european future
innovation system
centre

High level value chain mapping in the Baltic Sea Region:

Pilot exercise on circular bioeconomy

Elina Griniece, Alasdair Reid and Vladimir Cvijanović

Brussels - June 2020

Interreg Baltic Sea Region
EUROPEAN REGIONAL DEVELOPMENT FUND
EUROPEAN UNION
THE BALTIC INSTITUTE OF FINLAND

Table of contents

List of figures

List of tables

Abbreviations used in the text

Abbreviation	**Meaning**
BSR	Baltic Sea Region
CBE	Circular bioeconomy
DESI	Digital Economy and Society Index
EC	European Commission
EUSBSR	European Union Strategy for the Baltic Sea Region
FP	Framework Programme
MS	Member State of the European Union
R&D	Research and development
R&I	Research and innovation
S3 (or RIS3)	Smart specialisation (strategies)
VC	Value chain

Please cite as: Reid, A., Griniece, E., Cvijanović, V. (2020). High level value chain mapping in the Baltic Sea Region: pilot exercise on circular bioeconomy. Study funded by the INTERREG Baltic Sea Region Programme (2014-20) project BSR S3 Ecosystem. EFIS Centre, Brussels. DOI: 10.5281/zenodo.3949883

Executive summary

The Baltic Institute of Finland contracted EFIS Centre to support the methodology development for a high-level interregional smart specialisation (S3) value chain (VC) mapping in the Baltic Sea Region (BSR) for the area of circular bioeconomy (CBE). The main part of work has been done during the worldwide Covid-19 health and sanitary emergency that triggered a socioeconomic crisis and caused some delay in responding to the inter-regional circular bioeconomy mapping survey. Drawing on the questionnaire (circulated for completion to 16 BSR regions from 7 BSR countries) as well as on secondary sources, this report provides analytical insights on value chains in a selected focus area and fosters motivation for the mobilisation of BSR interregional effort in S3 collaboration.

Value chain mapping is defined here as an analytical and visual tool that helps understanding how a particular innovation ecosystem is organised spatially, as well as size wise and direction wise.

Overall, the lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries) appears to be the most serious challenge in CBE development as identified by the BSR regions. Nevertheless, it seems that it is moderately difficult to mobilise financial support for investments/projects in the area of CBE, notably for smaller companies in earlier stage development. These answers may suggest the need for a **more targeted funding line to support the emergence of stronger collaboration mechanisms among the key CBE infrastructures**.

The challenges related to slow establishment of a stimulatory framework for the new bio-based industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion and issues related to new skills for CBE implementation are noteworthy aspects to take into account in the design of inter-regional support measures. Furthermore, the reality of the region is one of fragmented markets in which CBE faces issues related to the economies of scale. Hence, **improving overall supporting conditions for CBE development in the BSR should be a priority.**

Moreover, the survey analysis suggests that the needs for new data and their better overviews are increasingly prioritised given the complexity of CBE value chains. The mapping of specialist expertise in relevant technologies, as well as identification of leading firms across CBE value chains in BSR are particularly highlighted. **Gaining more fine-grained data and better intelligence on the complex cross-sectoral field like CBE should be supported** by joint BSR collaboration mechanisms.

Only a minority of the BSR regions seem to have placed an emphasis on digitalisation as an accelerator of CBE. New data and digital opportunities may aid the improvement of value chains by helping to identify the missing links or potentially beneficial new links e.g. new products emerging from biomass that was previously defined as waste or new industrial symbiosis connections among previously unrelated industries. Data generated from **digitalisation is a promising avenue of how to foster the interlink of the highly complex CBE value chains across the diverse BSR regions**.

1 Introduction

The Baltic Institute of Finland contracted EFIS Centre to support the methodology development for a high-level interregional smart specialisation (S3) value chain mapping in the Baltic Sea Region (BSR). The main part of work has been conducted in the first six months of 2020, over half of which has been marked by a worldwide Covid-19 health and sanitary emergency that triggered a socioeconomic crisis.

In 2009, the BSR was the first macro-region to adopt a common strategy, the European Union Strategy for the Baltic Sea Region (EUSBSR). The BSR comprises eight countries: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden. Norway, Belarus and Russia also collaborate with the BSR countries.

The value chain mapping exercise supports the Interreg BSR Smart Specialisation Ecosystem 'Platform' project[1], which aims to build capacity across the macro-region for innovation-focused interregional collaboration. This study contributes to two key objectives of the project:

1. It provides analytical insights on value chains in a selected focus area and fosters motivation for the mobilisation of BSR interregional effort in S3 collaboration (this report);
2. It develops an outline manual explaining the key steps to take and tools to use in undertaking a macro-regional value chain mapping exercise for strategic innovation domains at BSR level. The manual has been developed as a stand-alone report.

