and recycling of ash supports the idea of circular economy (Biotalous 2021). In principle, positive results could be achieved in agricultural land as well, but in most cases heavy metal content of ashes exceeds the limits set by the EU directives (Finlex, 2021).

New opportunities are sought in up-grading of ash-based fertilizers for improved economy but also for expanding the areas where it is applicable, e.g. in mineral soil forestry and agriculture. Extracting valuable components from ash flows is also a development target (Jokiniemi, 2019). Wider use of ash-fertilization is promoted as a measure to increase forest growth and carbon sinks at peatlands. Planning of peatland management and spreading of ash-fertilizers are supported by the Finnish government. The support for spreading is 270 Euros per hectare for private forest owners (Karppinen, 2024).

Major challenges for larger use of ashes are quality problems with ashes, logistic inefficiency, especially when collecting ashes from remote small sources and delivering products to scattered users, and in under-developed fertilizer markets. Still, cost-competitiveness of ash-based products is getting better due to developed processes and rising land-filling costs.

The Ecosystem of the Hackathon Process

The process of finding the best solution gave Holmen a wide variety of different solutions to choose from and was an eye opener in understanding that solutions and competence could be found outside of their traditional network. The open call for solutions for Holmen Hackathon received 12 applications with solution ideas. In total, 10 of the applications came from Sweden and two from Poland. Since Finland was expected to be ahead of Sweden when it comes to utilization of ash, the Holmen team was a bit surprised that no Finnish company applied.

The presented solutions were varied ranging from dispersal of ash with drones, to extracting chemicals, to biochar production and to soil restauration to improving compost production. Five of the solutions came from research institutes or universities, one was a start-up and six were SMEs. It turned out that ash had more applications that the Holmen team had thought. Reviewing the applications, the Holmen team did not find an immediate favourite but

found that 10 out of the 12 solution proposals were completely new ideas for them to consider. Holmen invited six teams to join the Hackathon process. However, after two dropouts, in the end there were four teams competing on the Hackathon Days.

Picture 2. Holmen Hackathon mentoring and networking day on 7 December 2023 (Photographer: Samuel Pettersson, CC BY-SA 4.0)

To support the selected teams in refining their solution proposals, BioFuel Region invited mentors from potential future partners to join the process. Connecting with partners is important since BioFuel Region is a small organisation, and a varied competence is needed to support the teams. Mentors presented competences ranging from start-up support and business development to research within the field of ash and generic bioeconomy competence. Holmen and BioFuel Region provided four mentors respectively, Jamk University of Applied Sciences provided one and three mentors came from other regional parties. Despite the wide range of expertise available, evaluation of the solutions' potential was in some cases hindered by the lack of exact data on the residual streams from Holmen.

Picture 3. Holmen, the challenge provider, is having a mentoring session with Team Biocompost, where they ask each other questions. (Photographer: Samuel Pettersson, CC BY-SA 4.0)

Ash for Improving the Compost Process and a Source of Nutrients

In the end of the Hackathon days, winner was selected, and it was Biocompost, an SME from Sweden. The solution presented by Biocompost met all three evaluation criteria: sustainability, potential profitability and circularity. Today, Holmen is using a lot of peat in their nurseries. According to the Swedish Environmental Agency, peat is considered fossil and should be phased out in the coming years (Naturvårdsverket, 2024). By adding ash into the composting process, the produced soil from the Biocompost reactor has potential to replace the peat.

> *”Biocompost solution meets Holmen’s need to create value from the ashes. It can potentially be used locally at their own nurseries. We will now move on and discuss the forms for our future collaboration. We are extremely excited about the opportunity to participate in this hackathon process, and it has been exciting to follow the variety and creativity of the different solutions submitted. Through*

this process, we have quickly gained a completely new perspective on various opportunities that exist to develop the business for the ashes and we've also created many new contacts", says Marcus Kyrk, project manager at Holmen (BioBoosters, 2023).

Biocompost is a small company passionate about transforming waste into valuable resources in a sustainable way. Biocompost mainly sells services and products within industrial composting. The technology used are compost drums or compost reactors, which is an environmentally friendly and time-saving composting method. When composting, for example, sludge from the process industry, the moisture content is often too high and must be adjusted to get a suitable temperature for the process. Normally, the sludge is mixed with wood chips to get the right carbon/nitrogen ratio and moisture content. However, the proportion of wood chips is sometimes higher than desired due to the moisture content. To maximize the sludge proportion in the compost, the idea is to mix the ash into the blend before starting the composting process. The benefit of adding ash into the composting process is the elements in the ash with fertilizing properties, which contributes to a better final product.

Thomas Storsjö, CEO at Biocompost AB say's "We thought it was exciting to participate in this Hackathon and especially to have the opportunity to meet many different people in the field and discuss and develop our idea together. The fact that we also won feels incredibly fun and we are now looking forward to the continued collaboration with Holmen." (BioBoosters, 2023).

Picture 4. The winning team, Biocompost AB, together with Holmen. (Photographer: Samuel Pettersson, CC BY-SA 4.0)

Ways of finding new applications for waste or residual streams is becoming more and more crucial for both businesses and society (Bioimpact, 2023). Biocompost has the potential to be part of this necessary development. A fun fact is that Thomas has participated as mentor in the Cosun Beet Hackathon and has also been selected as one of the solutions providers in Võiste Hackathon on the spring 2024. It surely seems there is a great demand for the expertise of Biocompost in the bioeconomy companies seeking to boost their circularity.

Since they are not planning to start the compost operation themselves, Holmen has actively tried to find an interested entrepreneur for collecting the ash and turning it into soil in the reactor drum. Discussions with a few companies have been held during the spring 2024. Biocompost has helped with contacts and leads. However, when writing this article Holmen has decided to withdraw from the process without further notice.

Lessons Learned from First Time Hackathon Organiser

It is both hard, as well as fun and rewarding to run a hackathon. Hard because it is difficult to find all needed partners, in our case the challenge provider was the hardest. This new way of tackling a challenge within a large company also reveals organisational issues that must be handled. Still, the journey was also fun because of the new collaborations and the hands-on help that it offers and rewarding because of the business opportunities that arise.

BioFuel Region and BioBoosters network managed to attract 12 different solutions and engage mentors from three regional partners of BioFuel Region as well as one mentor from Finland. Ten out of the twelve solutions were unknown to Holmen prior to the hackathon. Participants – challenge provider, mentors, and teams – gave very positive feedback on their experience with the Holmen Hackathon. Excitement was high, but the co-operation did not launch as expected.

Even though Biocompost has helped with contacts and leads, Holmen has decided to withdraw from the process without further notice. They have no objections against Biocompost but can't see that their solution can be incorporated in the day-to-day business. As the service agreement between organiser and challenge provider extends only to the hackathon days, the organiser has limited opportunities to influence how the promised support to the winning team is realized. This presents a potential development area for the BioBoosters Hackathon process – how to support the launch of the started co-operation and what support could be offered for the winning team(s) with validated solutions relevant to the circular transition of a bioeconomy sector.

