Strategy for Innovation and Growth in Ostrobothnia 2022–2025

Smart specialisation

Regional Council of Ostrobothnia

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Strategy for innovation and growth in Ostrobothnia 2022–2025: Smart specialisation
Regional Council of Ostrobothnia 2022
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Content

> ***"The need for development is spurred by the region's strong exports and international economy."***

1. Introduction

Ostrobothnia needs innovations and reforms for the region to remain successful even in the future. The world is on the brink of change due to the digital and green transition. At the heart of this change are the digital industry, reduced CO2 emissions, increased circular economy, and reduced pressure from human activity on nature. The transition will create new competitive frameworks and requirements for reforms, but it will also open up great opportunities for Ostrobothnia's green growth for the next ten years (see e.g. IEA https://www.iea.org/reports/net-zero-by-2050, p. 81). The region needs swift action and focused efforts to support its entire innovation system's transformative capacity.

The need for development is spurred by the region's strong exports and international economy. In Ostrobothnia, the manufacturing industry's turnover of exports is 68% (2019), the third highest in the country (Statistics Finland, see Appendix 1). Industry in Ostrobothnia is built on advanced technology and a high level of expertise. The region's large businesses are global actors. In addition, the region is home to many exporting SMEs and new companies that target international markets from the start. Large export-heavy businesses with extensive regional subcontracting networks will continue to form the backbone of Ostrobothnia's export and economy.

In order to cope with the competition and create wellbeing, the region needs continuous investments in research and education in businesses, schools, universities, and the public sector. Global competition sets high requirements for businesses' innovative and transformative capacities – both in regard to global actors and regional subcontracting networks. Moreover, large businesses often experience intra-group competition for research and development funds. Ostrobothnia competes with its expertise and added value that are created in collaboration between the value chain's companies, in various consortiums that also involve public research and development, and in the development of global system solutions for the export market. Competition takes place between global systems and cooperation networks, not regions.

Ostrobothnia currently has a business-driven innovation system in which businesses – especially large ones – annually invest circa 200 MEUR in the development of innovations, whereas the public sector spends circa 30 MEUR. Education, along with

research and development supporting the creation of new competence and innovations, needs more regional public funds. Public contributions to new know-how and innovations are needed for the region's companies to survive in global competition, for the creation of new sectors of expertise and export, and for the region to attract new investments.

The strategy highlights four thematic priority areas that can help create growth through innovations:

- **Advanced Production Methods**
- **Digital Solutions**
- **Energy Technology and System Solutions for Renewable Energy Production**
- **Circular Economy and Carbon-Neutral Economy**

Ostrobothnia's selected priority areas are built on current strengths of the region's business life, research and development, and education. At the same time, the prioritisations are based on three global trends that affect Ostrobothnia's innovation system and future growth opportunities through innovation. These trends are digitalisation, climate change and renewable energy, and industrial modernisation and industry 4.0[1].

In addition, the selection of these prioritisations has been evaluated on the basis of the work of the Finnish Parliament's Committee for the Future (see A Hundred New Opportunities for Finland 2018-2037 and Towards a Better Future - Technological Opportunities and Threats to the Promotion of Sustainable Development). The prioritisations are also in line with EU's current guidelines: A New Industrial Strategy for Europe focusing on the industrial green and digital transition, A Digital Agenda for Europe, A European Green Deal, and The Recovery and Resilience Facility.

[1] Industry 4.0 is a term that is used to describe the increasingly compact entity that combines the Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR), advanced analytics, and advanced automation. (http://home.kpmg.com/fi/fi/home/Pinnalla/2018/02/teollisuus-4-0.html)

2. Starting Points of the Strategy

> ***"Ostrobothnia must map new growth sectors and purposely invest in them."***

The Strategy for Innovation and Growth in Ostrobothnia is based on smart specialisation as a method for regional development activities. The aim of smart specialisation is to identify and invest in priority areas within business life, research, and new technology in which the region excels and which can create new opportunities and strengths for the region. Its purpose is to strengthen the region's sustainable, inclusive, and smart economic growth. Emphasis will be placed on the development of expertise that creates conditions for the implementation of new solutions and operational models as well as for the creation of new business.

Regional and International Cooperation

The strategy leans on the strength of close regional cooperation between businesses, education, and the public sector, along with the region's ability to engage citizens and civil society in development work. The strategy should be regarded as a tool for the creation of an innovation system that widely spreads innovations and ties regional actors together so that they can understand each other's needs and, consequently, combine different skills and resources.

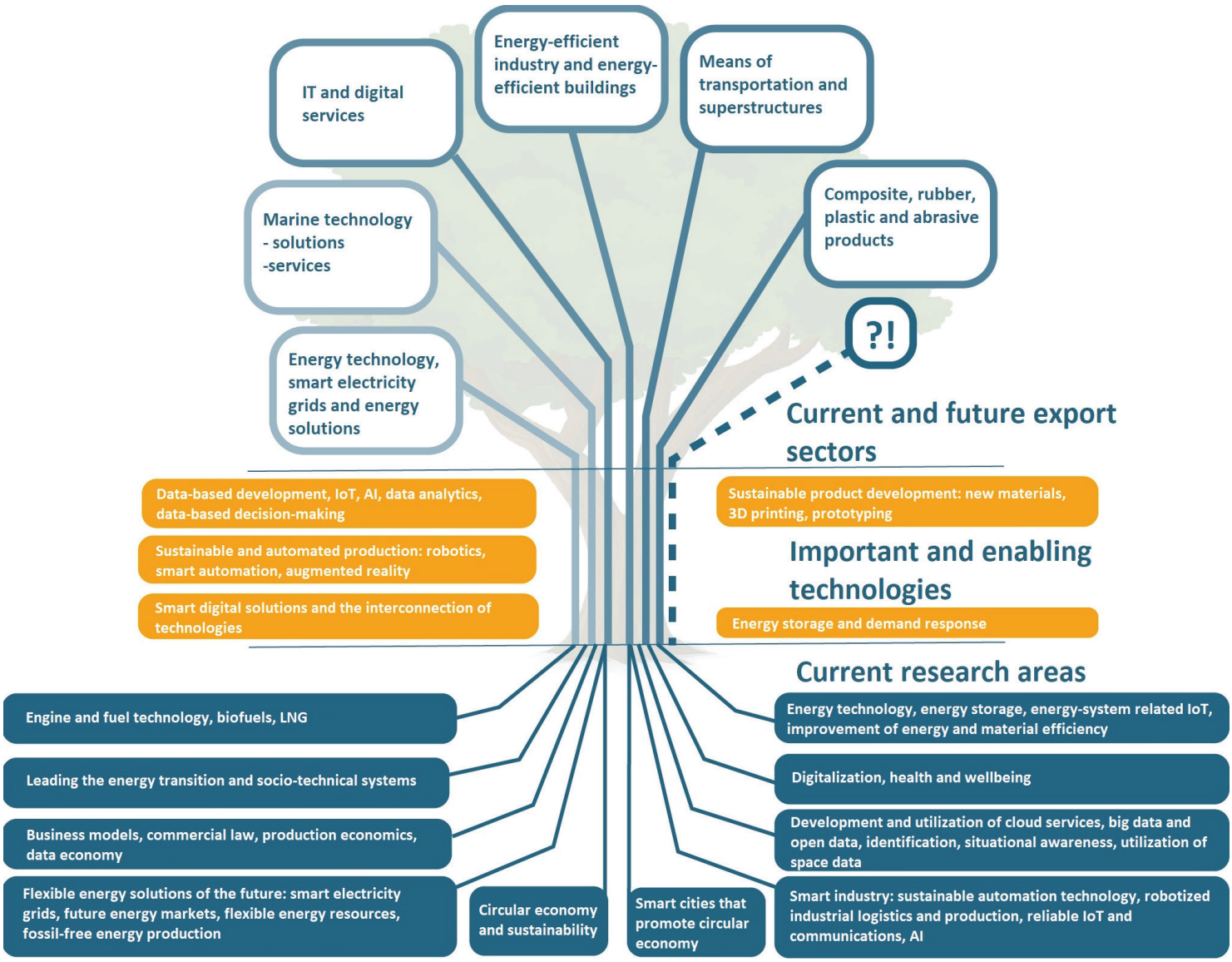
At the same time, international cooperation and transnational learning within business life, education, and the public sector are important. International cooperation is necessary for Ostrobothnia to acquire new expertise and find complementary collaboration partners from European and global value chains. The selected priority areas offer the region's actors opportunities to operate widely in the international arena. By clearly highlighting the region's prioritisations, the strategy also functions as a link to European partnerships and the EU's cooperation platforms between regions.

Manufacturing Industry

The strategy's important starting point is the manufacturing industry's need for change, new technology, and new expertise. Ostrobothnia is Finland's most industry-oriented region. The region's industrial turnover per inhabitant is 36,000 EUR, among the highest in the country. Production is based on a high level of technology and expertise, and Ostrobothnia's value added in manufacturing was the highest in the country in regional comparison (Statistics Finland, 2019). In the Vaasa region, the energy technology cluster's main sectors (machinery and equipment, electronic and electrical equipment, basic metal) produce more than half of Finland's added value in industry. The wood industry, pulp and paper industry, food industry, and the chemical industry are also central sectors, especially in the

Development of new areas of expertise and export sectors based on Ostrobothnia's current competence structure.

Figure 1.



Jakobstad region, whereas the manufacture of vehicle body structures is an important industry in Coastal Southern Ostrobothnia.

High productivity is a defining characteristic of Ostrobothnia, recently accompanied by a lower productivity growth than the national average (Honkatukia, 2021) . For instance, the value added in manufacturing by Ostrobothnian industrial companies was the highest in the country (2019), while the region's growth was the weakest in 2010–2019 (Statistics Finland). High productivity requires increasingly larger investments in research and development activities in order to maintain the same pace of innovation (see "Kortela / Finnish Broadcasting Company YLE, 2021"). Existing high productivity requires new approaches to increase value added. Therefore, investments built on new technology and digital solutions are necessary to create new modes of operations and change the logic of value creation (e.g. the transition from products to services and comprehensive solutions).