For the purpose of this assignment **value chain mapping is defined as an analytical and visual tool that helps understanding how a particular innovation ecosystem is organised spatially, as well as size wise and direction wise**. It should improve the understanding of value flows and aggregation in the economic and innovation system in an organised and integrated manner. To serve the purpose of enhancing S3 development, we adopt **a meso-level view** (that comprises key networks/clusters/centres rather than all individual actors) when mapping major components and relationships between them. This includes knowledge creating and brokering actors (e.g. universities, research centres, research and technology organisations, centres of excellence, innovation platforms, research infrastructures and testbeds) and innovation diffusion actors (e.g. clusters and other industry-led networks).

This report summarises the results and learning from a pilot value chain mapping exercise carried out in the area of circular bioeconomy. **Circular bioeconomy** (CBE) has been selected as the area for the piloting exercise given the recent policy developments at the EU level – the adoption of the European Green Deal[2], a new Circular Economy Action Plan For a cleaner and more competitive Europe[3] and the adoption of an EU Industrial Strategy[4]. This focus area presents a game changing opportunity for European regions.

Investment in green economy and development of a circular economy are seen as crucial for the European Green Deal as well as to support the response to and recovery from the Covid-19-induced crisis. Moreover, the Industrial Strategy for Europe underlines that there are twin (digital and ecological) transitions that need to be supported through innovation and investment and a circular economy, among others.

Smart specialisation (S3) as a governance instrument prescribing participation of government, industry, enterprises and civil society representatives in managing design and implementation of smart specialisation strategies remain a cornerstone of research and development (R&D) investments in the EU. S3 will remain the approach to follow in the next programming period (2021 – 2017) in the EU. It has furthermore been underlined as an approach to needed to support interregional cooperation, competitiveness and innovation at the regional level.

[1] https://projects.interreg-baltic.eu/projects/bsr-s3-ecosystem-214.html.
[2] https://ec.europa.eu/info/publications/communication-european-green-deal_en.
[3] https://ec.europa.eu/environment/circular-economy.
[4] https://ec.europa.eu/info/sites/info/files/communication-eu-industrial-strategy-march-2020_en.pdf.

Nevertheless, not all regions have equally well-developed infrastructure and activities in the area of the CBE. This is also the case with strategies (in)directly concerning circular and/or bioeconomy that do not all support the development of CBE equally well.

Furthermore, what is clear from this report is the fact that there are capacity challenges in certain BSR regions connected with the type of data gathering an exercise like this entails. There is furthermore a need for regular update on mapping for the main technologies and main stakeholders, across the BSR. This will also help boost awareness of what each region is doing in the area of CBE in terms of its main expertise and facilities.

In the next EU Multiannual financial framework (MFF) period 2021 – 2027 there remains the promising proposal to support S3-focused interregional collaboration through a new 'interregional innovation investment' instrument. This could generate a new impetus, with ground-breaking results in the area if BSR-focused investment for CBE.

The approach to a high-level value chain mapping is experimental. Due to the time and resource constraints of the Interreg project, the pilot analysis performed adopted a **'fast-track' approach**. It is also an early exercise that needs to be followed up by adequate programming and investment efforts which will build the CBE capacities and capabilities of the BSR. The main objective was to identify and map the current possibilities at an inter-regional level and highlight the existing gaps in data availability and coverage.

The report tests the opportunities and limitations of value chain mapping approaches. The pilot exercise aims to trigger further thinking and input from the BSR regions and innovation actors concerning additional, market-relevant information which could be added to the mapping effort. Based on the pilot results, recommendations for the next phase of interregional value chain mapping are outlined to support new interregional opportunities for innovation / smart specialisation collaboration.

In section two, we present the findings and conclusions from the piloting exercise on CBE, which include both an analysis of existing data and a summary analysis of a mapping questionnaire completed by selected BSR regions. Section three presents conclusions and recommendations for next steps and potential co-operation activities and investment priorities to strengthen the CBE in the BSR.

2 Learning from the piloting exercise on circular bioeconomy

2.1 Circular bioeconomy – definition of scope

The term **bioeconomy** refers to the production of biomass and the conversion of biomass into value added products, such as food, feed, bio-based products and bioenergy. It includes the sectors of agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries. The EU definition includes also manufacturing of bio-based textiles[5]. A central concept to innovation-led bioeconomy is biorefinery - a conversion mechanism that through the adoption of a cascading approach favours the production of highest value-added by-products from biomass.

Circular economy is an approach to promote the responsible and cyclical use of resources contributing to the decoupling of economic growth from resource use. In its Circular Economy Action Plan, the European Commission defined the 'circular economy [as the economic space] where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised.'[6]

Documenting the bioeconomy is a challenge for policy analysis because official statistics only report on traditional sectors with no distinction between synthetic and bio-based production (e.g. manufacture of synthetic textile vs bio-based textile). At EU level, indicators for the bioeconomy are estimated based on a combination of multiple sources, mainly by industry associations. There are generally quite good statistical and descriptive materials on bioeconomy, but these do not fully cover all the bioeconomy sectors and also do not extend to regional levels. A similar situation can be found with statistics on circular economy. There is data available for some aspects of the circular economy though, for instance recycling rates and waste statistics.