Info box: Holmen Hackathon	
Challenge	Ash-to-Assets
Target groups	Companies and institutions – ranging from academic institutions to companies close to the market with applications to create value from ash.
Organiser	BioFuel Region AB, Västernorrland, Jämtland/Härjedalen, Västerbotten and Norrbotten, Sweden BioFuel Region is a cluster organisation owned by its members – municipalities and companies. The mission of BFR is to support the development of the bioeconomy in northern Sweden and to push the transition to a fossil-free vehicle fleet by initiating and participating in different regional, national and international projects and we collaborate with the public sector, business and research and development bodies.
Mentors	Holmen (Sweden) BioFuel Region (Sweden) Swedish University of Agricultural Science (Sweden) Bizmaker (Sweden) Skogstekniska Klustret (Sweden) Jamk University of Applied Sciences, Institute of Bioeconomy (Finland)
Hackathon days	7–8 December 2023, Umeå
Applicants	12 applications 10 from Sweden and 2 from Poland
Selected teams	6 teams (Sweden)
Winner	Biocompost AB with a solution to mix the ash to the composting process to improve the process and to give the end product a higher nutritional content. The final product, the compost, could potentially replace some of the peat that are used in Holmen's nurseries today.
Impact	Holmen produces approximately 450 tons of ash. The estimated amount of produced ash for all Swedish sawmills is 20 000 tons, i.e. there is a potential for scaling up the solution. 

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Unlocking the Biorefinery of the Future with Cosun Beet Hackathon

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More than 135 innovative applications for a single crop; sugar beet refining holds the key to sustainable solutions across agriculture, food, chemicals, energy, and transportation. Are we ready to unlock its full potential by valorisation of the processing side streams? This article will show how Cosun Beet Company, a sugar beets processing company, is accelerating on its path towards circular economy and how the Cosun Beet Hackathon helped to untap the slumbering potential of sugar beet refining.

Picture 1. Sugar beet (Photographer: Cosun Beet Company)

From Waste to Value – Biorefinery as a Central Hub for Circular Bioeconomy

With measures against climate change being top of the agenda and prices for energy and raw materials skyrocketing, circular economy is becoming a method of choice. All over the economy businesses are looking for ways to optimize the use of raw materials while minimizing energy consumption and ecological imprint by extending product lifecycles and putting formerly discarded residues to use thus leaving behind outdated patterns of the traditional linear economy.

As outlined in the roadmap for implementing the bioeconomy in Germany (Fraunhofer-Gesellschaft 2023, 35), circular bioeconomy is crucial for securing and improving the German economy's competitive position, and to achieve the national and European targets for climate protection and sustainability. Researchers at the Fraunhofer-Gesellschaft are highlighting e.g. strengthening food system resilience via regional processing, systemically translating innovations into real-world industrial applications, and developing biorefineries as enabling framework conditions to be implemented already in short term. Cosun Beet is responding to this call.

The Royal Cosun Beet Company is a leader in sustainable sugar beet processing producing white sugar, bioethanol, and biomethane, serving essential roles in the food, energy and fuel sectors, via generating a variety of biogenic residues. Sugar beet can surely deliver a lot. Cosun Beet company is accounting for 135 possible applications for sugar beet in their Bright Beet Book, incidentally the world's first book made from beet paper. 135 applications – this is the amazing and realistic potential that the sugar beet refining offers in the future to provide sustainable products for diverse applications in the agricultural sector, the food and chemical industries as well as the energy and transport sector. (Cosun Beet Company, 2024.)

At their Anklam site situated in Vorpommern-Greifswald in Germany, Cosun Beet Company aims to transform their sugar processing plant into a green biorefinery, expanding its product range and exploring new markets with sustainable solutions. The goal is to create plant-based solutions for a sustainable future, including food products, animal feed, proteins, biobased products, and green energy. Cosun Beet Company calls these solutions Bright Beet Solutions. (Witeno, 2024; Sauer, 2024.)

This vision aligns with global environmental goals and represents a significant step towards a more sustainable future which was recently developed in a net zero roadmap for the German sugar industry (Geres, Geres

& Weigert 2024). The vision of becoming a pioneer at innovating plant-based refining has also a regional aspect to it.

Already, Cosun Beet Company is playing a significant role in the local and regional economy:

- As one of the major employers in the region providing some 200+ qualified jobs;
- As partner in local value creation processing approx. 2 MTons of sugar beets a year for some 340 agricultural businesses thus strengthen local agricultural producers; and
- Bioethanol and biomethane produced in the sugar refining processes provides local businesses with sustainable alternatives for fossil fuels.

There is more to come as Cosun Beet Company is taking an active position in various regional networks and research and development projects such as ”biogeniV” aiming at turning biogenic residues into green fuels and resources, ”Plant3” looking for innovative strategies to refine plant-based resources, or ”Physics for Food” that is searching for innovative physical technologies for agriculture and food production.

Picture 2. Harvesting sugar beet (Photographer: Cosun Beet Company)

Launching the Open call with a Wide Range of Feedstock Options

Future biorefinery, as the one envisioned by Cosun Beet, are needed as we move away from carbon-based economy. As outlined in the study by Calvo-Flores & Martin-Martinez (2022), biorefineries already produce bio-based fuels, chemicals, and polymers, with production expected to grow driven by economic and environmental factors. However, bio-based production still must improve their effectiveness to be competitive. Integration of processes is a key strategy to improve the cost-efficiency. Developing integrated processes is crucial for maximizing biomass value. Challenges include improving biomass conversion and developing new technologies as well as establishing cross-sectoral co-operation. (Calvo-Flores, & Martin-Martinez, 2022.)

To make headway on their vision, the Cosun Beet Company chose a hackathon as means to draw innovators, not only from the food industry but explicitly from other fields, to unlock the potentials of the sugar beet. The hackathon aimed to identify innovative solution providers who could offer groundbreaking concepts, technologies, and equipment for the effective utilization of these residues. Especially, the solutions that were not yet on the market where of great interest to Cosun Beet's innovative team and their long-term development vision. (Witeno, 2024; Sauer, 2024.)

The Cosun Beet challenge was deliberately formulated in such a way that a total of six side streams from sugar, biogas and bioethanol production as well as wastewater treatment were included. The open call requested solution ideas for (Witeno, 2024; Sauer, 2024):

- 500,00 tons of beet leaves, currently left on the field
- 50,000 tons of beet soil from the cleaning processes
- 10,000 tons of sewage sludge from the wastewater treatment plant
- 70,000 tons of carbonation lime from the juice purification
- 90,000 tons of digestate from the biogas plant
- 190,000 tons of thin vinasse from the bioethanol plant

As apparent from the variety of the side streams, the operation at the Anklam plant has already taken several key steps towards sustainable biorefinery with multiple outputs. The biorefinery at Anklam can be characterized as a phase II biorefinery with a single feedstock but multiple products (Calvo-Flores & Martin-Martinez, 2022). As a complex system, it would not be ideal to focus on optimization of an induvial stream but rather a systematic overview of the

integrated system is needed. Furthermore, Cosun Beet was interested to obtain a broad spectrum of ideas that would also tackle all their under-valorised side streams challenges. In addition, the hope was that residue streams could be combined for improved product development. All in all, it made perfect sense to tackle the wide variety of side streams, although it caused some rather positive challenges in terms of the open innovation process management. For example, how to evaluate and select the participants among 25 international applicants?