High export-intensity is typical for the region's manufacturing industry. Consequently, the industry is believed to possess successful innovation networks along with high demands in terms of product development and innovation activities. Regions tend to modernise and diversify in relation to existing functions; in other words, new and emerging business operations are often already connected to a region's existing strengths and expertise. Therefore, it can be said that Ostrobothnia's manufacturing industry has the best conditions to create innovations for growth in the future. This is why the manufacturing industry has been given a central role in the strategy's preparation. The strategy also emphasises the manufacturing industry's significance as an intermediary of expertise in relation to other sectors.

Development of New Areas of Expertise and Export Sectors

From the viewpoint of recovery, it is important that the region strives to find new and successful combinations from existing functions in order to support future development paths (see Figure 1). Ostrobothnia must map new growth sectors and purposely invest in them. The competitive diversification of a regional industrial structure refers to the reinforcement of existing strengths and knowledge resources, together with the increase of specialisation and the share of expertise unique to Ostrobothnia (see Elekes & Eriksson, 2021).

Horizontal Prioritisations and Transfer of Expertise

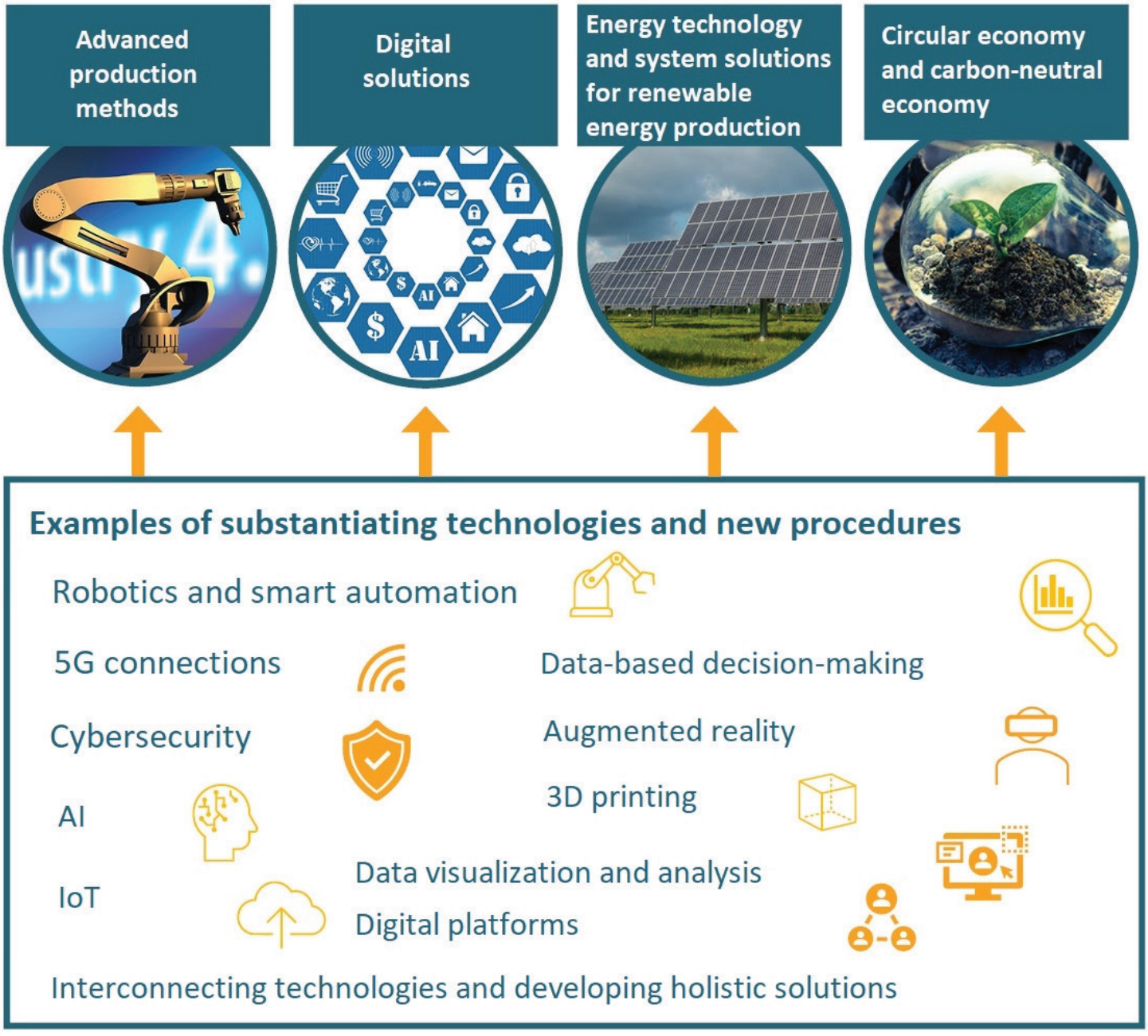
The strategy focuses on priority areas and technologies that horizontally support and promote various sectors. The priority areas are closely interconnected since they are largely based on similar technology competence and new modes of operation (see Figure 2). Therefore, they are also topical for several businesses – both in Ostrobothnia's industries and other sectors. In other words, the strategy's investments and development measures are targeted at more than one individual industry, and the strategy focuses on developing expertise that creates conditions for the implementation of new solutions and operating models.

A cross-sectoral transfer of expertise is necessary because the priority areas span various industries and are based on similar technologies. Owing to horizontal solutions, the innovation capacity and knowledge of different sectors and areas can be combined. One example of horizontal learning is the transfer of expertise related to advanced production methods, such as robotics and 3D printing, from industry to the social and health care sector and the agricultural sector. Moreover, new innovations and strengths can be found in interfaces between different sectors.

2. Honkatukia, J. (2021). "Maakuntien tuottavuus" (unoff. transl. "Report on the Productivity of Regions"). Unpublished material.

Towards a green and digital transition in Ostrobothnia – Horizontal prioritisations and technologies.

Figure 2.



2.1 Vision, Goals, and Priority Areas

The strategy highlights four thematic priority areas that can help create growth through innovations (see Figure 3).

The strategy's general goals:

- Improve the innovative and competitive capacity of SMEs and, consequently, enhance the operating conditions of large global businesses in the region's ecosystem.
- Improve the region's higher education institutions' ability to support the innovation activities of SMEs and complement research done in large businesses.
- Create a versatile business life and foster the birth of new functions and export industries in the region.

The strategy's target group consists of businesses, the educational sector, and the public sector and development organisations (triple helix). The strategy focuses on developing its underlying regional innovation system and strengthening cooperation between different actors with triple helix coordination. In this way, we can strengthen the businesses' innovative and competitive capacity as well as the region's transformative capacity.

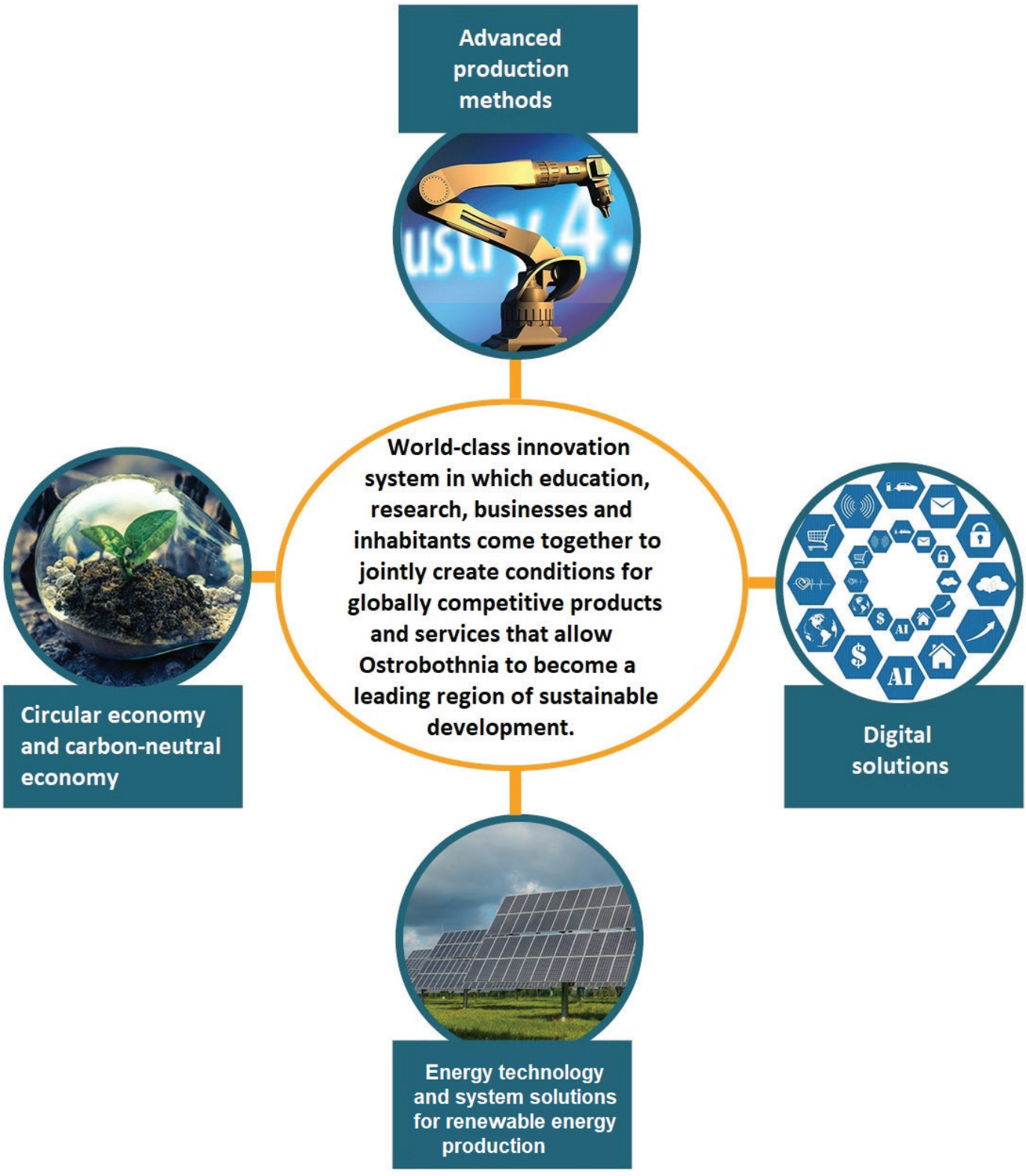
2.1.2 Goals and Focus for 2022–2025

The innovation system's successful transformation is founded on new cooperation models, strong research and development activities, and a competent workforce. In terms of cooperation, we see that businesses reform their activities as a result of global change-related phenomena and implement new methods of cooperation in the region. Discussions with businesses heavily emphasise the need for ecosystem thinking and changes in value chains. Cooperation between actors in possession of different types of expertise is highlighted as a key factor for innovation and growth. One recent example of this is the Wärtsilä Sustainable Technology Hub. We must strengthen the businesses' conditions to find and engage new cooperation partners as well as exchange knowledge concerning the application of new technology. Measures that strive to strengthen RDI cooperation between the region's businesses and universities, higher education institutions, vocational education, and the public sector are likewise central (see Figure 4).