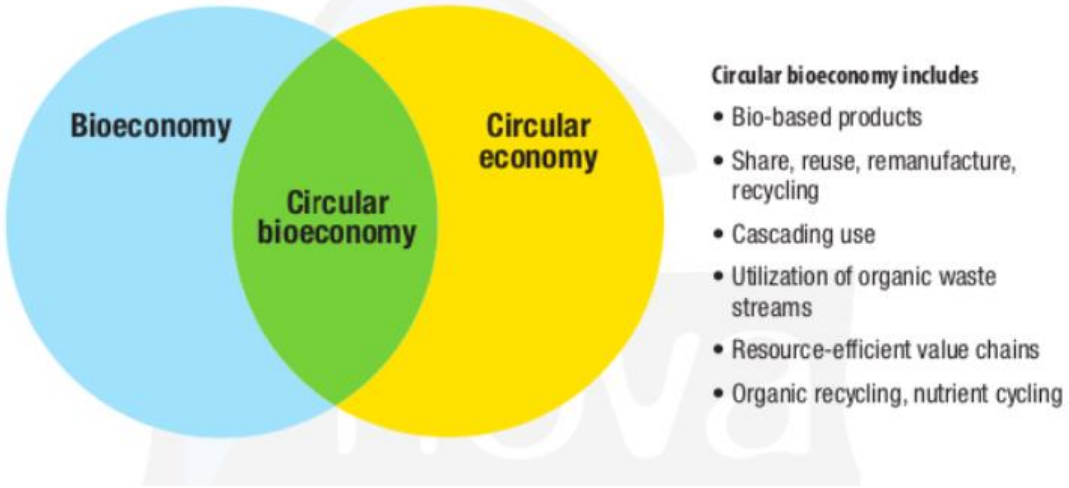
The principles of both bioeconomy and circular economy are in synergy as both aim at a more sustainable and resource efficient world with a low carbon footprint. The approach of both circular economy and the bioeconomy is to avoid using additional fossil carbon to contribute to climate targets. The cascading use[7] of biomass is strongly overlapping with the concept of the circular economy and is mostly a part of it.

They are complementary, but still different approaches. Many elements of the bioeconomy go beyond the objectives of circular economy, including aspects focused on product or service functionality (new chemical building blocks, new processing routes, new functionalities and properties of products). Other specific features of the bioeconomy, which are not covered by the concept of circular economy include the new developments in agriculture and forestry (precision farming, gene editing), new processing pathways with lower toxicities and less harsh chemicals, biotechnology, chemicals and materials with new properties and functionalities as well as more nature-compatible, healthy bio-based products.[8] It is also recognised that some sectors of the bioeconomy cannot satisfy the principles of circular economy, e.g. bioenergy and biofuel, as they are considered a dead-end path for biomass.[9]

The circular bioeconomy is defined as the intersection of bioeconomy and circular economy. The overlap between different material sectors and the concept of circular economy is shown in the Figure 1 below.

[5] https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=strategy.
[6] https://ec.europa.eu/environment/circular-economy/first_circular_economy_action_plan.html.
[7] On the concept of cascading use see Birdlife Europe and the European Environmental Bureau (n.d.).
[8] Carus, M. and Dammer, L. (2018) The "Circular Bioeconomy" - Concepts, Opportunities and Limitations, available at: http://bio-based.eu/downloads/nova-paper-9-the-circular-bioeconomy-concepts-opportunities-and-limitations
[9] https://www.brain-biotech.com/blickwinkel/circular/the-bioeconomy-is-much-more-than-a-circular-economy

Figure 1: Circular bioeconomy scope



Source: Pursula & Carus (2017), in: Newton, A. et al. (2017)

In summary, the concepts of bioeconomy and circular economy have similar targets and they are overlapping to a degree, but neither is fully part of the other nor embedded in the other. The circular economy is not complete without the bioeconomy and vice versa. The huge volumes of organic side and waste streams from agriculture, forestry, fishery, food and feed and organic process waste can only be integrated in the circular economy through bioeconomy processes, while the bioeconomy will hugely profit from increased circularity.

Taking as a reference the work of the EC Expert Group on Bioeconomy[10], the circular bioeconomy (CBE) entails the following activities:

- Utilisation of organic side and waste streams from agriculture, forestry, fishery, aquaculture, food and feed and organic process waste to applications such as aquaculture feed and all kinds of chemicals and materials;
- Biodegradable products being returned to the organic and nutrient cycles;
- Successful cascading of paper, other wood products, natural fibres textiles and many more;
- Innovative additives from oleo-chemicals enhancing recyclability of other materials;
- Once the critical volume of new, bio-based polymers is reached, collection and recycling of bioplastics;
- Linking different industrial sectors (e.g. food industries and chemical industry).

A systematic review of the most prevalent CBE value chains in the EU[11] has singled out the following twelve sectors and their respective pathways (see Figure 2).