Picture 3. Hackathon participants at the Anklam plant of the Cosun Beet Company. (Photographer: Cosun Beet Company)

Diversity as a Decisive Booster for Open Innovation

The diversity of the challenge was directly reflected in the proposed solutions submitted: Not only were there ideas for all six side streams, but teams from different, complementary disciplines came together for the submission. Solopreneurs, start-ups as well as larger companies and associations were reached and the teams picked either individual, several or even all side streams for their proposed solutions. In addition, roughly the same number of solutions

were submitted from Germany as from abroad. Interestingly, individual teams acted directly as joint partners from research and companies. The ideas submitted focused primarily on composting, biogas, fertilizer, biochar, algae, extraction of proteins and chemicals for further use. (BioBoosters, 2024; Mernitz, 2024.)

The breadth of the challenge and the corresponding solution providers was also reflected in the range of expertise of the mentors. Particularly relevant was the input from the mentors of the challenge provider from the various specialist areas with the corresponding depth of information, but also the expertise that came from external mentors who were able to provide particularly excellent advice on sub-areas, such as regulatory aspects or the possibilities of combining solutions. (Mernitz, 2024.)

The Cosun Beet Hackathon brought together an impressive and diverse assembly of 10 teams, six jury members, 12 mentors, and organisers from across the Baltic Sea Region to tackle the challenge of converting sugar beet residues into valuable resources. After a rigorous development phase, eight teams presented their innovative ideas in Anklam, on April 16–17, 2024. For Cosun Beet, the hackathon was a complete success and showed the possibilities for a sugar beet biorefinery of the future (BioBoosters, 2024).

Already at the kick-off, when all submitters got to know each other, possible co-operations were discussed directly among the participants. This open exchange and the interest in cooperating in the future, regardless of the outcome of the hackathon, continued during the hackathon days. One participant described this as a key output of the hackathon process and emphasized how valuable it was to exchange ideas and discuss future joint projects. Overall, the atmosphere during the hackathon was characterized by a great willingness to cooperate and showed a desire to act together in the spirit of circularity rather than giving the impression of competition between rivals. (Mernitz, 2024.) As reflected in the experiences of the participants, the competition offered not only a platform to present their innovations, but also an opportunity to network, exchange ideas and discuss the potential of the bioeconomy for the region.

> *”With this hackathon the scientific spirit meets the hackathon concept very well, we develop our idea, we meet with other groups, we meet with the people from COSUN BEET and develop our ideas, get new opportunities and new hints what is important for the company, what is important for the scientific community, find our meeting points and develop our idea more and more.”* stated Cedric Klimt of Team Vinasse2Proteins. (BioBoosters, 2024).

Picture 4. Products from sugar beet processing at Anklam site (Photographer: Cosun Beet Company)

Diversity and Sustainability go Hand in Hand

The wealth of promising submissions ultimately led to the selection of three winning teams introduced here. The winning solutions offer opportunities to boost the sustainability of the whole biorefinery operation.

Firstly, a startup from Belgium, **Team n-fix** has developed an innovative method to produce microbial biofertilizers from beet pulp digestate, promising to reduce greenhouse gas emissions in sugar beet cultivation while enhancing plant robustness, yield, and sugar content, along with minimizing nitrogen input. As demonstrated by Elias et al. (2024, 13) in a techno-economic-environmental analysis of an industrial biofertilizer production facility coupled with a sugarcane ethanol biorefinery, the integration of biofertilizer production into an ethanol and sugar biorefinery is a more sustainable alternative to isolated biorefinery operation.

Picture 5. Winning team n-Fix (Photographer: Cosun Beet Company)

Secondly, with its solution, the **Team Vinasse2Proteins** from Biberach University of Applied Sciences is focussing on the increasingly important role of plant proteins in the sustainable food supply of the future. These can be obtained, for example, from mushrooms that grow on residues from the bioethanol plant. Apart from the protein and nutritional value, with the use of biotechnological applications, mushrooms have gained further attention as a source of biomedical components and bioenergy. The residual water is still of such good quality that it can be used to cultivate algae, which in turn can be processed into food. (Llanaj et. al., 2023.)

Picture 6. Winning team Vinasse2Protein (Photographer: Cosun Beet Company)

Finally, **Team CAPitalize Leaves**, a consortium of the Helmholtz Centre for Environmental Research UFZ and the German Biomass Research Centre DBFZ, Leipzig, aims to further develop the innovative, climate friendly Capraferm process, which enables the conversion of beet leaves into carboxylic acids that can be used as starting materials for high-quality chemicals for example, as additives in lubricants, detergents or feed additives or can be esterified in a further step. (Helmholtz Centre for Environmental Research, 2023.)

All three solutions fulfil Cosun Beet's need to convert sugar beet residues from waste into value. Each of the three proposed solutions requires additional research and development, necessitating external funding. For one project, initial laboratory trials have already commenced. Furthermore, preparations are underway for a funding application to establish a demonstration plant in Anklam. Participation in the hackathon significantly contributed to regional support for these initiatives. It looks certain that Cosun Beet will reap the fruits of the hackathon still for many years to come as the ideas are tested and commercially scalable innovations emerge from the trials and launched co-operations.

Picture 7. Winning team CAPitalize Leaves (Photographer: Cosun Beet Company)

Info box: Cosun Beet Hackathon	
Challenge	Transforming Sugar Beet Residues from Waste to Value
Target groups	Innovators, startups, researchers, and technology providers focused on sustainable solutions in agriculture and biotechnology.
Organiser	WITENO GmbH, Greifswald, Germany WITENO GmbH has been driving technology and knowledge transfer for 30 years, connecting science and business. As the operator of office, laboratory, and production spaces, WITENO supports startups, young companies, and established SMEs on their path to growth and success, while also offering business development consulting and engaging in regional and national networks and projects.
Mentors	CosunBeet Company (Germany), INP Greifswald (Germany), Universität Greifswald (Germany), Nachhaltigkeitsforum (Germany), BioFuel Region (Sweden), Danish Teknologisk Institute (Denmark), BioCompost (Sweden), Stormossen (Finland)
Hackathon days	April 16–17, 2024 in Anklam, Mecklenburg Western Pomerania, Germany
Applicants	25 applications – 12 Germany, 5 from Finland, 3 from Sweden, 2 from Poland, 1 from Norway, 1 from Belgium, and 1 from Hungary
Selected teams	10 teams – 6 from Germany, 2 from Finland, 1 from Belgium and 1 from Norway
Winners	Team n-fix from Belgium Team Vinasse2Proteins from Biberach University of Applied Sciences, Germany Team CAPitalize Leaves, a consortium of the Helmholtz Centre for Environmental Research UFZ and the German Biomass Research Centre DBFZ, Leipzig, Germany
Impact	Approximately 2 million tons of sugar beets are processed each year from September to January, with intermediate products stored and bioethanol and biomethane produced throughout the year at the Anklam Factory. 

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Harnessing Open Innovation for Green Biomass Valorisation with Võiste Greenhouses

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In recent years, the global push for sustainability has sharpened the focus on the circular bioeconomy, prompting industries across various sectors to innovate in ways that reduce waste and maximize resource efficiency. A notable example of this trend is the recent BioBoosters Võiste Hackathon, which highlighted the power of open innovation in tackling complex challenges to biomass valorisation within the horticulture sector. At the heart of this process was Võiste Greenhouse, one of Estonia's leading horticulture companies that is embracing green transition through collaborative, international innovation. (Pärnumaa Arenduskeskus, 2024.)

With rising production costs and Estonia's challenging growing conditions — unable to compete with the sunny and warm climates of Western and Southern Europe — the horticulture sector in the region has faced significant economic pressures. To remain competitive, Võiste Greenhouse has adopted smart production principles, investing in automation and precision fertilization to lower costs and enhance productivity. Furthermore, the company has expanded its focus on research and innovation, creating spin-off ventures which collaborate with universities and have turned Võiste's production site into a living lab for R&D, showcasing the company's commitment to sustainable development.