With reference to its identified priority areas, the strategy is an important document for the region, guiding the regional implementation of the Structural Funds Programme and the granting of project funding in the framework of the Innovation and Skills in Finland 2021–2027 Programme.

The strategy's vision and priority areas

Figure 3



2.2. A Method to Identify Cooperation Gaps and Bottlenecks for Innovation Diffusion

The strategy should be regarded as an opportunity-seeking development strategy. For this reason, its contents take shape in a continuous learning process, with the exchange of experience and dialogue between businesses, the research and educational sector, and public sector at the heart. The Regional Council of Ostrobothnia carries out regular and structured dialogue (2014, 2015, 2017/2018) concerning innovation collaboration with these actors (see Figure 5). The purpose of the dialogue is to:

1) identify change factors and new technologies, especially in the businesses' operating environments;
2) map the experiences and expectations of cooperation between the actors in order to identify the regional innovation system's possible gaps and bottlenecks;
3) monitor the innovation system's development, assess implemented project measures, and identify the need for new measures.

The goal of the dialogue is to gain a shared view of the innovation system's most important shortcomings, discover new opportunities to invest in together, and coordinate measures. In this way, the process lays the foundation for the strategy's governance.

LThe learning process (Figure 5) begins with interviews, primarily with export-heavy manufacturing industry companies. The manufacturing industry encompasses both manufacturing companies and service companies. The dialogue takes into account the regional and sectoral distribution of the companies participating in the mapping. Previous studies (2014–2018) have interviewed companies from the following sectors: energy technology, maritime industry (boat industry, maritime technology and maintenance), composite materials, and fur farming.

The learning process is founded on a method developed to identify cooperation gaps (see the example in Appendix 4). Businesses, the educational sector, and the public sector all understand each other's needs and combine different skills and resources in an interconnected innovation system. The method can also be used as a tool for follow-up and assessment in order to measure the achieved results in relation to the strategy's goals.

The learning process must be inclusive and bring together different actors, views, and competence. Combining different kinds of expertise and varying views is of increasing importance to find new growth opportunities and to adjust existing products and processes to technological changes. The underlying premise of the green and digital transition is a change that applies to the whole society. This means that social values, needs, and expectations must be more firmly connected to research and innovation activities. In accordance with the European Commission's recommendations concerning smart specialisation, there is work in progress to create broader transparency, visibility, and commitment around the region's priority areas.

Action Plans Supporting the Strategy's Implementation

Horizontal priority areas require extensive dialogue regarding the strategy's implementation. The learning process also encompasses the preparation of action plans for the strategy's priority areas. These plans are updated annually.

Vision, goals, and focus for 2022–2025

Figure 4

Vision:
World-class innovation system in which education, research, businesses and inhabitants come together to jointly create conditions for globally competitive products and services that allow Ostrobothnia to become a leading region of sustainable development.

Advanced production methods

Goal 2022–2025: Increase the productivity and transformative capacity of businesses by strengthening their competence in the application of robotics, 3D printing, augmented reality, and artificial intelligence.

Digital solutions

Goal 2022–2025: Open up new business opportunities in the region and strengthen the development of the businesses' smart processes through increased knowledge of the Internet, big data, advanced analysis, and artificial intelligence.

Energy technology and system solutions for renewable energy production

Goal 2022–2025: Strengthen the development of the businesses' system solutions in renewable energy production by increasing competence concentrating on energy storage, smart electricity grids, and flexibility along with maintaining a high level of preparedness to test and apply new energy technologies in Ostrobothnia.

Circular economy and carbon-neutral economy

Goal 2022–2025: Accelerate the transition toward a smaller carbon footprint and promote the region's role as a pioneer of circular economy through stronger circular economy expertise, renewable fuels, and new transportation solutions.

Foundation for Ostrobothnia's successful regional innovation system:

Cooperation: New networks, cooperation models, and forms of cooperation
Focus 2022–2025: Creation of low-threshold environments that enable the testing and piloting of new technologies as well as knowledge exchange and innovation cooperation between the region's businesses and the research and educational sector.

Transformative capacity, research and development
Focus 2022–2025: Creation of goal-oriented research and development investments that support the transformative capacity of businesses and the entire innovation system from the perspective of digitalisation, industrial reformation, and green transition.

Education, new expertise and competent workforce
Focus 2022–2025: Support the development of new and flexible forms of cooperation between businesses and higher education institutions in the education of students and the continuing education of employees.

In 2021, the Regional Council of Ostrobothnia prepared four thematic action plans in wide-ranging cooperation with various actors. These plans contain draft measures that are important to implement during the next 1–3 years in terms of research and development, cooperation, education, and competent workforce. The region's businesses have also evaluated the action plans' contents to verify that they correspond to their needs.

The plans function as the strategy's implementation and monitoring instrument and as a tool to ensure more rapid dialogue. They are also used to support the strengthening of regional funding's focal points.

2.3 Short Analysis of Achieved Results: Where Are We Now?

Structured dialogue with the innovation system's various actors began in 2014 (see also Appendix 2). Results from the learning process and its effects on interest-representation and/or implemented measures can be condensed into a three-level summary.

Internationally:

In 2014–2021, international cooperation systematically mapped how innovation-related work was carried out in accordance with the principles of smart specialisation. The EU's Smart Specialisation Platform has opened up new networks in Europe and also in South America due the Commission's wish to showcase European models. Experiences from international cooperation show that the path to international markets for small companies often goes through large businesses, as part of their value chain. At the same time, large businesses transfer their knowledge to small companies, thus enabling them to climb up the value chain. Learning is at the heart of international activities, and the region's universities and public sector have a vital role in supporting the value chain's development.

Organisational learning is important in a constantly changing world because it lays the groundwork for the support of innovation networks sustaining the value chain. Learning takes place partly spontaneously between the value chain's companies, but the purpose of smart specialisation is to enhance this trend and to systematically draw conclusions from implemented measures. This occurs in multi-level governance with national and international partners.

Nationally:

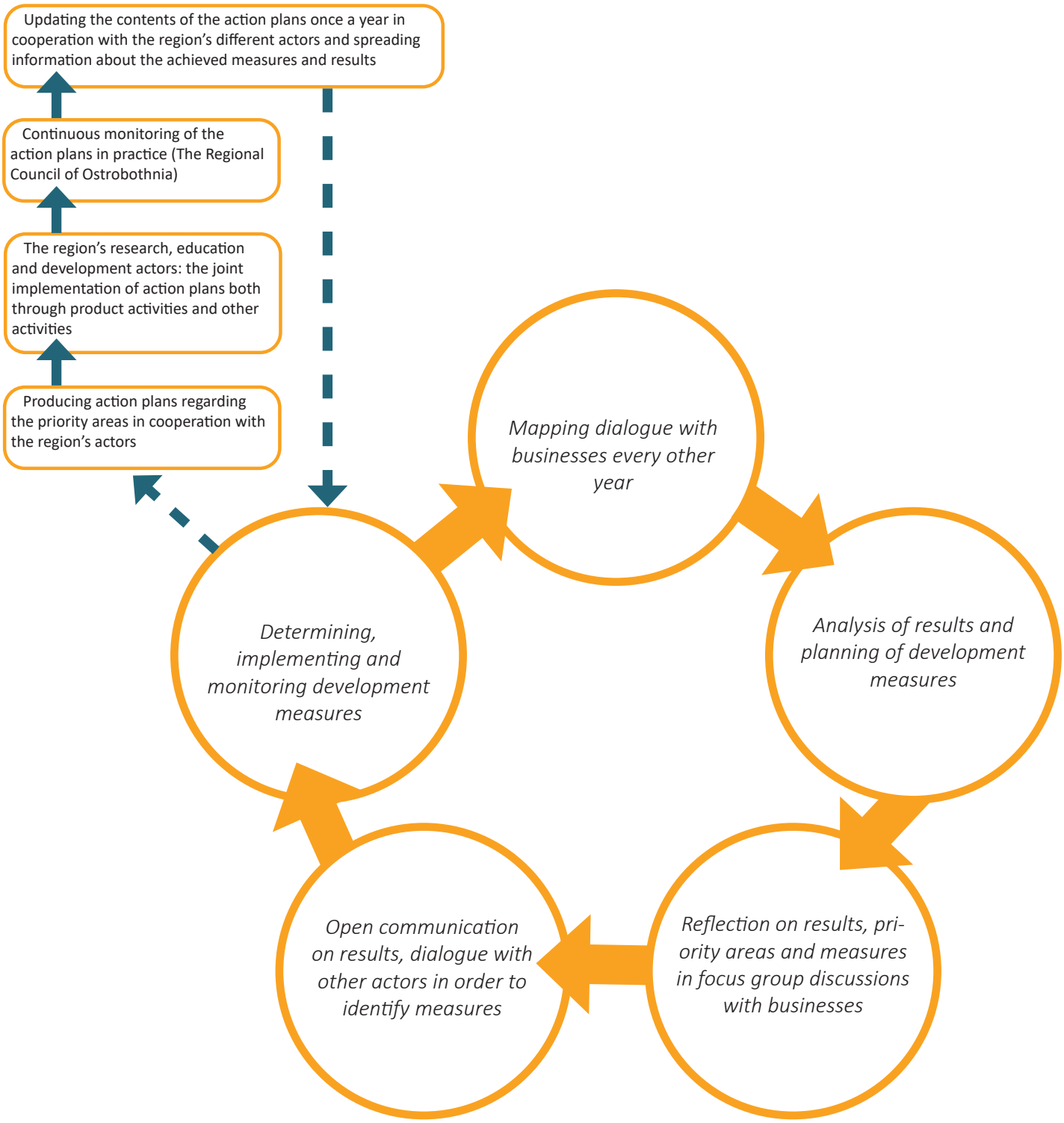
Results of the dialogue have been important in 2018–2021 in e.g. the national preparation of the EU's new Cohesion Policy Programme (2021–2027). The analysis has functioned as an essential foundation for the presentation of regional challenges, opportunities, and need for measures, above all in terms of the upcoming Cohesion Policy's two investment priorities: Smarter EU (focusing on innovation, digitisation, economic transformation and support to SMEs) and a Greener, Carbon-Free Europe (focusing on energy transition, renewables, and the fight against climate change). See also https://ec.europa.eu/regional_policy/en/2021_2027/.