Figure 2: Most prevalent circular bioeconomy value chains

Sector	Value Chain
Chemicals	Cellulose to bio solvents
Disposable food packaging	Starch to bioplastic food packaging
Agriculture	Starch to bio-based mulch films
Fabrication	Starch to bioplastics for fabrication
Automotive	Vegetable fats to bio lubricants

[10] Newton, A. et al. (2017) Expert Group Report: Review of the EU Bioeconomy Strategy and its Action Plan.
[11] Lokesh, K., Ladu, L and Summerton, L. (2018) Bridging the Gaps for a 'Circular' Bioeconomy: Selection Criteria. Bio-Based Value Chain and Stakeholder Mapping. Sustainability (10), 1695; doi:10:3390/su10061695

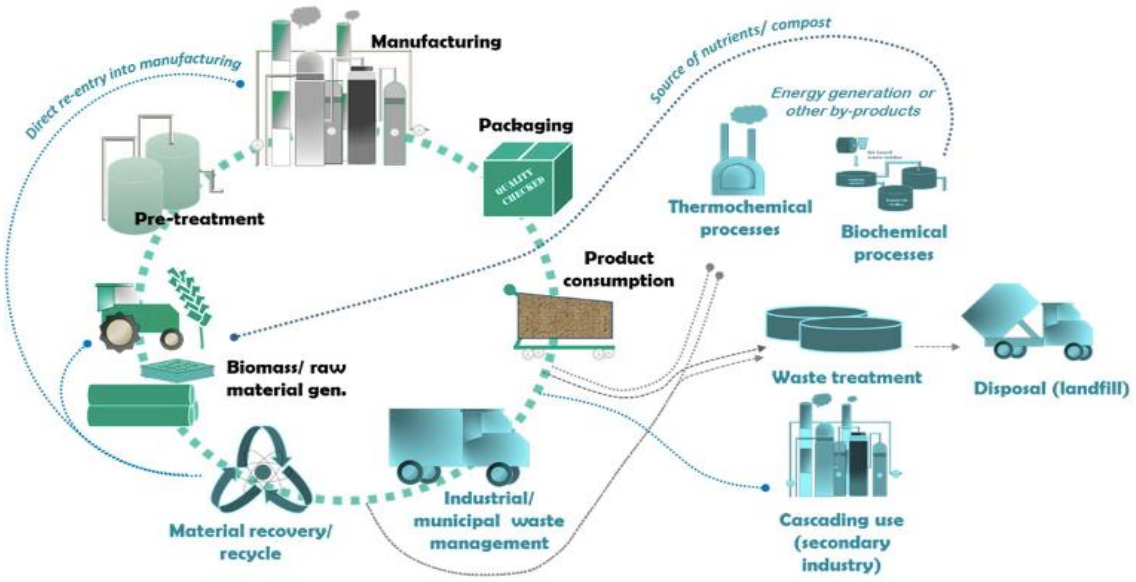
Sector	Value Chain
Agriculture/waste management	Solid biomass to fine chemicals
Textiles	Cellulose to fabric
Food packaging	Cellulose to plastic paper cups
Construction	Waste biomass to insulation material
Construction	Waste biomass to wood-plastic composites
Agriculture	Polysaccharides to crop health inducers
Animal husbandry	Plant-based chemicals to fine chemicals

Source: Lokesh, K. et al (2018)

Circular bioeconomy value chains are highly complex involving a wide diversity of actors. Figure 3 provides a generalised map to convey the connected flows. The main stages of a CBE value chain are:

1. Biomass availability (activities around feedstock production and procurement)
2. Pre-treatment/pre-processing (includes R&D activities)
3. Conversion and formulation using various technologies (includes R&D activities)
4. Packaging and distribution
5. Consumption
6. End of life management.

Figure 3: A generalised map of circular bioeconomy value chains



Source: Lokesh, K. et al (2018)

2.2 Design of the pilot value chain mapping exercise

The selected area for value chain mapping targets the most innovative part of the bioeconomy that concerns highly cross-sectoral activities, including bio-based products, cascading use, utilisation of organic waste streams, organic recycling, etc. While CBE is very relevant from a smart specialisation (S3)[12] perspective, these new cross-sectoral fields are generally not mainstreamed in the EU-level datasets and existing data analysis tools[13]. For this reason, a data-driven approach (using clearly defined and comparable datasets) to circular bioeconomy VC mapping as initially envisioned was substantially refocused making use of more qualitative analysis approaches and connecting this as far as possible to quantitative data and evidence.

2.2.1 Existing evidence base on CBE value chain, investments and policies

EFIS Centre team gathered the available **evidence from the existing EU level databases**, **interregional projects and other dedicated initiatives** to the degree possible within the limited time period. This was done so as to identify the possibilities in data matching and pinpoint main data gaps. A fast-track review of the available data sources of relevance for value chain mapping in CBE revealed that there is sufficient statistical information on many angles of the bioeconomy, yet a more fine-grained view on circular bioeconomy characteristics, especially regarding more interlinked process-oriented value chain perspectives, is hard to form due to the current data structures and ways of reporting.