Picture 1. Mirko Metsaoru, Owner of Võiste Greenhouse (Photographer: Kristi Kuusmik-Orav)

As one of the largest producers of greenhouse tomatoes in Estonia, the family-owned Võiste Greenhouse has played a significant role in the local economy by supplying fresh, locally grown produce for over two decades. The company's commitment to sustainability and quality is evident in its short supply chain and eco-friendly growing practices. In recent years, Võiste Greenhouse has also focused on integrating circular economy principles, aiming to transform its horticultural residue biomass into valuable resources, thus reducing waste and increasing operational sustainability. (Pärnumaa infovärav, 2024; Võiste Aiand, 2024.)

This waste, consisting of plant residues such as stems, leaves, roots, and non-standard tomatoes, represents not just an environmental burden but also a missed opportunity, hence the company's need for a solution that would transform organic material from a disposal problem into a valuable resource. As a rural bioeconomy company, finding such a solution required expertise beyond their immediate reach. This is where the concept of open innovation, facilitated through the BioBoosters innovation community, became invaluable.

Setting the Stage for Circular Horticulture: The Context of Võiste's Challenge

In a greenhouse, plants convert water, fertilizer, and CO_2 into biomass. For certain crops, the entire plant is harvested, but for tomatoes, only a portion of the biomass — mainly the fruit — reaches consumers. The remaining biomass, including roots, leaves, stems, and non-standard fruits, is typically considered organic waste. However, greenhouse biomass holds potential for creating new value chains. By-products like stems, leaves, and unsellable produce can be repurposed into various valuable products such as salts for fertilizers, organic matter for growing media, bio-stimulants, fibres for sustainable packaging, proteins for food and feed, and compounds for cosmetics and pharmaceuticals. These opportunities support circular economy by reducing waste and generating both environmental and economic value for the agricultural sector.

With the wealth of research on the topic of valorising biomass and residual flows, one of the guiding visions for the future of greenhouse horticulture in a circular economy is to phase out dependence on finite natural resources and instead rely on local, renewable sources. By closing material cycles and collaborating with other sectors, greenhouse production can become more sustainable and resource efficient. As shown by van Tuyll van Serooskerken et al. (2022, 9) even in a high-tech greenhouse system, the resource efficiency is far from 100%; from the three main inputs, water, carbon and nutrients, only 92, 85 and 49 per cent respectively end up in the tomato fruit yield. This means that even half of the nutrient input is in the residual biomass (stems, leaves and roots) presenting a potential for circulation of nutrients within greenhouse horticulture or cross-over exchange of material to other processes. (van Tuyll van Serooskerken et al. 2022, 9.)

Bringing Together International Expertise and A Diverse Pool of Innovators

The BioBoosters Võiste Hackathon, held on May 16–17, 2024, at the Pärnu County Development Centre's Innovation Hub, was a significant milestone in Võiste Greenhouse's sustainability efforts. Organized in collaboration with nine bioeconomy innovation hubs from the Baltic Sea Region, the event brought together international teams and mentors to explore sustainable solutions for biomass valorisation in tomato horticulture. One of the key strengths of the hackathon was the diversity of its participants. During the Hackathon days, six international teams from Sweden, Finland, Poland, and Estonia brought

unique perspectives, supported by twelve mentors, creating an environment conducive to collaboration and innovation. (BioBoosters, 2024.)

The diversity was not just geographical but also disciplinary. The mix of skills enabled solutions that were innovative, practical, and scalable, with a range of approaches from small-scale processes to market-ready solutions and high-research potential projects. For example, Estonian company Mahlametsa offered a small-scale solution by turning Võiste's non-standard tomatoes into tomato juice and soup, showcasing the potential for local production with minimal environmental impact (Mahlametsa). Meanwhile, NPO Veggies Cultivation from Estonia proposed converting tomato waste into fertilizers through Bokashi technology, emphasizing nutrient recovery with zero CO_2 emissions (NPO Veggies Cultivation). At a larger scale, Swedish company WA3RM aimed to utilize tomato biomass for mushroom cultivation, demonstrating how waste could be converted into a new agricultural product (Wa3rm).

Other participants included Team Biochar (Politechnika Bydgoska) from Poland, which suggested producing biochar from biomass, contributing both environmental and commercial value to residual flows, and Finnish startup Three Mushketeers (Three Mushketeers), which explored transforming horticultural by-products into multifunctional food ingredients and enriching both food and cosmetics value chains. Biocompost AB (Biocompost) from Sweden offered an efficient, eco-friendly approach to turning greenhouse biomass into nutrient-rich compost, by creating a closed-loop system, while minimizing the overall climate footprint and supporting sustainable farming practices and returning the needed CO_2 to the greenhouse.

These varied solutions — ranging from local, small-scale repurposing to high-value, scalable innovations — gave Võiste and the mentors a rich pool of alternatives to consider, each offering unique pathways for integrating circular economy principles into greenhouse operations. The diversity of approaches allowed for a comprehensive evaluation of alternatives, each with its own strengths in terms of scale, sustainability, and readiness for implementation.

Highlight of the Hackathon: The Winning Solution from Biochar

The highlight of the hackathon was the announcement of the winning team — 'Team Biochar' from Bydgoszcz University of Science and Technology in Poland. Their solution to convert greenhouse biomass into biochar stood out for its innovativeness, economic viability, technical feasibility, and environmental impact. Biochar, a stable form of carbon created through the

pyrolysis of organic material, has multiple applications, e.g. it can be used as a fertilizer, a soil improver, a filtration material, a cosmetics ingredient, a phytotoxins absorber, and much more (International Biochar Initiative, 2024a).

This solution was particularly appealing to Võiste Greenhouse because it addressed multiple challenges at once. Not only did it offer a way to manage biomass waste sustainably, but it also created a new product that could enhance soil health and potentially generate additional revenue streams for the company. Biochar, created through pyrolysis, transforms organic waste into a stable carbon form, providing numerous benefits for soil health and carbon sequestration (International Biochar Initiative, 2024b). Similar circular initiatives have already been proven successful elsewhere, especially in the Netherlands with its innovative greenhouse horticulture sector, but also in Sweden, where WA3RM, one of the participants also at Võiste Hackathon, has demonstrated how greenhouses can benefit from waste heat capture and reuse to grow food products (Wa3rm). The solution also aligns with Estonia's environmental goals, providing a way to reduce greenhouse emissions while creating economic opportunities. By looking at suitably scaled industrial symbiosis models, Võiste Greenhouse can now integrate the biomass valorisation process into its operations, significantly reducing environmental impact while boosting its sustainability credentials.

Picture 2. Team Biochar – Winner of the Võiste Hackathon. (Photographer: Kristi Kuusmik-Orav)

The Power of Open Innovation: A Collaborative Approach to Problem-Solving

The success of the BioBoosters Võiste Hackathon underscores the power of open innovation in solving complex, real-world problems. Unlike traditional innovation processes, which often occur within the confines of a single organisation, open innovation leverages external ideas and expertise. It involves collaborating with partners, including startups, universities, research institutions, and other organisations, to develop and implement innovative solutions. (Bogers et al., 2018.)