By contrast, it must be stated that the effect of dialogue on interest-representation concerning national innovation policies has been limited. This is primarily due to a lack of a national channel of influence and dialogue.

Regionally:

Learning process

Figure 5



The impact of the learning process is significant at regional level. Moreover, the dialogue has been an important instrument for the implementation of the EU's Digital Strategy in regional development work. Structured dialogue has deepened the understanding of industry 4.0 and key technologies as well as their impacts on innovations and growth in Ostrobothnia.

The Regional Council of Ostrobothnia's monitoring of allocated funds shows that the learning process has, over the years, led to a more centralised allocation of the European Regional Development Fund's financial resources for the improvement of competence relating to the Internet of Things, robotics, and digitalisation. The dialogue's results have also significantly aided the Council to take a more active role in the coordination of the innovation process's actors, functions, and resources and in the ongoing discussion. The learning process has increased direct dialogue with businesses which, in turn, has led to a more amicable discussion and understanding of the innovation network's weaknesses and future technological needs.

Owing to open communication, the region's other actors have processed the dialogue's results, which has had an impact on education, among others. Universities and schools have utilised the mapping dialogue with businesses as e.g. the foundation for the application and planning of short-term information and communication technology continuing education programmes in 2019–2021. These programmes are funded by the Ministry of Education and Culture in Finland. Overall, we see that the educational sector has established new education programmes intended for students as well as shorter continuing education for employees in line with the strategy's priority areas.

Results from 52 business interviews within the learning process in 2017/2018 show that businesses experience different actors to have a higher significance as innovation partners in the regional innovation system (see Appendix 3). Based on these results, it can be stated that measures resulting from the learning process are concrete and have created conditions for cooperation with actors and increased information exchange. Above all, the businesses' expectations of research and development collaboration with universities and higher education institutions have increased (see Appendix 4, Table 3). The results also support the strategy's follow-up investments in measures that strengthen cooperation in the innovation system.

Despite the above-mentioned results and the fact that different actors have corresponding development measures on their agenda, it has proven challenging to obtain a mutual regional understanding on strategic priority areas and targeted joint investments of financial resources at regional level. Herein lies a significant challenge in the future. The growing specialisation of production and competence also increases the need to bring together more actors to produce innovations. It is important to note that the learning process may cause actors to become stuck in existing functions, whereupon new areas of strength are not researched or invested in sufficiently due to fears.

3. Description of the Priority Areas and Key Technologies of Ostrobothnia's Innovation-Driven Growth

The analysis below is based on a learning process launched in 2017. It consists of business interviews, focus group discussions, and open dialogue. The Regional Council of Ostrobothnia, together with the Technology Centre Merinova, carried out 52 personal interviews with SMEs from the Vaasa region. The interviewees consisted of manufacturing industry companies and service companies from various sectors. In addition, the Regional Council of Ostrobothnia conducted 24 personal interviews in the Jakobstad region in 2018, focusing on the boat and fur industry.

The Regional Council of Ostrobothnia engaged in follow-up group discussions in 2020–2021 and conducted individual interviews with businesses, development organisations, and research and educational operators in order to identify the priority areas' most important development measures. The analysis below has been supplemented with results from ongoing or recently concluded projects related to digitalisation and green transition (CERM, Greenovet, GRETA, Sustainable Industry Ecosystem, InnoDigi).

Priority Area: Advanced Production Methods

Digitalisation and new technologies will accelerate the vast majority of future development and growth, combining people, machines, and processes.

Advanced production methods and digital solutions will enable productivity growth, the transition from goods to services, a more circular approach, and the local relocation of manufacturing (European Industrial Strategy, 2020). The change is about more than just the application of new technologies; it requires a completely new way of thinking about production and value-creation.

"The degree of automation must be increased, we need to go all in. If we want to be at the forefront technologically, we must invest in this." (Business interview, 2017/2018)"
(Business interview 2017/2018)

Increasing the degree of automation and ensuring a wider application of robotics in production is a prerequisite to maintain manufacturing in the region, alongside competence tied to production, product development, and end products. Moreover, the same requirement concerning the application of automation will progressively affect the region's large businesses and SMEs.

Advanced Production Methods: Need for Transformation and Bottlenecks for Innovation Diffusion

"Main suppliers no longer bring you finished drawings. Instead, the subcontractor themselves must be able to create added value to the product, development, maintenance."
(Business interview 2017/2018)

In the future, businesses' operating environments will be characterised by even stronger globalisation and global competition. Simultaneously, closeness to subcontractors is held as an important competitive advantage. Digital transition requires faster development cycles and, consequently, closer and deeper cooperation between the subcontractor and principal. The transition sets increasingly higher standards on the subcontractors' innovative capacity and competence concerning e.g. new materials, product development, and digitalisation.

The increased application of advanced production methods requires new expertise in businesses, which can also be seen in their increased cooperation expectations with the region's research and educational operators (see Appendix 4). However, results show that the businesses' experiences of cooperation are still relatively limited. Companies describe some common bottlenecks for cooperation with universities and higher education institutions (2017/2018) as follows:

- Companies are not aware of cooperation opportunities in research and development, what research is being done, and who the correct contact person is. To some extent, cooperation networks are perceived as being tied to certain persons and, thus, described as limited.
- Companies have no information about test and demonstration environments and their uses. H
- Some smaller companies need help identifying their development needs and finding out how to make the best use of cooperation. The starting point must be concrete business problems in cooperation, and the cooperation must be given clear goals.
- Companies call for more applied research and a stronger focus on the piloting and testing of new technologies and product development in research and development projects. The possibility to combine demonstration, testing, and continuing education is emphasised.

It should also be mentioned that challenges faced by SMEs are not only limited to the implementation of new technologies, but also to the ability to create new modes of operation and working methods. This challenge is especially related to creating new mindsets in the production process, developing complete deliveries, and raising understanding of the new ways of value-creation. For instance,

new requirements are imposed on the value chain, including more efficient data flow, greater transparency, improved traceability of components and materials, and increased interactivity of equipment and systems.

Differences are significant between the region's SMEs and their reform plans as to the implementation of advanced automation and digital solutions. Some companies are only at the start of their digital journey and must increase the application of new technologies in the field of advanced automation. Below are some bottlenecks highlighted by this group:

- There is a lack of knowledge about advanced automation and its opportunities, the scopes of application, and how to identify the greatest needs and benefits of new technology. Incomplete information about the costs of new investments and the time required to produce returns. There is demand for more information exchange between businesses:

"Subcontractors are also beginning to invest in the development of automation and robotics themselves when they see their principal doing so. These cases should be brought up."
(Business interview 2017/2018)"

- A need for stronger competence to help choose the right technology. Companies call for more continuing education to test new technologies and explore new possibilities.
- Lack of competent workforce in the company to process and integrate new technology, optimisation, and guidance:

"We've got a welding robot. We've had it for five years, but it's still not in the kind of use it should be."
(Business interview 2017/2018)

- The challenge lies in the fact that some companies see themselves having the role of a traditional subcontractor, which reduces the perceived need for new product and process innovations.

Some companies also have the need to take the next step in advanced automation. This group of companies emphasises new competence in data-based development and calls for research and development measures in the application of smart processes and solutions. New competence is seen as crucial in terms of further development and new innovations in the development of system and comprehensive solutions where different technologies and systems are joined:

"Integration with other things and intelligence is a particular challenge that currently limits additional investments in robotics. It's not just a matter of individual robots – we also need to build holistic processes and combine everything else into them. This is what we need help with." (Business interview, 2021)

The need for competence regarding system and comprehensive solutions in which e.g. collaborative robotic systems, machine vision, advanced analysis, 3D scanning, and the ERP system are combined and underlined are emphasised for the development and sales of new products and services and to increase the company's own automation. In order to improve innovation diffusion, the region needs development measures that:

- advance the expertise of research and educational organisations and strengthen R&D cooperation with businesses with regard to the Internet, big data, and AI;
- further develop demonstration and piloting environments, focusing on the combination of different technologies, machines, and industrial processes;

Table 1. Advanced production methods.

Goal (2022–2025): Increase the productivity and transformative capacity of businesses by strengthening their competence in the application of robotics, 3D printing, AR, and AI.

Examples of key technologies and development areas:	• Application of flexible and movable robot cells and collaborative robots: machine vision, integration of AI and robotics, robotics and cybersecurity. Educational investments in usage, programming, optimisation, and cybersecurity. • Application of 3D printing: 3D product planning, design, and scanning, integration of robotics and 3D printing, new materials. Educational investments in new work methods, design, and product planning, introduction of prototyping. • Augmented reality: Application and added value of VR/AR/Digital Twins solutions and the illustration of areas of use with examples. • Internet of Things and production automation: Internet of Things and data usage in the company's production process. Connecting machines, systems, and data to one value chain between various actors. • AI-based automation. • Development of system and comprehensive solutions in which different technologies and systems are joined together in new and smarter ways. • Adjustment of new technologies for Ostrobothnia's key industries: development and testing of industry-specific solutions. • Demonstrations and pilotings that enable the testing and simulation of the application of new technologies in different sectors. • Short trainings that support the usage and implementation of new technologies in companies. Trainings that enable the testing and research of new technologies along with information exchange between companies.

- increase the businesses' competence in the application areas of the Internet, big data, and AI;
- attract new competence to the region in the field of advanced automation through national and international cooperation, including e.g. larger and directly funded EU projects.

Priority Area: Digital Solutions

"We have long followed a strategy that fine-tunes the engine's efficiency to perfection. Now we're taking the next step with smart devices. Smart systems, IoT, or whatever it's called, we'll start utilising things in a completely new way." (Business interview 2017/2018).