In addition to the EU level datasets, there is a number of dedicated studies and projects underway, which may add more insight in the future to the current gap in understanding and thus help shape CBE value chains. The Nordic Council of Ministers has commissioned a trend analysis for bioeconomy in the Baltic Sea Region[14]. The final report is expected to be released by July 2020 summarising the most important and relevant macro trends for the area. European Commission's (EC) Joint Research Centre (JRC) with the help of the Bio-based Industry Consortium (BIC) has undertaken a study on all three Baltic States on their bio-based activities, capacities and future potential.[15] BIC also has recently launched a digital bioeconomy partnering platform where regions and industry can make contact based on mutual interest.[16] Similarly, the Interreg project RDI2Club has piloted a Biobord Platform[17] as an open virtual innovation hub for connecting bioeconomy developers across the Baltic Sea Region. An Interreg-supported project on Baltic Industrial Symbiosis[18] aims to promote the concept of industrial symbiosis connecting companies from different industries to integrate waste streams into production cycles. Project activities should generate more fine-grained information on the opportunities for integrating industrial symbiosis principles in CBE of the BSR.

In terms of the main CBE value chain stages, there is detailed data available on current biomass production levels, as well as more complex overviews on the general trends in biomass flows. It is helpful to understand the shares and types of biomass that end up in bio-material production even if the distinction of products that benefit from waste and side stream processing is not clear cut.

Eurostat statistics also provide comparable background data on biomass and land availability, the structure and performance of various bio-economy sectors in terms of human resources, industrial

[12] See https://s3platform.jrc.ec.europa.eu/what-is-smart-specialisation-.
[13] The authors have reviewed a long list of existing data sources including EUROSTAT, Regional Innovation Monitor reports, KNOWMAK tool, EU Trade tool and Trade Competitiveness Map, European Observatory for Clusters and Industrial Change and Cluster Organisation Mapping tool, Regional Ecosystem Scoreboard, MERIL database, ESFRI Roadmap, Eye@RIS tool and ESIF Viewer, among others.
[14] https://nordregio.org/research/trend-analysis-for-bioeconomy-in-the-baltic-sea-region/.
[15] https://biconsortium.eu/green-growth-EU-13.
[16] https://www.bioeconomy-regions.eu/
[17] http://www.rdi2club.eu/
[18] https://symbiosecenter.dk/en/project/bis/

structure, innovation indicators across years and regions. The granularity of the data available does not allow, however, to fully capture the specificities of the CBE focus area.

In terms of the pre-treatment/pre-processing and conversion stages, important pointers of the BSR potential for CBE are provided by biorefinery mapping (see below[19]). Detailed information is available on types of facilities, their main feedstocks and end products allow to form judgements on the areas that hold the highest conversion capacities.

Cluster mapping tools should also help shed light on the current industrial strengths in CBE of the BSR regions. While spatial information on cluster locations is available, the classification of represented sectors and technologies gives only an approximate idea on the business clustering in the specific domain of CBE.

In terms of policy efforts to develop and support the CBE, the existing EU-level policy knowledge base also provides a good understanding of the main national-level strategies. Smart specialisation priority mapping (eye@RIS3[20]) and several past studies have contributed to the understanding of S3 regional priorities across the spectrum of CBE-related domains. However, information on public-private investments into CBE in the BSR remain sketchy. In terms of research and innovation investments, with some effort required for data cleaning, it is possible to extract quite clear information on the main R&I actors active in international research collaboration projects, as well as to identify the main governmental agencies, industry players, networks and projects from databases and structured qualitative reporting. Additional effort in spatial mapping of key players across BSR regions could help to gain a more integrated view on regional strengths and opportunities.

2.2.2 Inter-regional CBE mapping survey

While the external data analysis provides some pieces of the puzzle for generating a better insight on CBE value chains in BSR, a more in-depth understanding is necessary to place the data in the context of the perceived challenges and opportunities for regional collaboration as well as the existing funding landscape. Given the data gaps, a second source of information for the pilot exercise, was a **tailored questionnaire** (see Annex 1) that was circulated for completion to 16 BSR regions from 7 BSR countries.

This survey sought to generate insights into important projects, actions, plans and strategies across the Baltic Sea Region, as well as details about major clusters, industry associations, networks, knowledge and technology institutions. The aim was to **learn more about the nature of BSR regions' innovation investment environment** in the area of circular bioeconomy (e.g. public and private sector sources of funding / investment). In addition, the survey also aimed to **identify key CBE technologies** which are being developed and deployed in the BSR.

It was recommended that the questionnaire was completed through a consultation process that gathers views of a core group of regional experts (e.g. cluster managers, companies, technology experts, policy experts, etc.) to discuss the challenges and priorities for the region in the field of circular bioeconomy and related technological and skills needs. Only one response per region was requested.