In the case of Võiste Greenhouse, open innovation was not just a buzzword — it was a practical approach that delivered tangible results. By opening up their biomass challenge to a broader pool of talent and expertise, they were able to identify a solution that might not have emerged through internal efforts alone. The hackathon provided a platform for these external innovators to engage directly with the challenge provider, as well as with the international mentors, testing and refining their ideas in real-time.

Simultaneously, beyond the international collaboration, another significant partnership was developed at the hackathon between two Estonian companies: Võiste Greenhouse and Mahlametsa. Although the companies are relatively close geographically, it was through the hackathon that they connected and realized an opportunity for collaboration. Mahlametsa, also a rural company, producing fresh juices and ice-cream, is currently already helping Võiste to valorise their surplus tomatoes by producing tomato juice under a private label. This solution effectively addresses Võiste's seasonal surplus of non-marketable tomatoes, transforming waste into a new product and demonstrating a very practical circular economy approach. The connection forged at the hackathon has led to an ongoing collaboration, with both companies benefiting from this sustainable venture.

Picture 3. Võiste tomato juice by Mahlametsa (Photographer: Terje Mitev)

From Hackathon to Reality: The Next Steps in a Promising Partnership

With the hackathon concluded, the collaboration between Biochar and Võiste Greenhouse is now focused on bringing the biochar solution to life. The first step involves testing the biochemical properties of biochar produced from Võiste's green biomass using pyrolysis technology. This pilot phase is crucial for fine-tuning the technology and ensuring that it meets both environmental and economic goals. If the initial tests prove successful, with biochar samples demonstrating significant improvements in soil quality, the partnership will progress to scaling up production and exploring commercial opportunities for biochar.

The potential impact of this collaboration extends beyond Võiste Greenhouse. Team Biochar's solution offers a scalable approach that could be adopted by other greenhouse operations in many countries. By turning waste into a resource, this innovation contributes to the circular bioeconomy and supports sustainable agriculture practices. Interviewed after the hackathon, Piotr Wojewódzki from Team Biochar is excited to see how the co-operation evolves. The team believes that the hackathon was just the beginning and biochar solutions have the potential to enhance greenhouse operations not just in Estonia, but globally.

The BioBoosters Võiste Hackathon exemplified how innovation challenges can spark impactful partnerships. Whether through local co-operation or international collaboration, the event has shown that hackathons can not only generate innovative solutions but also foster business relationships that contribute to the green transition. With both the biochar and tomato juice projects now moving from concept to reality, these partnerships illustrate the power of open innovation in advancing sustainability.

Picture 4. Participants at the BioBoosters Võiste Hackathon in Pärnu (Photographer: Kristi Kuusmik-Orav)

Part of a Larger Movement: The BioBoosters

The BioBoosters Võiste Hackathon is part of a larger initiative known as the BioBoosters project, led by Jamk University of Applied Sciences and co-funded by the Interreg Baltic Sea Region Programme. The project aims to support responsible business practices and the transition to a circular economy by organizing 18 hackathons across the Baltic Sea Region. These hackathons are designed to address specific challenges faced by bioeconomy companies and to foster collaboration between industry, academia, and other stakeholders. (BioBoosters, 2023.)

What sets the BioBoosters demand-driven hackathon model apart from other models of open innovation is its focus on a single company with a clear circular bioeconomy challenge. This approach allows for deep, business-oriented R&D collaboration, with the hackathon serving as a platform for SMEs, startups, and research teams to test and develop their ideas in dialogue with a potential customer and a variety of mentors and experts. The flexible process can be adapted to different formats, whether fully on-site, fully

online, or hybrid, ensuring that the event can be tailored to the needs of the participants.

For Võiste Greenhouse, participating in the BioBoosters Hackathon was not just about finding a solution to their biomass challenge—it was also about building a network of industry experts and solution providers that they can draw on for future projects. This network, which includes both national and international partners, is invaluable as the company continues to explore and develop circular business models.

The Road Ahead

The BioBoosters Võiste Hackathon, held in Pärnu County in Estonia serves as a compelling example of how regional innovation systems can drive the green transition through open collaboration. By integrating bio-based solutions, the event, besides addressing the immediate needs of Võiste Greenhouse, also enhanced the wider regional bioeconomy, as the hackathon fostered co-operation between academia, industry, and local authorities, emphasizing the importance of valorising local biomass resources.

The success of the event can be attributed to its alignment with broader initiatives such as the Estonian Circular Bioeconomy Roadmap and the national smart specialization strategy (Ministry of Regional Affairs and Agriculture, 2023). These initiatives aim to transform waste into valuable resources, supporting economic growth while reducing environmental impact. The hackathon model facilitated the creation of new partnerships, helping to strengthen the regional innovation ecosystem in Pärnu County.

For Pärnu County Development Centre, the event marked a significant milestone in advancing circular bioeconomy strategies in the whole region of Western Estonia. The hackathon showcased the potential for collaborative international networks to drive environmental stewardship and economic resilience. Moreover, Võiste Greenhouse has become an inspiring regional example of how open innovation can convert biomass waste into value-added products, contributing to Estonia's overall sustainability goals (Invest in Estonia, 2021).

In conclusion, the BioBoosters Võiste Hackathon highlights the transformative power of open innovation in addressing global sustainability challenges. As these initiatives continue across the Baltic Sea Region, the BioBoosters network will play a key role in achieving a sustainable circular bioeconomy, benefiting both businesses and communities.

Info box: Võiste Hackathon	
Challenge	Mining the green gold from greenhouse biomass
Target groups	Entrepreneurs, scientific entities, research entities, academic/ student entities with solutions on valorising green biomass or non-standard tomatoes from the greenhouse production.
Organiser	Pärnu County Development Centre, Estonia Centre steers the development of Pärnu County, develops entrepreneurship, youth entrepreneurship and entrepreneurial education, and civic engagement. The regional Innovation Hub of Pärnu County is a future-oriented development accelerator for the whole region of Western Estonia, with focus on facilitating green transition and sustainable development, including circular bioeconomy and renewable energy.
Mentors	Võiste Aiand (Estonia), Rural Network Unit of the Centre of Estonian Rural Research and Knowledge (Estonia), Tehnopol (Estonia), Jamk University of Applied Sciences, Institute of Bioeconomy (Finland), Estonian University of Life Sciences (Estonia), BioFuel Region (Sweden), WITENO (Germany), Pro Civis Foundation (Poland)
Hackathon days	16–17 May, 2024 in Pärnu, Estonia
Applicants	12 applications – 4 from Estonia, 3 from Sweden, 3 from Finland, and 2 from Poland
Selected teams	9 teams – 3 from Estonia, 2 from Sweden, 2 from Finland, and 2 from Poland
Winner	Biochar from Bydgoszcz University of Science and Technology in Poland. Their solution was to convert greenhouse biomass into biochar, which can be used in a multitude of ways, e.g. as a fertilizer, soil improver, filtration material, cosmetics ingredient, and phytotoxins absorber.
Impact	Every year, from April to October, up to 50 tons per season of biomass consisting of roots, stems, leaves and non-standard tomatoes (5–7 tons per month) is produced and needs to be disposed of. Estimated impact of the solution is to reduce that amount by at least 50%. 