"All technologies that are currently under development strongly need to take into account the development and integration of learning software and analytics." (Business interview 2017/2018)

Competence in digital solutions is a central key to innovations and growth in all priority areas. This know-how enables the development of new operating models, the emergence of new business activities in the region, and new areas of knowledge that can be built on. For instance, a study involving the region's 66 business representatives showed that competence in digital solutions, industry 4.0, and product and service design was seen as the most important aspect in terms of the development of the businesses' green innovations (Greenovet, 2021).

The priority area Digital Solutions focuses on the expertise and application of data-based development and innovation.

Digital Solutions: Need for Transformation and Bottlenecks for Innovation Diffusion

Businesses are aware that they need to create new modes of operation by combining existing know-how with new technologies. The challenge lies in the fact that businesses do not know how to accomplish this, how to create added value, or what the revenue logic should look like. Service-oriented business production connected to the manufacturing industry will grow due to digitalisation. Products, production, and services will become even more intertwined. As a result, the SME sector and subcontractors need to take more responsibility of the service perspective in the value chain.

In addition to IoT and big data, artificial intelligence is one of the biggest current trends. Results from the learning process in 2017/2018 show that AI is a multi-sectoral technology that attracts a growing number of companies in Ostrobothnia. Discussions with manufacturing industry businesses (2021) indicate even more clearly that the region has a demand and interest in research, development, and educational measures regarding data-based development, such as AI and production automation, the usage of AI in decision-making, refinement, visualisation, and data analysis, along with the development of new business models and the design of new services with the help of data.

It is estimated that demand for turnkey deliveries and more processed components will grow in the future in the businesses' operating environments. This signifies a transition from component deliveries to system deliveries, which increases the need for cooperation networks in the region's smaller and larger companies:

"Buyers want increasingly bigger entities. This makes local cooperation imperative if we want to deliver from this region." (Företagsintervju 2017/2018)

Production must become increasingly flexible, and value creation logic will also undergo changes due to digitalisation. Digitalisation enables and creates requirements for a more wide-ranging business

model and new comprehensive solutions based on the generation and use of data.

"We'll examine the whole ecosystem today; how can we help our customers do business smarter." (Business interview 2017/2018)

"We need to choose if we want to remain only as a component or equipment manufacturer or if we want to start offering a more extensive holistic solution." (Business interview 2017/2018)

New business opportunities may also emerge outside a self-produced product or service, which is why new ways of cooperation in the value chain are increasingly important in view of innovations. The value chain's several regional actors operate in the energy sector, from which the following example also comes:

"All actors of the whole value chain should be brought together around the same table, from component-level to electricity supplier and maintenance operations. The region is home to this entire chain. We could think of how to move forward together, pilot new solutions, and take them to the world. – We could very quickly generate new products." (Företagsintervju 2017/2018)

In other words, digital solutions are not only about component-level innovations, but also about new solutions at system-level that are created in the value chain in collaboration between different actors. The business interviews reveal that more cooperation is needed with the region's other companies in the development of new technologies, products, and services (see Appendix 4, Table 1). Therefore, the field of digital solutions and innovations requires research and development investments that also take into account changing value chains and the development of industrial ecosystems. Through investments, we must strengthen the businesses' conditions to find and engage new cooperation partners as well as create new cooperation models e.g. between universities and higher education institutions, the public sector, and the end users.

Similar to the priority area of Advanced Automation, differences are considerable in terms of how the region's businesses work with digitalisation. Some of the bottlenecks for digitalisation include the following:

- Digitalisation continues to be an unclear concept for some SMEs. Many companies that possess a weak level of digitalisation do not have long-term plans or strategic thinking pertaining to it (InnoDigi).
- Competence is lacking concerning digitalisation's opportunities and areas of application, companies are unable to identify digitalisation's greatest needs and benefits, and they lack information about the costs of new investments and the time required to produce returns. Thereby, there is a need to reach out to companies with information, resources, and support in order to enable the digitalisation of their activities.
- Especially smaller manufacturing industry companies describe digitalisation as an instrument to streamline internal functions, but they do not consider digital solutions as tools to change business models or create new products and services to an equal extent.
- Companies call for more experience and knowledge exchange regarding digitalisation, also in a cross-sectoral and horizontal manner (InnoDigi).
- The application of digital solutions and the usage of digital tools sets higher requirements for the workforce's level of competence and specialisation.

Table 2. Digital solutions

Goal (2022–2025): Open up new business opportunities in the region and strengthen the development of the businesses' smart processes through increased knowledge of the Internet, big data, advanced analysis, and AI.

Examples of key technologies and development areas:	• Refinement, visualisation, and analysis/processing of big data: improve the accessibility of useful data. • Data-based decision-making: use of data to optimise and improve business activities, including logistics control and resource management, forecasting. • Development of new services: development of processes/products that collect smart data, revenue logic, service design, user-friendliness, appropriate user interfaces. • Cybersecurity: need to organise training and improve competence at various levels in businesses. Data collection and protection. • Forums for the development of B2B competence, data transfer, and cooperation. • Open laboratory environments that attract a larger target group of businesses owing to their low threshold and that support the development of new business enterprises. • Demonstrations and pilotings that enable tests and simulations on how the IoT, big data, advanced analysis, and AI can be applied in different areas. • Shorter trainings for companies regarding big data, machine learning, AI, data analysis methods, data-based decision-making, programming, service design.

Priority Area: Energy Technology and System Solutions for Renewable Energy Production

"The region must continue to invest in one thing – the energy sector! The energy market will change so much over the next few years that the market will be overflowing." (Business interview 2017/2018)

Ostrobothnia has a strongly business-driven energy cluster that develops technological solutions for smart electricity grids, the maritime industry, renewable energy production, and energy efficiency. The development of new solutions is of utmost importance in these sectors. Over 90% of Finland's research and development investments in electricity and automation take place in Ostrobothnia.

Climate change, renewable energy, and changes in energy production are trends that offer the region growth opportunities because many of the region's businesses possess products, solutions, and expertise that meet future needs. The region's growth has a positive climate impact from a global perspective because the businesses' solutions reduce their customers' carbon footprint. The region's major energy investments (see e.g. IEA https://www.iea.org/reports/net-zero-by-2050, p. 81) will stimulate demand for environmental technology produced in Ostrobothnia. At the same time, the rising demand will lead to even greater global competition and the

fact that the innovation system's actors must become even better at developing new solutions that are tailored to a target area's needs.

The priority area of Energy Technology focuses on the development of new expertise and the use of new technologies in the following sectors: system solutions, sectoral integration, energy storage, smart electricity grids, and flexibility of energy production.

Energy Technology: Need for Transformation and Bottlenecks for Innovation Diffusion

The transition to renewable energy – and the green transition in general – requires system-level innovations. It is not only a question of promoting the development of new, individual products or processes; instead, it is about solutions that e.g. change the whole system of energy supply and energy use. As a result, a significant part of the market for renewable energy solutions will be composed of investments in system solutions. This creates a need for system-level research and development activities in order to enable the development of larger holistic solutions that will survive global competition. Cooperation between businesses and consortiums, including public research and development, has a central role in this. Ongoing initiatives to develop future system solutions for renewable energy production have been successfully carried out in Ostrobothnia. These include e.g. EnergiaSAMPO and H-Flex-E. Ostrobothnia has great potential because the region is home to world-leading actors with expertise in energy production, distribution, and use, in addition to component manufacturing covering the entire value chain.

A significant bottleneck hindering the region's innovation diffusion is the need for more sectors to simulate, test, and pilot new energy solutions. In other words, Ostrobothnia needs major investments in regional demonstration and living lab environments in order to further support the development and sales of the businesses' new energy solutions and the transition of SMEs from delivering components to delivering systems. Regional environments that offer testing, verification, and piloting opportunities to both businesses and higher education institutions in authentic environments are important so as to create conditions for innovation cooperation between companies and for knowledge exchange between different actors. These kinds of environments enable the development of new technologies and faster development cycles. They also strengthen commercialisation and the implementation of research results.

Lastly, the environments also possess a key role in research and development work from a socio-technological viewpoint. Regulatory changes, among others, are important for the promotion of new technologies in businesses because the green transition requires changes in the functioning of entire systems:

"Changes at system-level often require changes and development in regulation so that business activities and markets may also develop. This applies in particular to energy. It's important when we're talking about the SME sector."
(Focus group discussion, 2021)

In order to foster understanding of the transition to renewable energy and to promote the transition, we need a socio-technological approach that combines technological, economical, and societal viewpoints. With the help of multi-disciplinary pilotings and tests, we can bring Ostrobothnia to the forefront of sustainable development.

In addition to system solutions, the biggest challenges facing renewable energy are the integration of energy production methods, the development of energy storage, and greater focus on the customers. Bottlenecks are formed by the need for new expertise and cooperation between research and educational

institutions and the industry's businesses.

As renewable energy gains more ground and energy production diversifies, the need for energy storage grows. Above all, there is an increasing regional demand for battery solutions (encompassing both small and large stationary batteries) and short-term energy storage. Competence must be developed regarding e.g. the handling and use of batteries in smart electricity grids. This requires investments in the battery technology research infrastructure that enables the testing of different applications. Expertise in hydrogen gas will be needed in the longer term. The region already has expertise and carries out RDI activities in e.g. electrification, the control and optimisation of electricity grids, and the fields of power conversion. Moreover, it also possesses system solutions that can be further improved to develop new, hydrogen-based energy storage methods. New opportunities may also arise from the development and commercialisation of production waste caused by hydrogen production.

Smart digital solutions forms another important sector for renewable energy's research and development investments. Data collection and usage along with the advanced analysis and development of simulation models are central themes. More expertise is needed e.g. in the fields of AI, big data, high-speed communication (5G), and also concerning opportunities provided by these technologies for the optimisation and control of electricity grids, their resilience, and the need for cybersecurity.