The regions invited to complete the survey were as follows[21] (also see Figure 4):

- *BSR S3 Ecosystem partner regions: Swedish region of Västerbotten (NUTS 3), German region (Federal state) of Hamburg (NUTS 3), Finnish Helsinki-Uusimaa (NUTS 3), Päijät-Häme (Lahti) (NUTS 3), Pirkanmaa (NUTS 3) and Kanta-Häme (NUTS 3) regions, Lithuania (NUTS 2), as well as Norwegian Sør-Trøndelag region (corresponding to NUTS 3).*
- *Regions represented in Directors' Network are the following ones: Swedish Gävleborg region (NUTS 3), Finnish regions of Northern Ostrobothnia (Oulu Region) (NUTS 3), Lapland (NUTS 3) and Southwest*

[19] For biorefinery mapping we used https://datam.jrc.ec.europa.eu/datam/mashup/BIOBASED_INDUSTRY/index.html.
[20] https://s3platform.jrc.ec.europa.eu/eye-ris3.
[21] The authors would also like to thank EUBSR PA Innovation and PA Bioeconomy teams.

Finland (NUTS 3), Polish region of Warmińsko-Mazurskie (NUTS 2) and Pomorskie (NUTS 2), Latvia (NUTS 2), and German region (Federal state) Brandenburg (NUTS 1).

Figure 4: BSR regions surveyed

Note: Figure shows Trøndelag instead of Sør-Trøndelag.
Source: Map was created with mapchart.net.

The regions were given from 25 February 2020 to 20 March 2020 for filling out the questionnaire. After prolonging the deadline due to the Covid-19 crisis, the final date for sending the completed questionnaires was set for 8 April 2020. Overall there was some delay in responding to the questionnaire as the Covid-19-related crisis spread and stakeholders in the region were not as mobile as they had previously been. All contacted regions, except one Polish region (*Warmińsko-Mazurskie*), completed the survey by 16 April, hence the analysis takes into account the inputs from 15 questionnaires.

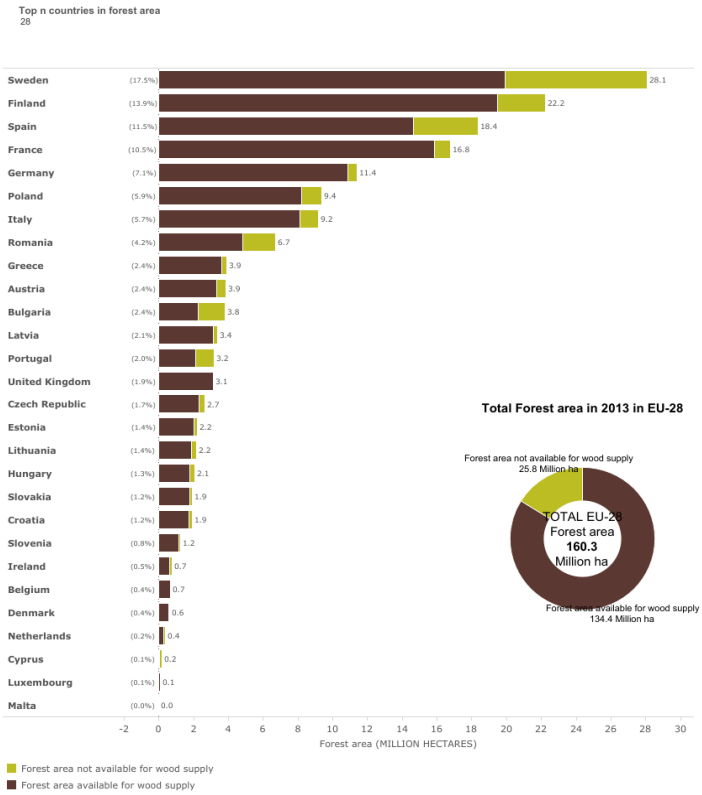
The information collected via the questionnaire provides structured qualitative information on the challenges related to the adoption of CBE technologies, and specialisation in relevant CBE technologies and aimed to better rank regional priorities. The survey sought to collate information for analysis on the sources of funding for developing and implementing CBE technologies, as well as consolidate information on the existing policy strategies, support programmes and priorities for inter-regional co-operation.