VÕISTE CHALLENGE WAS ALSO TACKLED BY LIFE-LONG LEARNING STUDENTS AT JAMK UNIVERSITY OF APPLIED SCIENCES

In April 2024, before the actual Võiste Hackathon, continuing education students from the circular economy and sustainability course developed a wide range of innovative solutions to up-cycle tomato production by-products. The students had very large competence background from agrologist to business, tourism and engineering. While the solutions were interesting, there were no stakeholders to implement them. Jamk University of Applied Sciences shared these solutions with Võiste, who found them interesting.

Range of ideas was as impressive as in the actual hackathon. One idea was to fibre the tomato stems and use them in cardboard production for tomato transportation boxes. The fibres could also be suitable for T-shirt fabric production. Additionally, the fibres could be used to produce biodegradable strings to hang growing tomatoes, avoiding the harmful plastics among biobased by-products.

The students also proposed solutions for non-standard tomatoes. Võiste could collaborate with a café to convert these tomatoes into soups, pickles, or salads. Another suggestion was to squeeze the tomatoes into raw tomato juice, as one team proposed during the actual Hackathon. Donating non-standard tomatoes to a food bank for those in need was another option, enhancing Võiste's social sustainability.

Alternatively, Võiste could process all the side streams in an industrial-sized biomass compactor. The nutrient-rich output could be used as tomato fertilizer, and the remaining mass could be utilized in a biogas production plant. This would recycle nutrients back into the growth process, and the dried leftover mass would be easier to transport due to its reduced weight.

From the perspective of the teacher of the students, the real challenge is always motivating. It also gave an exceptional point of view to act as a mentor in the real Hackathon.

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Closing Words: Zooming in on the Sustainability of the Inter-regional Co-operation

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In this publication, the BioBoosters network has brought forward nine challenges of circular transition presented by bioeconomy companies across the Baltic Sea Region. These challenges have been tackled by the means of BioBoosters hackathon; an open innovation process implemented in inter-regional co-operation. The experiences of applying open innovation process and connecting macro-regional networks have been explored along with the solutions found and validated in the BioBoosters Hackathon journeys.

What is next in line for the BioBoosters network and innovation community? In autumn 2024, the second round of BioBoosters Hackathons is launched across the Baltic Sea Region. Nine new challenges, new partnerships, and open innovation process improvements via continuous learning are on the way. For the second Hackathon round, the key questions to explore are the expectations of the BioBoosters network and our readiness for the post-project phase.

Picture 1. BioBoosters team in Tartu having a project meeting and workshops for evaluation of the results of first four Hackathons

Every Hackathon is a Lesson Learned

In this article, the BioBoosters evaluation team attempts to synthesize the key findings related to the impact and viability of the BioBoosters Hackathon. Before exploring the results, let us take one step back and start with the imperative question – why? What is the purpose of implementing 18 business-driven hackathons in inter-regional co-operation? The open innovation process implemented in each BioBoosters Hackathon had already been proven effective in collaboration with 15 companies by Jamk University of Applied Sciences by the time the international piloting was launched, so why do we need to carry out 18 more hackathons to establish the viability of the model?

While the open innovation process itself has not changed notably, the fact that there is a network of nine regions from seven countries collaboratively running the process is a complete game changer. The inter-regional co-operation raises several key questions such as:

- What is the added value of the inter-regional co-operation? What complementary strengths our regions have? What types of partnerships are beneficial for the innovation community?
- Is the model developed in the context of Finland applicable to the other countries in the Baltic Sea Region and beyond? How can we facilitate the uptake and transfer of the model to new partners?
- How can the inter-regional co-operation be sustained in a cost-effective manner post-project? How to keep the international innovation community engaged post-project? What tools does the innovation community need to maintain the inter-regional co-operation?

Our piloting is aimed to analyse the transferability and viability of the BioBoosters Hackathon model for long-term application by the connected regions and beyond. As per the BioBoosters Hackathon Evaluation Plan (2023, 3), the analysis is based on four evaluation criteria:

1. Relevance
2. Effectiveness
3. Impact
4. Sustainability

The piloting is implemented in two rounds. After completing the first iteration, we are able to pause and reflect before the next round. All partners have at least six months to recap and recover – to collect the lessons learned and plan the way forward. In May 2024, after analysing the data from the first nine BioBoosters Hackathons, the BioBoosters evaluation team consisting of representatives from Jamk University of Applied Sciences and Pro Civis Foundation, presented first conclusions and recommendations for the second pilot round.

Strong Delivery of Innovative Solutions and Value Creation

As the nine hackathon stories featured in this publication have showcased, the range of the challenges put forward in the first round of nine BioBoosters hackathons was far reaching and comprising most of the key and current topics of the European and global circular bioeconomy agenda. The

challenges of Valio, Aloja Starkelsen and Nando highlight the need of the biobased industries to opt data-based management of the biomass flows for enhancing sustainability. Challenges featuring Moelven, Targi Kielce and Fibenol, demonstrate the industries' need to discover and commercialize new biobased ingredients, materials, and products to bring higher value to the biomass and to replace fossil alternatives. Thirdly, the articles on Holmen, Cosun Beet and Võiste have explored the challenges of bioeconomy sectors to create new value chains from side streams and residues. The range of the challenges depicts the circular transition needs of the bioeconomy sectors in the Baltic Sea Region, as well as reflects the EU and global drive towards sustainable and circular bioeconomy.

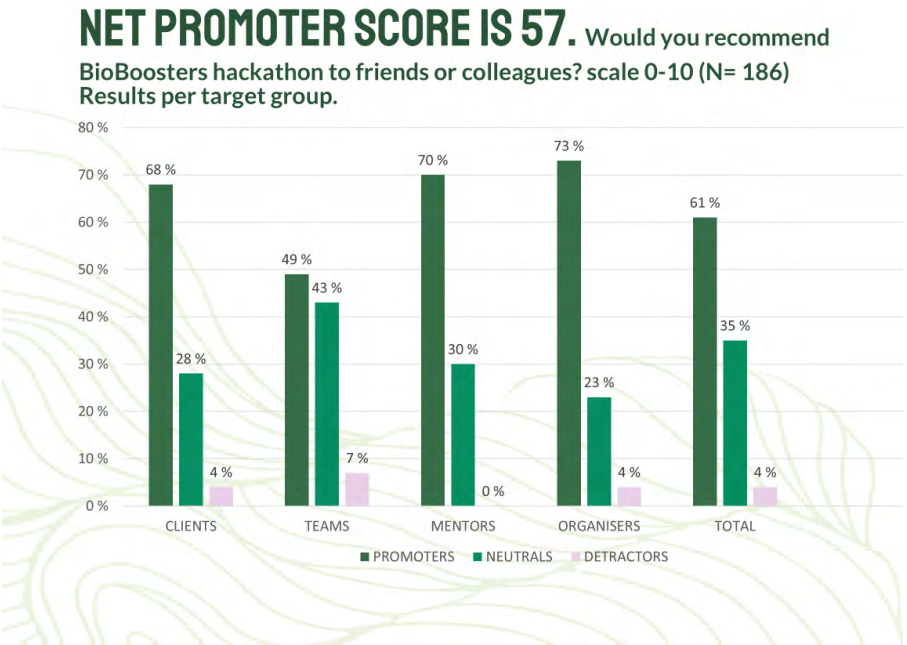
Reviewing the 123 applicants and their solution proposals as well as the 64 selected teams, it can be also noted that the hackathons have delivered strongly on the innovative solution ideas and concepts. It seems that the proposed products, services, methods, and models are responding to the given circular bioeconomy challenges in novel and market-oriented ways. Looking at the responses to the feedback survey from the challenge providers (mainly large companies), the impact of the open innovation process has been significant (Olesiak et al., 2024):

- 96 per cent of the respondents reported high or moderate impact to finding promising solution ideas for solving the challenge (N =26, response rate 57%);
- 96 per cent of the respondents mostly or totally agreed that BioBoosters hackathon is a good tool for large company to grow international research, development, and innovation networks (N =24, response rate 52%);
- 100 per cent of the respondents mostly or totally agreed that BioBoosters hackathon is a good tool for a large company to grow national research, development, and innovation networks (N =24, response rate 52%);
- 100 per cent of the respondents mostly or totally agreed that BioBoosters hackathon is a good tool for large company to connect with small-scale innovators (N =24, response rate 52%); and
- 100 per cent of the respondents mostly or totally agreed that BioBoosters hackathon is a good tool for large company to get out-of-box ideas and new perspectives on a challenge (N =24, response rate 52%).