Energy production based on renewable energy sources is weather-dependent, which necessitates great flexibility. Both energy storage and demand response are needed to balance the imbalance of production and consumption. These areas are crucial in the transition to renewables, and the region's businesses and research and educational organisations' knowledge of and interest in these areas can be further developed with new investments. For instance, pilotings that study how the flexibility of electricity grids can be strengthened via demand response are important. More competence is needed on the activation of electricity users as energy producers, property energy solutions in which the user is part of the energy solution, the processing of consumption data, and the development of customer-centred energy solutions. Secondly, competence is needed regarding the various forms of flexibility and energy storage. Pilotings that encompass e.g. different kinds of energy storage opportunities in both private and public properties and that study them as resources to increase the flexibility of electricity grids are also important. The region needs research and development investments in the integration of various energy forms: electricity, heat, gas. Thirdly, competence revolving around the creation of micro grids is increasingly important.

Table 3. Energy technology and system solutions for renewable energy production.

Goal (2022–2025): Strengthen the development of the businesses' system solutions in renewable energy production by increasing competence concentrating on energy storage, smart electricity grids, and flexibility along with maintaining a high level of preparedness to test and apply new energy technologies in Ostrobothnia.

Examples of important technologies and development areas:	• Digital solutions, renewable energy, and smart electricity grids: application of data, advanced analysis, AI. • Cybersecurity of smart electricity grids, protection relays, smart networks. • Integration of various energy production methods. • Energy storage, battery technology, short-term storage, power-to-x and x-to-power, emission-free hydrogen, sectoral integration. • Flexibility of energy production (creation of micro grids, activation of energy users as energy producers, demand response). • Customer-centred energy solutions and property energy solutions. • Establishment of national and international cooperation in order to attract new expertise to the region and to enable larger piloting and demonstration investments. • Waste-to-energy system solutions

Priority Area: Circular Economy and Carbon-Neutral Economy

"Global warming impacts our business activities; we must reduce our carbon dioxide emissions. This changes a lot of things." (Business interview 2017/2018)

The region's large businesses are changing their activities from product manufacturers to system solutions developers that also answer to climate challenges. A study conducted among the region's 66 business representatives shows that a significant number of the region's large and small companies from various sectors have recognised new opportunities revolving around sustainability (Greenovet, 2021). The results clearly indicate that green transition is not only about the adjustment of the companies' activities; instead, they recognise the potential in developing new innovations and creating reforms. Companies underline that success requires a new type of competence in four key areas:

1) design and development of sustainable products and services
2) smart/advanced digital solutions, advanced automation and industry 4.0
3) green innovations
4) innovation cooperation, new networks and forms of cooperation.

These results support the priority area of Circular Economy and Carbon-Neutral Economy and function as evidence of the great significance and potential of the industry's development investments.

The priority area strives to increase competence and promote the development of new solutions and work methods by investing in measures that support:

- the creation of circular economy products,

services, and processes, the application of digital solutions, the development of circular economy system solutions, and cooperation between businesses;

- the development of future renewable fuels and sustainable transportation solutions.

Circular Economy and Carbon-Neutral Economy: Need for Transformation and Bottlenecks for Innovation Diffusion

The transition to circular economy signifies changes in a company's business model and necessitates a new approach in terms of production and how and where value and profit are created. A large number of companies need to recognise the potential of circular economy. Increasing interest in and knowledge of the adjustment of activities into a circular economy business model is central. Therefore, the primary objective of research and development projects should be the widespread communication of project results to the region's businesses and the dissemination of examples concerning direct business benefits generated by circular economy. Simply put, the region needs a stronger link between the businesses and research and educational actors' results and examples.

In summary, a central bottleneck for many businesses is the fact that circular economy as a concept remains unclear, wide, and too abstract (GRETA). The bottleneck consists of e.g. the following:

- **Lack of competence regarding the significance of circular economy to Ostrobothnia's key industries.** As a result, there is a need for the operationalisation of the concept of circular economy in different sectors to 1) demonstrate to businesses its potential fields of application, and 2) to showcase to education providers and higher education institutions the businesses' knowledge gaps.
- **There are no demonstrations or information dissemination** activities that would allow businesses to discover existing research and development activities, technologies, and solutions that could be applied in the transition to circular economy. Existing demonstration and piloting environments must be further developed, focusing on circular economy and sustainability. In this way, environments can be applied as a starting point for circular economy cooperation between different actors.
- **There is a need for different forms of education, continuing education, and cooperation** between businesses and research and educational sectors as to circular economy. For instance, the region needs several basic courses on circular economy and sustainability for students in various education programs so that these students can contribute new expertise to businesses. Circular economy must be incorporated as a horizontal theme in teaching, which means that research and teaching personnel require new expertise. Businesses, in turn, are in need of short continuing education that combines education, the testing of new technology, and the study of potential areas of application. Lastly, there is potential to develop new forms of cooperation between businesses and the educational sector; cooperation that enables rapid interaction in RDI activities (e.g. sprints, prototyping, co-creation), where students are seen as resources for new ideas and as future customers and end users.

In order to strengthen the businesses' future operating conditions and create reforms, we must improve the conditions of SMEs to identify and utilise circular economy's potential.

Firstly, the region needs measures and innovations that enhance knowledge about the creation of sustainable products and services and the development of circular economy processes. Research and development investments in the use of new and renewable materials and the application of new technologies (e.g. 3D printing) are central in terms of the design and creation of new products. A circular approach is characterised by less production and more sales. Similar to the field of digitalisation, this

requires measures that launch the development of the businesses' new services and alter their revenue logic. Application of the life-cycle analysis and modelling of product development are crucial in this in order to discover new opportunities through cooperation (e.g. product recycling or new services) with the value chain's other actors. In order to strengthen the businesses' expertise regarding the creation and development of circular economy processes, research and development cooperation is required in e.g. the areas of material flows, side streams, and the development of industrial symbioses. This includes projects that identify new areas of application of material flows in businesses or between them.

Secondly, the region needs measures that enhance knowledge and innovations in data usage and the application of digital solutions in the field of circular economy. The application of digital solutions to increase energy and resource efficiency and to develop new products and services is vital. Businesses highlight both digitalisation and advanced automation as important tools for the green transition and green innovations:

"The environment is the first and probably the most important factor impacting our industry […] One solution for this is digitalisation. We need automation and computer-control to consume energy smarter or better or less."
(Business interview 2017/2018)

Research and development investments in e.g. data collection and usage in production processes and the application of digital platforms for data sharing and usage are important. Examples of essential measures include providing support to companies as they develop and apply data-based solutions and services for the control of material flows and logistics, together with increasing traceability through new technologies.

Thirdly, cooperation between businesses is a primary key in the transition to circular economy. As stated before in terms of renewables, the transition to circular economy will not, for the most part, be about the promotion of the development of individual new products, processes, or component-level innovations; instead, it will come down to changes and the development of innovations at system-level and in collaboration with the value chain's businesses and different actors. However, contrary to renewables, the region's knowledge of the development of circular economy system solutions is in its early stages (GRETA). Nonetheless, by increasing knowledge and pilotings concerning e.g. industrial symbioses and material flows between companies, we can create conditions for the development of circular economy system solutions in the region.

Application of the life-cycle perspective in product development may become a new way to establish cooperation between the value chain's various actors and together discover new products and services. In other words, research and development investments that focus on more than one actor or step of the value chain are essential. In this way, we can promote a mindset of system-level innovations and gradually increase the birth of circular economy system solutions:

Identifying the environmental impact of a product's entire life-cycle and, accordingly, avoiding measures that cause emissions or negative environmental impacts at system-level are important."
(Focus group discussion, 2021)

In the area of renewable fuels and transportation solutions, the scaling up of raw materials, competence, and development potential are central for the biogas sector. The biogas sector needs more research and development activities in order to develop its technological solutions, conditions for commercialisation, and business activities. The

region's existing knowledge regarding emission-free hydrogen in energy production, industry, and transportation can be further improved so as to offer significant development potential in the future. This includes research and development activities e.g. for the maritime industry's hydrogen and multi-fuel engines. Lastly, digital solutions and data usage are central tools supporting decarbonisation, strengthening the development of local and low-carbon transportation solutions, and accelerating the reduction of CO2 emissions in the region (e.g. the simulation of transportation solutions and impact assessment).

Table 4. Circular economy and carbon-neutral economy.

Goal (2022–2025): Accelerate the transition toward a smaller carbon footprint and promote the region's role as a pioneer of circular economy through stronger circular economy expertise, renewable fuels, and new transportation solutions.

Examples of important development areas:	• Planning and creating sustainable products by using e.g. new and renewable materials or by applying new technologies, such as 3D printing. • Use of data and digital solutions for the creation of circular economy products/services/processes and the attainment of better energy and resource efficiency. • Increasing competence and focusing on industrial symbioses and material flows between companies in order to develop circular economy system solutions. • Improving cooperation between the region's businesses, municipalities, and the research and educational sector so as to develop and pilot circular economy solutions. • Further developing existing demonstration and piloting environments, focusing on circular economy and sustainability. • Flexible and new forms of knowledge exchange and cooperation between businesses and the educational sector in the field of circular economy. • Attracting new expertise on circular economy and sustainability to the region via national and international cooperation.

4. Good Governance of the Strategy

The European Commission's proposal for a new, multiannual financial framework for the years 2021–2027 attaches great importance on smart specialisation in regard to the European Structural and Investment Funds (ESI). In Finland, the largest share of the European Regional Development Fund's (ERDF) budget for the 2021–2027 programme period is allocated to support the EU's first policy objective: "A Smarter Europe by Promoting Innovative and Smart Economic Transformation". A In accordance with the Commission's proposal, the fulfilment of the said condition must be monitored and evaluated throughout the entire programme period.

Good governance entails drawing up the strategy as an opportunity-seeking development strategy and a learning-based process in which the region analyses and draws conclusions from project and development activities. By imposing a condition for good governance, the Commission goes one step further to ensure that a region implements its strategies, follows up on them via a systematic and repeated process, and that it has an operator managing the process. In this context, it is important to note that Ostrobothnia's smart specialisation process already functions in accordance with the aforementioned condition.

The enabling condition of good governance in the region is composed of seven fulfilment criteria. These criteria are presented in Table 5, which also demonstrates the fulfilment of each criterion in the Strategy for Innovation and Growth in Ostrobothnia. The criteria are included in the smart specialisation process that has been applied and developed in the region of Ostrobothnia since 2014 as a basis for the evidence-based strategy.