2.3 Key findings on CBE value chain stages

2.3.1 Biomass production and biomass flows

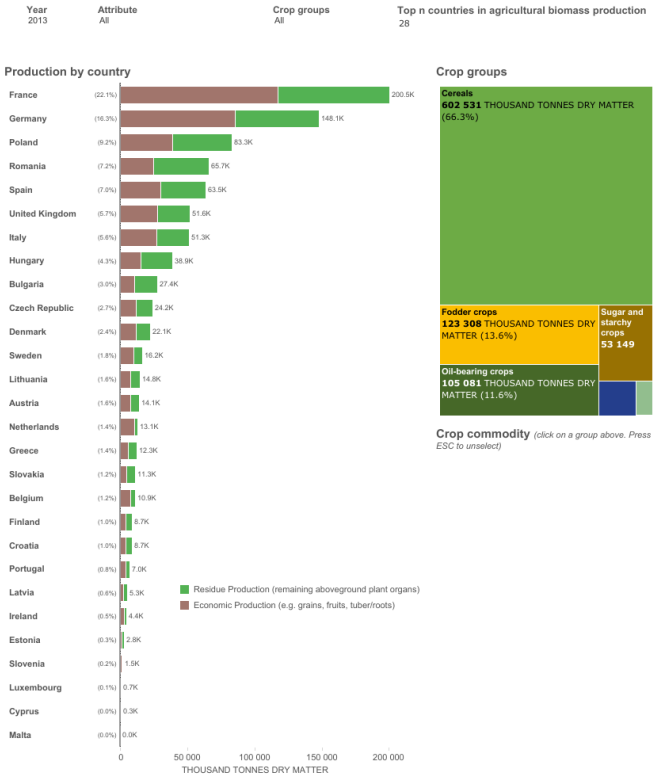
Biomass availability and production is a well-covered aspect in statistics[22]. From the EU perspective, the BSR countries stand out for having the highest availability of land for wood biomass supply. Countries like Sweden, Finland, Poland as well as the Baltic States all represent high shares of forest areas available for wood supply (see Figure 5). With respect to agricultural production, especially from residue biomass, only Poland features as a strong leader among the EU countries (see Figure 6). From all BSR countries, microalgae production is taking place only in Denmark. France and Ireland are the other two major European players in this field.

Figure 5: Top EU countries with forest area availabilities for wood supply



[22] https://ec.europa.eu/knowledge4policy/bioeconomy/topic/biomass_en

Figure 6: Top EU countries with agricultural biomass production, including residues



Source: Knowledge Centre for Bioeconomy of the European Commission

Figure 7: Top EU countries with waste biomass production

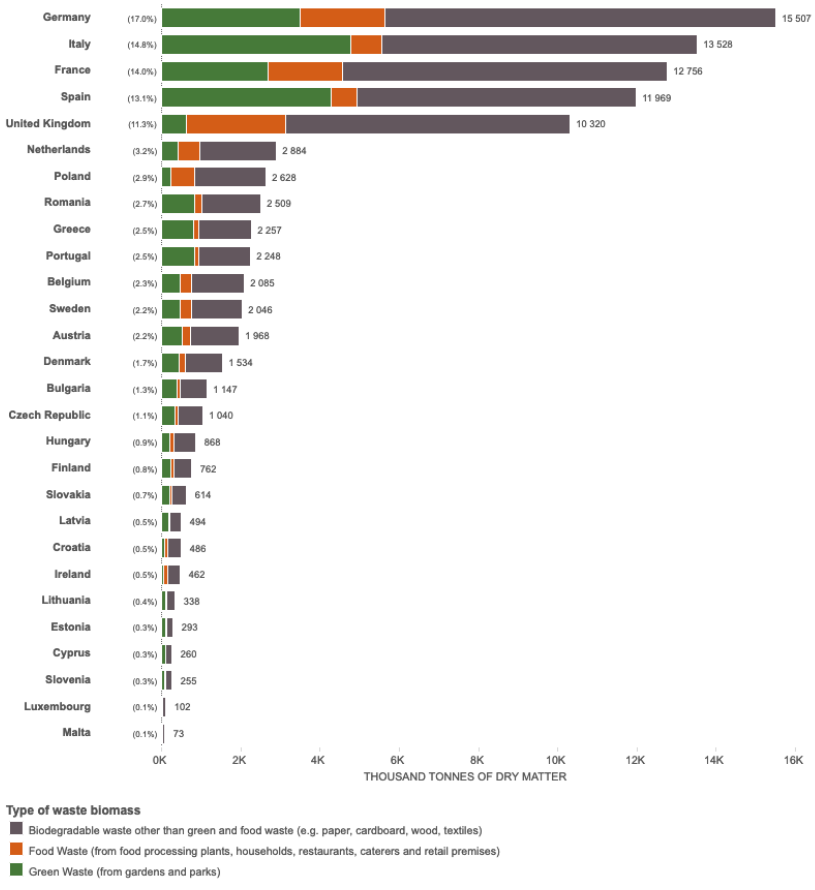
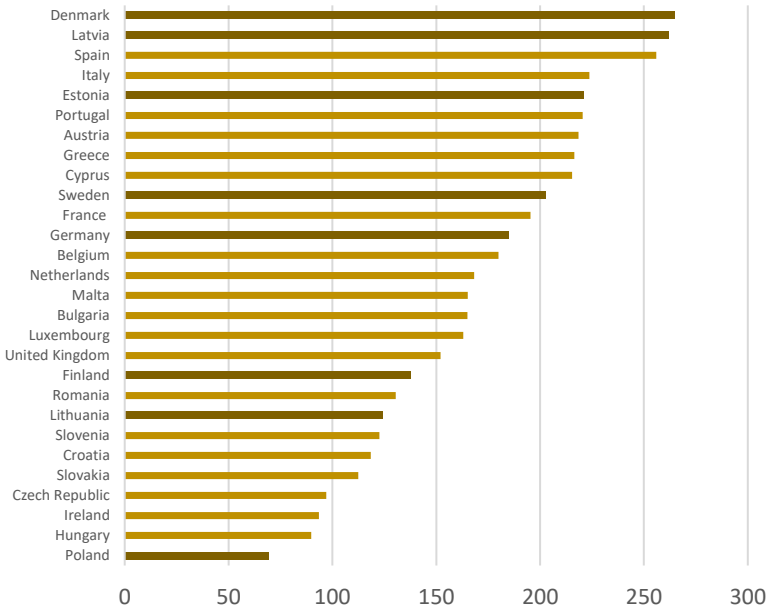