What is important to note is that 96 per cent of the respondents reported a high likelihood of their company working with the organiser on another hackathon challenge within the next three years (N =25, response rate 54%). This strong loyalty of the target groups is also reflected in the responses of the solution provider teams and mentors (Olesiak et al., 2024.):

- 90 per cent of the respondents representing the solution provider teams reported a high likelihood of their team participating in another hackathon challenge within the next three years (N = 84, response rate 59%).
- 96 per cent of the mentors reported a high likelihood of participating as a mentor in another hackathon challenge within the next three years (N = 55, response rate 64%). (Olesiak et al., 2024.)

The loyalty of the target groups is also shown by the Net Promoter Score (NPS) of 57 which can be considered very high (Picture 2). In the NPS, the target group is asked if they would recommend BioBoosters hackathon to friends or colleagues. Responses are given on a scale of 0–10. Respondents are considered to be promoters if they answer 9–10 and neutral if they respond 7–8. The respondents giving a score of 6 or lower are considered detractors. The percentage of detractors is decreased from the percentage of promoters to get the NPS. The share of 'promoters' in the BioBoosters hackathons has been high – 68 per cent of challenge providers, 49 per cent of teams, 79 per cent of mentors and 73 per cent of organisers would gladly and full heartedly recommend BioBoosters hackathon to a friend of colleague.



Picture 2. Net Promoter Score of the nine BioBoosters Hackathons in 09/2023-05/2024 (adapted from Olesiak et al. 2024, 46).

Why do the teams and mentors hope to return to the hackathon ride? The main benefits highlighted by the solution provider teams included ability to enter into a dialogue with large companies (95%), getting visibility for their team's expertise (96%), getting an opportunity to validate a business idea or a proof of concept (90%) and building partnerships for idea testing and commercialization (93%). Most notable impact for the teams was reported to come from the gained knowhow from mentoring (95%). In turn, the mentors had experienced the benefits from learning on real-world application of circular bioeconomy business models (78%), growing relevant RDI networks (73%), gaining visibility (75%) and validation (71%) for their professional expertise as well as being able to make an impact on the innovation journey of the participating teams (82%). (Olesiak et al., 2024.)

In addition, all organisers reported a high likelihood and motivation for continuing to organise BioBoosters hackathons also after the project lifetime. It demonstrates that BioBoosters hackathons can strengthen the supportive

potential of regional innovation hubs, by presenting to them an open innovation model, which at the same time boosts the circular and green transition as well as offers growth opportunities to the regional businesses. The open innovation method enables a regional innovation hub to build partnerships to solve arising challenges in a flexible manner and by utilizing the needed functionalities of existing regional innovation ecosystems. Furthermore, the model allows for the interregional exchange of know-how and innovative insights. (Olesiak et al., 2024.)

These regional innovation system impacts are highlighted also in the feedback survey responses of the organising teams (Olesiak et al., 2024.):

- 96 per cent of the respondents agree that BioBoosters Hackathon supports green transition in the Baltic Sea Region (N = 25, response rate 78%);
- 96 per cent of the respondents agree that BioBoosters Hackathon supports growth in bioeconomy sectors in the Baltic Sea Region (N = 25, response rate 78%);
- 96 per cent of the respondents agree that BioBoosters Hackathon initiates business-driven research, development, and innovation activities in regional context (N = 25, response rate 78%); &
- 96 per cent of the respondents agree that BioBoosters Hackathon model is transferable to other Hackathon organisers in the Baltic Sea Region (N = 25, response rate 78%).

The above presented results and conclusions demonstrate and give very unequivocal responses to the initially posed inquiries about the added value of inter-regional co-operation in the Baltic Sea Region aiming at strengthening the innovativeness as well as the circular and green transition. The responses are positive – the Finnish model is applicable to other BSR countries, and it strengthens the innovative potential of the given regional (and rural) innovation ecosystems. The inter-regional co-operation proves potential to be a strong development factor for the whole BSR, as well as for the individual regional structures represented in the BioBoosters.

Still More to Learn and Share

As shown by the feedback surveys administrated to the Hackathon participants, the value propositions to challenge providers, solution providers, mentors and organisers have been successfully maintained and the overall Hackathon

journey experience has been evaluated very positively. However, looking at the data in details to compare the responses between the individual Hackathons, the differences in value capturing by the target groups have been high in many questions. (Olesiak et al., 2024, 5.) Most notably the variation can be seen in the responses of the mentors, for example, when asked about the created values for the mentors in terms of opportunities to establish networks.

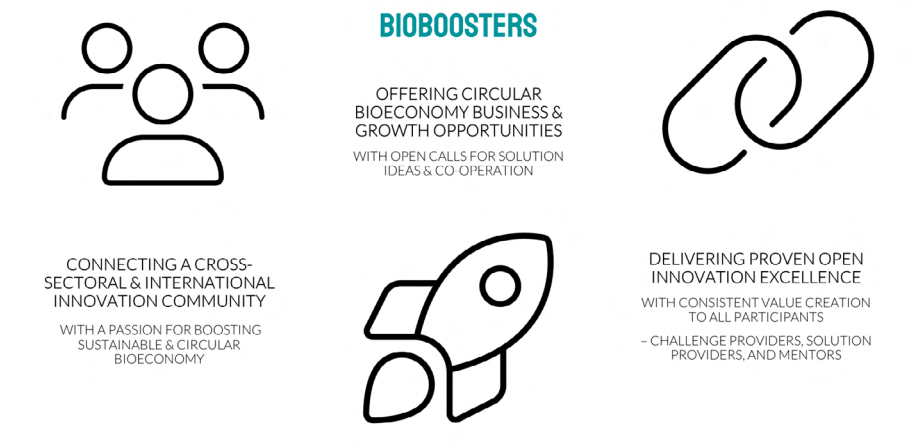
It is necessary to conclude that there are lessons on organisation practices to be transferred among the organisers and some aspects of the process might benefit from greater standardization. In the coming hackathons, the BioBoosters team aims to focus especially on more consistent value delivery to the mentors. Key actions recommended in the mid-term review include e.g. early involvement of the mentors to the hackathon process, systematic guidance to the mentoring role, increased interaction between the mentors, and feedback provision from solution provider teams to mentors. (Olesiak et al., 2024, 5.) Furthermore, attention is paid to consistency in the provision of international mentors to all hackathons.