Table 5. European Commission's fulfilment criteria for smart specialisation

European Commission's fulfilment criteria for smart specialisation	Fulfilment of criteria in Ostrobothnia
1. Up-to-date analysis of challenges for innovation diffusion and digitalisation.	The analysis of bottlenecks for innovation diffusion is included in the actual smart specialisation process, which is based on structured dialogue and analysis of 1) the operating environment's change factors, 2) new technologies, and 3) expectations of cooperation in the regional innovation system (for a more detailed description, see Chapter 2 and Figure 5 of the strategy's learning process). Chapter 3 contains an up-to-date analysis of the bottlenecks for innovation diffusion and the need for measures in the priority area.
2. Existence of a competent regional/ national institution or body, responsible for the management of the smart specialisation strategy.	The Regional Council of Ostrobothnia answers for the management of the smart specialisation strategy through the Regional Cooperation Group (MYR) and the Regional Government. The smart specialisation strategy is part of the Regional Programme of Ostrobothnia and its central implementation tool.
3. Monitoring and evaluation tools to measure performance towards the objectives of the strategy.	Assessment of the strategy is primarily based on qualitative assessment as follows: 1) Structured dialogue (see Figure 5) is repeated at regular intervals, thus functioning as a tool for assessment. The process measures the innovation system's connectivity by reviewing the actors' experiences of cooperation with each other. Explanations for identified cooperation gaps are sought in dialogue with different actors. The purpose is to find more accurate measures to narrows the gaps. 2) Project results and changes brought about by project mass are evaluated in relation to the strategy's priority areas and their identified challenges. There are currently no quantitative indicators for assessment.

European Commission's fulfilment criteria for smart specialisation	Fulfilment of criteria in Ostrobothnia
4. Functioning of stakeholder cooperation ("entrepreneurial discovery process", in other words, it is a process that develops and implements priority areas based on the region's strengths and opportunities in close cooperation and dialogue with different regional actors.)	Triple helix coordination of the innovation process (see Figure 5). The businesses' views on change factors in the operating environment, new technologies, and expectations of cooperation in the regional innovation system are being mapped. In addition, the geographical position of the businesses' cooperation partners is being mapped in Ostrobothnia, Finland, and all over the world. The results lay an important foundation for the continuation of structured dialogue with the open innovation system's different actors by reflecting on priority areas and targeted measures.
5. Actions necessary to improve national or regional research and innovation systems, where relevant.	Measures to enhance the region's innovation activities are described in Chapter 3. The following measures are also important: 1) Determining the placement of the innovation ecosystem's different parts in the value chain, which is essential in order to achieve the right kind of research and development activities connected to the businesses' needs. 2) Analysing how the businesses' research activities are linked to and complemented by research conducted by the region's universities. 3) Identifying the need for national and international cooperation in order to achieve critical mass, to obtain new expertise, and to find complementary cooperation partners.

European Commission's fulfilment criteria for smart specialisation	Fulfilment of criteria in Ostrobothnia
6. Where relevant, actions to support industrial transition.	The strategy emphasises the challenges and opportunities of Ostrobothnia's manufacturing industry based on three global trends: digitalisation, climate change and renewable energy, and development of industry and industry 4.0. Based on these trends, the strategy presents development measures that are connected to 1) cooperation networks, 2) research and development activities, and 3) education and competent workforce (see Chapter 3). For instance, an action plan shall be drawn up to manage the transition to digitalisation and industry 4.0. The action plan shall determine concrete development measures for the next 1–3 years, and it shall be drawn up in close cooperation with the innovation system's different actors.
7. Measures for enhancing cooperation with partners outside a given Member State in priority areas supported by the smart specialisation strategy.	Internationalisation is a constant theme throughout the strategy, and the strategy's selected priority areas offer international opportunities. Therefore, regional measures within the thematic priority areas can strengthen the actors' participation in international value chains and research networks and, consequently, create an even wider and stronger export base in the region. Other measures pertaining to international cooperation include: 1) Participating in the European Commission's thematic Smart Specialisation Platforms (Platform for Industrial Modernisation and Platform on Energy). 2) Participating in international projects that support the development of the smart specialisation process and improve innovation environments 3) Network collaboration concerning the continuous improvement of smart specialisation methods in a continuous learning process between different regions and actors.

Additional Information

Additional information about the process of smart specialisation in Ostrobothnia, the results, and international cooperation can be found in the following publications:

Elekes, Z. & Eriksson, R. (2021) Analys av specialiseringar och diversifieringsmöjligheter i Kvarkenområdet (Västernorrland, Västerbotten och Österbotten). CERUM Report, Umeå University. Available at: http://umu.diva-portal.org/smash/record.jsf?pid=diva2%3A1578564&dswid=1889

Mäenpää, A. (2021), The Case Study of Ostrobothnia. In Perianez Forte, I., Guzzo, F., Hegyi, F.B. & Gianelle, C. (Eds.) (2021) Case Studies on Smart Specialisation (pp. 16–24). Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC124478

Mäenpää, A. (2020), The Challenges of Public Organisations in Coordinating Smart Specialisation and a Connectivity Model as One Solution. Doctoral dissertation, University of Vaasa. Available at: https://osuva.uwasa.fi/bitstream/handle/10024/10254/978-952-476-898-6.pdf?sequence=2&isAllowed=y

Penttilä, K., Ravald, A., Dahl, J. & Björk, P. (2020), Managerial Sensemaking in a Transforming Business Ecosystem: Conditioning Forces, Moderating Frames, and Strategizing Options. Industrial Marketing Management, 91 (pp. 209–222). Available at: https://www.sciencedirect.com/science/article/pii/S0019850120308397

Johnson, J., Dahl, J. and Mariussen, Å. (2019), Smart Specialization Driving Globalization of Small and Middle-Sized Companies in Ostrobothnia. Ekonomiaz, 95 (pp. 176–201). Available at: https://osuva.uwasa.fi/handle/10024/10309

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Virkkala, S., Mäenpää, A., & Mariussen, Å. (2017), A Connectivity Model as a Potential Tool for Smart

Specialization Strategies, European Planning Studies 25(4), pp. 661–679. Available at: https://osuva.uwasa.fi/bitstream/handle/10024/10239/Osuva_Virkkala_M%c3%a4enp%c3%a4%c3%a4_Mariussen_2017.pdf?sequence=2&isAllowed=y

Teräs, J. & Mäenpää, A. (2016), Smart Specialisation Implementation Processes in the North: Lessons Learned from Two Finnish Regions. Available at: https://www.obotnia.fi/assets/S3/Smart-specialisation-Implementation-Processes-in-the-North.pdf

Johnson, J. & Virkkala, S. (2016), Learning Smart Specialisation Using the Ostrobothnian Model. Smart Cities in Smart Regions 2016 Conference Proceedings. Available at: https://www.theseus.fi/bitstream/handle/10024/121900/LAMK_2016_27.pdf?sequence=4

European Commission (2016), Smart Stories: Implementing Smart Specialisation across Europe (p. 17). Available at: https://s3platform.jrc.ec.europa.eu/documents/20182/176472/S3P+Booklet+Smart+Stories/716d2278-3a69-4ffb-891c-d38582eb6879

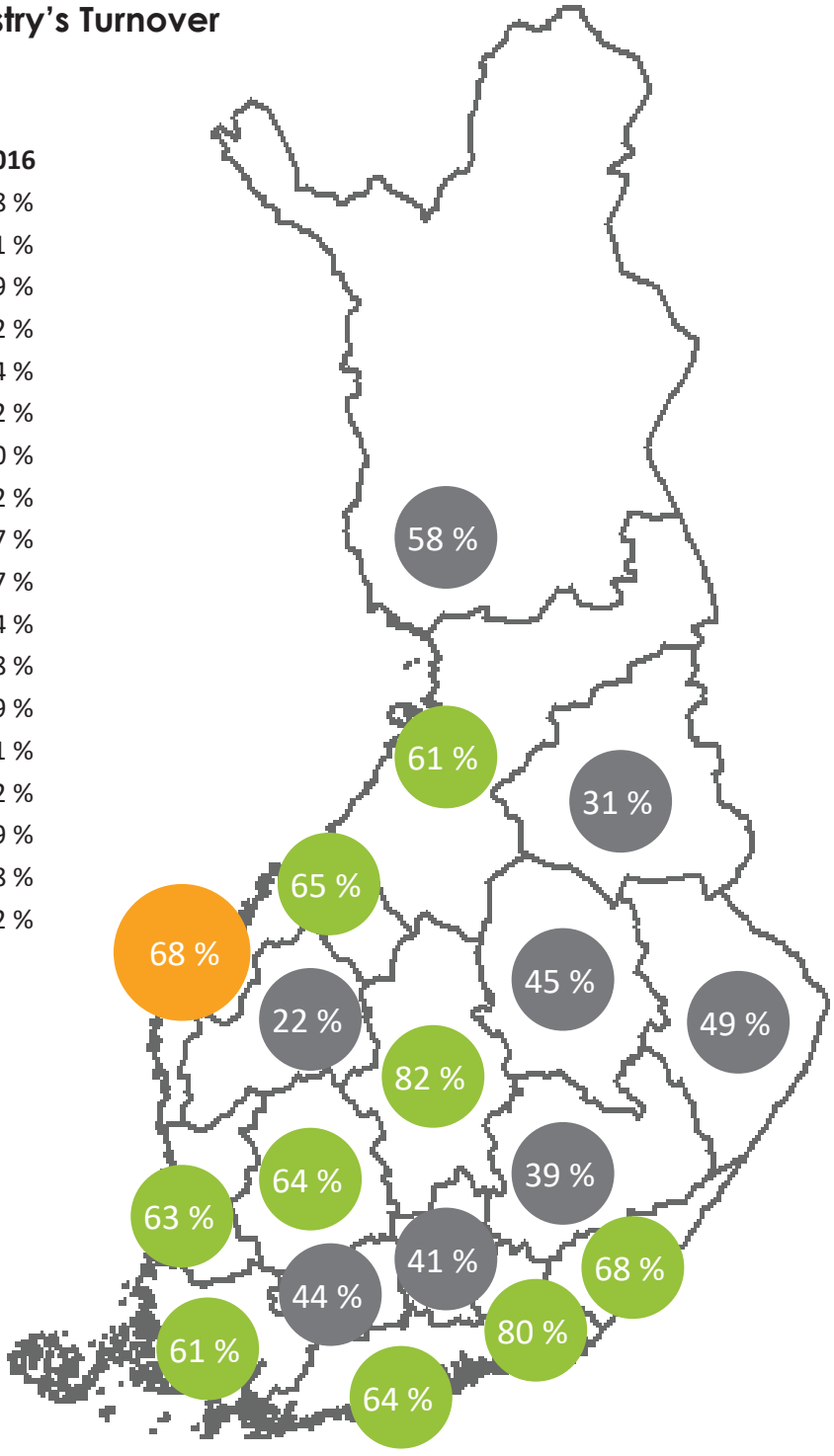
Virkkala, S., Mäenpää, A. & Mariussen, Å, (Eds.) (2014), The Ostrobothnian Model of Smart Specialisation. Available at: https://www.univaasa.fi/materiaali/pdf/isbn_978-952-476-577-0.pdf