Other identified standardization needs relate to the pitching guidance for teams and the hybrid facilitation. Although, the onsite participation is preferable on Hackathon days for networking purposes and better engagement, it is necessary to have a workable approach to hybrid participation. Hybrid facilitation knowhow supports a positive online participation experience. As highlighted in the mid-term evaluation report, a well-functioning hybrid format is a must-have for cost-effective long-term adoption of the international hackathon model. (Olesiak et al., 2024, 5.)

Even if the main process flow is shared, there is still a lot the partners can learn from one another. All organisers are bringing their past experiences and knowhow to the process, and it has been very inspiring to witness the hackathons in other countries and regions. In fact, as a lesson learned from the first hackathons, the BioBoosters network members are aiming to increasingly engage onsite at the hackathons organised by other partners. Seeing and experiencing the hackathon organised by a partner, in the role of a mentor or co-organiser, is a chance to benchmark and adopt the good practices of partners as well as to reflect on the own organisation approach. Furthermore, the partnership is engaged in a continuous sharing, collecting, analysing and documenting of the demonstrated good practices by the nine hackathon organisers via online platforms.

Working Towards a Durable but Flexible and Responsive Co-operation

Looking at the convincing results of the first nine hackathons, it has been concluded that the second pilot round should focus on building the sustainability of the inter-regional co-operation in the post-project time. Our findings suggest that BioBoosters hackathon can be successfully applied as a platform for initiating inter-regional (and regional) business-driven RDI co-operation to boost circular transition in the bioeconomy sectors. BioBoosters has a proven potential to strengthen innovation capacity of the rural bioeconomy regions around the Baltic Sea. Hackathons offer a platform for inter-regional stakeholder dialogue where the business interests are in the centre. For all target groups and participants, the BioBoosters hackathon process offers a good value for the time spent and a promising return on investment.



Picture 3. BioBoosters Vision as approved by the BioBoosters Steering Group on June 4, 2024 (adapted from Aalto, 2024).

As the relevance, effectiveness and impact are largely established, the long-term adaptation of the co-operation and service model should be the key focus of the second pilot round. As approved by the BioBoosters Steering Group on June 4, 2024, long-term vision for the BioBoosters network is

founded on three interdependent value propositions, as illustrated in Picture 3. Firstly, our network will offer up to 10 Open Calls annually, each addressing sustainable and circular bioeconomy challenges and presenting business opportunities for the winning teams. We anticipate diverse resourcing and new project initiatives, as well as service sales, to drive these calls through our partnerships. (BioBoosters, 2024.)

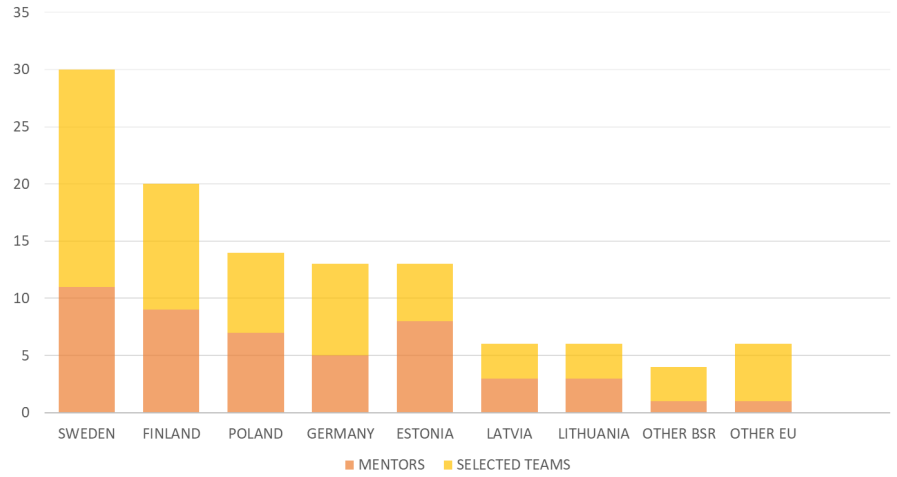
Secondly, our network brings together an expanding community of circular bioeconomy experts from both business and research sectors. These individuals, whether alumni of past hackathons or network connections of our partners, actively follow our open calls for solutions, and their outcomes. Within the circular bioeconomy development community, BioBoosters is a well-recognized brand, known for its anticipated open innovation calls and events. (BioBoosters, 2024.)

Thirdly, our proven open innovation method provides organisers with a comprehensive toolbox to address challenges in marketing, active scouting, and process management. This high-value brand for open innovation enhances our partners' value propositions for international development projects and private financing opportunities, ensuring a steady stream of open innovation calls. (BioBoosters, 2024.)

To elaborate further the potential of the BioBoosters hackathons as a platform for inter-regional smart specialization co-operation, more detailed analysis of the achievement of the core elements of inter-regional Entrepreneurial Discovery Process (EDP), and the long-term viability of the BioBoosters Hackathon activities shall be explored with the full data available on 18 BioBoosters hackathons by June 2025.

Setting our Sight on Sustainability

To work on the sustainability and durability of the activities within the international innovation community, it is important to address some of the key concerns raised by the mid-term data, such as the need of standardization addressed earlier in this article. In addition, the variation in the level of international participation between hackathons and between countries in the Baltic Sea Region require further assessment and analysis (Picture 4).



Picture 4. Origin countries of the mentors and selected teams (Olesiak et al. 2024, 44).

As the process is tailored to the needs and priorities of the challenge provider, variation is to be expected on the level of individual hackathons; however, it is also important to further study the challenge and country specific differences between the target group needs and expectations related to open innovation process. All in all, 112 organisations took part in the BioBoosters hackathon in autumn 2023 – spring 2024 as teams and mentors. Representation has been strong in many countries; however, the Baltic countries seem to suffer from a 'saturated' hackathon market as there are numerous 'hackathons' competing for attention. Consistent brand building, targeted specialization with the unique value proposition and international profile can alleviate this issue; still, follow-up is needed on the effects and implications.

Setting our sight on the durability of the Hackathon model adoption and co-operation, the partnership needs to work especially on the national adaptation, focus areas, and funding. Understanding the terms and restrictions as well as the operating environment for hackathon organisation in the connected countries and for the connected partners is a necessary precondition to successful integration of the BioBoosters hackathon to each region. Partners will be driving forward the integration of the Hackathon model to their operations already during the second pilot round with support of collaborative learning and experience exchange.

In 2024–2025, our piloting continues to demonstrate that there is a continuing demand for the BioBoosters hackathons as a springboard for co-operation and innovation in the dynamically developing substantive area of circular bioeconomy in the Baltic Sea Region. Our aim is to prove that co-organizing as a network is more cost-effective, and more impactful. This mission will guide our efforts through the next nine hackathons scheduled for autumn 2024 and spring 2025. (BioBoosters, 2024.)

Stay tuned, the results to be reported in the 'BioBoosters Impact Review 2025'.

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This publication offers an overview of the impact of the BioBoosters Hackathon for boosting the circular transition of bioeconomy sectors in the Baltic Sea Region. The publication explores nine innovation journeys of leading bioeconomy companies that shared their challenges at the BioBoosters Hackathons organized in autumn 2023 and spring 2024. The impact stories highlight the impact of open innovation and inter-regional co-operation. The lessons learned from the hackathons boosted by the international innovation community are recounted and the conclusion is clear – BioBoosters Hackathon is making an impact! Hackathons are often a wild ride for the organiser but in the end, we are proud to share the results. Hope you will enjoy the journey with us.

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