APPENDIX 1 – The Manufacturing Industry's Turnover of Exports

The Manufacturing Industry's Turnover of Exports

Region	2019	2016
South Karelia	68 %	68 %
South Ostrobothnia	22 %	21 %
South Savo	39 %	39 %
Kainuu	31 %	32 %
Kanta-Häme	44 %	44 %
Central Ostrothnia	65 %	62 %
Central Finland	82 %	70 %
Kymenlaakso	80 %	72 %
Lapland	58 %	57 %
Pirkanmaa	64 %	57 %
Ostrobothnia	68 %	74 %
North Karelia	49 %	48 %
North Ostrobothnia	61 %	59 %
Päijät-Häme	41 %	41 %
Satakunta	63 %	62 %
Uusimaa	64 %	59 %
Southwest Finland	61 %	58 %
North Savo	45 %	42 %

Source: Statistics Finland



Appendix 2. Chart 1. Development of the Strategy 2014–2021

Stages of the learning process	Mapping interviews with businesses and other stakeholders.	Follow-up focus group discussions with the interviewed respondents.	Open communication regarding results, discussion about priority areas and the need for measures.
2014	Interviews with businesses (16), the public sector (14), and universities and higher education institutions (12). The interviews were conducted in: Vaasa (energy technology, maritime industry) Jakobstad (boat industry and fur farming)	In Vaasa (energy technology, maritime industry), 2014. In Jakobstad (boat industry and fur farming), 2014.	
2015	Email survey for businesses, the public sector, and universities and higher education institutions (same participants as in 2014). The survey was sent to the same participants: Vaasa (energy technology, maritime industry) Jakobstad (boat industry and fur farming)	In Vaasa (energy technology, maritime industry), 2015. In Jakobstad (boat industry and fur farming), 2015.	

Stages of the learning process	Mapping interviews with businesses and other stakeholders.	Follow-up focus group discussions with the interviewed respondents.	Open communication regarding results, discussion about priority areas and the need for measures.
2018	52 interviews with business executives from the region's energy cluster . The interviews were distributed among 49 businesses and began in the autumn 2017. Interviews in the Vaasa region focused on manufacturing industry businesses and service companies from various industries, such as energy, metal, plastic, electronics, and multiple-conductor cables. 24 interviews with businesses, the public sector, and universities and higher education institutions. The interviews were conducted in Jakobstad (boat industry, 12 interviews, and fur farming, 12 interviews).	In Vaasa: 4/2018, for respondents representing the energy cluster.	Open event for project actors 9/2018. Presentation of results and discussion for higher education institutions, the City of Vaasa, VASEK, and Merinova 9/2018. Presentation of results for University of Vaasa's representatives prior to the preparation of a funding application to the Finnish Ministry of Education and Culture concerning regional ICT continuing education programmes 9/2018. Presentation of results and discussion event for the Regional Cooperation Group (MYR) 10/2018.
2019		In Jakobstad: 5/2019, for respondents representing the boat industry. 5/2019, for respondents representing fur farming.	Universities and higher education institutions: presentation of results from business interviews, competence-mapping, identification of project measures: – Åbo Akademi University 2/2019 – Novia UAS 2/2019 – Vaasa UAS (VAMK) 3/2019 – University of Vaasa 3/2019 – University of Vaasa (research platforms) 3/2019 – Centria UAS, Jakobstad, Kokkola, Ylivieska 4/2019 – Hanken School of Economics, Vaasa Campus 4/2019
2020-2021	Interviews and group discussions with businesses concerning action plans supporting the strategy's implementation.		Interviews and group discussions with universities, higher education institutions, upper secondary education, and business-development companies concerning measures supporting the strategy's implementation.

Appendix 3 – Cooperation in a Regional Innovation System – Businesses' Opinions

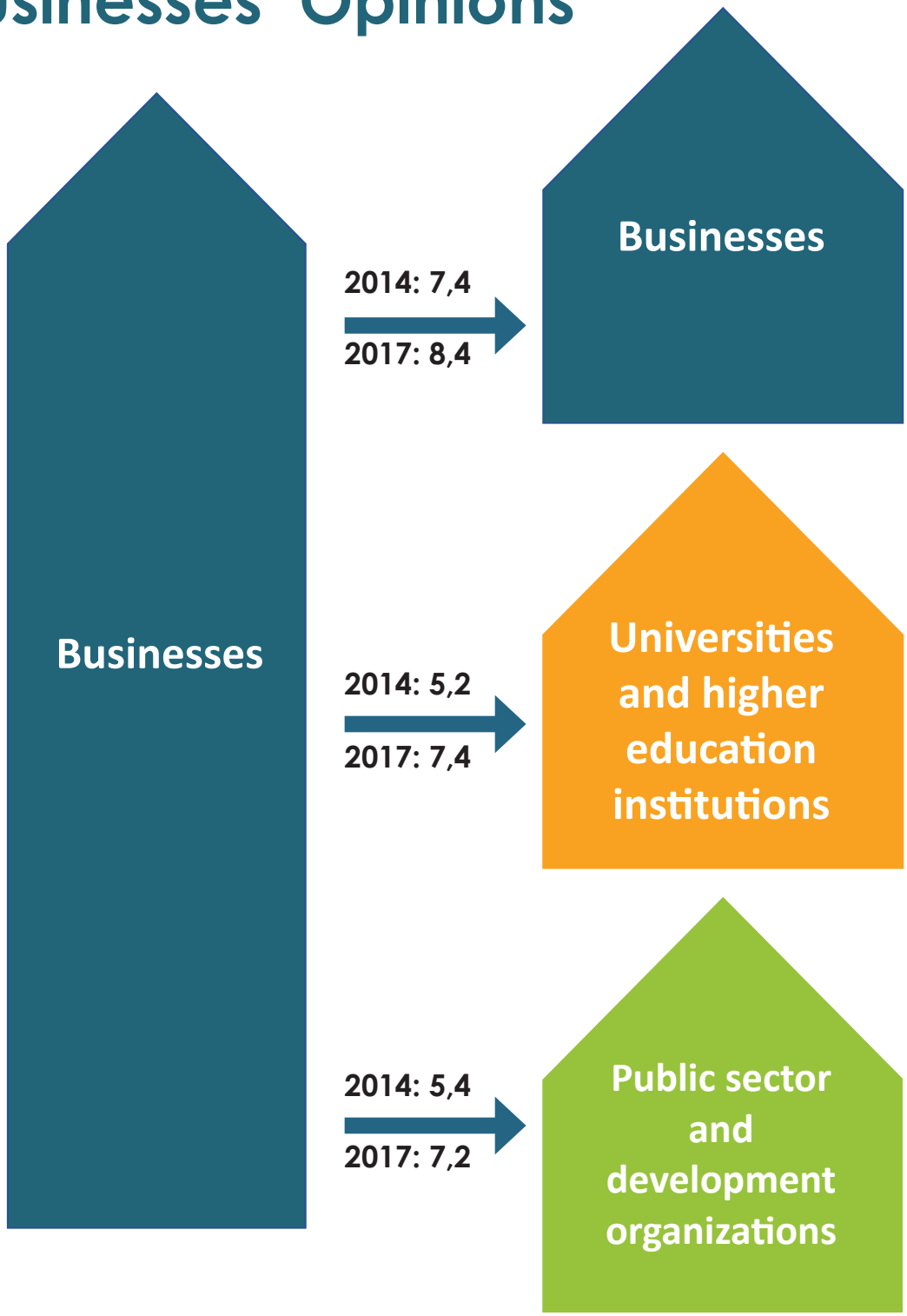


Figure 1. How important is innovation partnership with other businesses, the public sector, and universities and higher education institutions for the company's activities? Scale of 1 to 10, 1=low importance, 10=high importance

Results from 2017/2018 are based on 52 interviews with business executives from the region's energy cluster.

Appendix 4 – Businesses' Experiences and Expectations of Cooperation in a Regional Innovation System

Table 1. Businesses' experiences and expectations of cooperation with Ostrobothnia's other companies

Scale of 1–10, 1=very low, 10=very high

	2014			2017/2018*		
Cooperation	**Expectations***	**Experiences***	**Diff.**	**Expectations**	**Experiences**	**Difference**
Cooperation with other businesses in the development of technologies, products, and services	8.2	6.9	-1,3	8,8	7.0	**-1.8**

Table 2. Businesses' experiences and expectations of education-related cooperation with Ostrobothnia's universities and higher education institutions

Scale of 1–10, 1=very low, 10=very high

	2014			2017/2018*		
Cooperation	**Expectations***	**Experiences***	**Diff.**	**Expectations**	**Experiences**	**Difference**
Education	8.2	7.3	-0.9	8,8	6.9	**-1.9**

Table 3. Businesses' experiences and expectations of research and development cooperation with Ostrobothnia's universities and higher education institutions

Scale of 1–10, 1=very low, 10=very high

	2014			2017/2018*		
Cooperation	**Expectations**	**Experiences**	**Diff.**	**Expectations**	**Experiences**	**Gap**
Research	6.7	6.3	-0.4			
Development	4.7	4.0	-0.7			
Research and development				8.4	6.1	**-2.3**

*Results from 2017/2018 are based on 52 interviews with business executives from the region's energy cluster.

*Experiences refer to the actual level of cooperation, whereas expectations signify the respondent's hoped-for level cooperation. The variance between these two variables forms the difference.

A large difference refers to a need for development measures in order to reduce the difference and tie the regional innovation system's actors together.