Figure 8: Top EU countries with waste biomass production per number of inhabitants



Thousand tonnes of dry matter per million of inhabitants

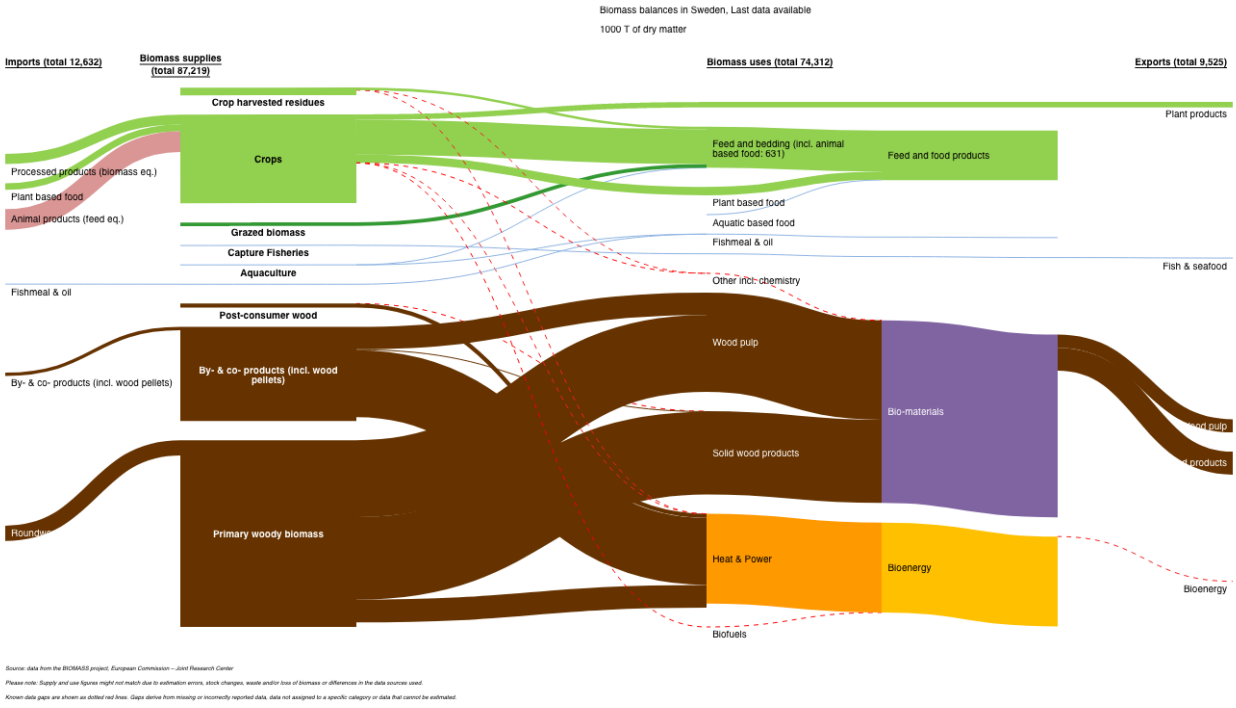
Source: Knowledge Centre for Bioeconomy of the European Commission, own calculation

Compared with other European countries, the BSR countries, aside from Germany, are not leaders in the absolute amounts of biodegradable waste production (see Figure 7). However, given the overall waste production levels per number of inhabitants, Denmark, Latvia and Estonia have high relative levels of waste biomass sources, while Poland has the lowest waste biomass production level in the EU (Figure 8).

Moreover, the Data portal of agro-economics research of the European Commission[23] includes detailed overviews of the main biomass flows in the EU Member States. Figure 9 shows an example of biomass flows in Sweden, including imports and exports. The Swedish as well as the Finnish cases stand out with a strong emphasis on biomaterial production from primary, as well as by- and co-products of wood.

[23] https://datam.jrc.ec.europa.eu/datam/mashup/BIOMASS_FLOWS/index.html.

Figure 9: Overview of biomass flows in Sweden



In the biomass flows of Baltic countries, a much higher share of wood biomass is converted into bioenergy (see Figure 10 for an example of Latvia). In Poland, the major emphasis in biomass flows concentrates on agricultural production for food and feed, yet there is also a notable share of biomaterial production from wood biomass (see Figure 11).

Figure 10: Overview of biomass flows in Latvia

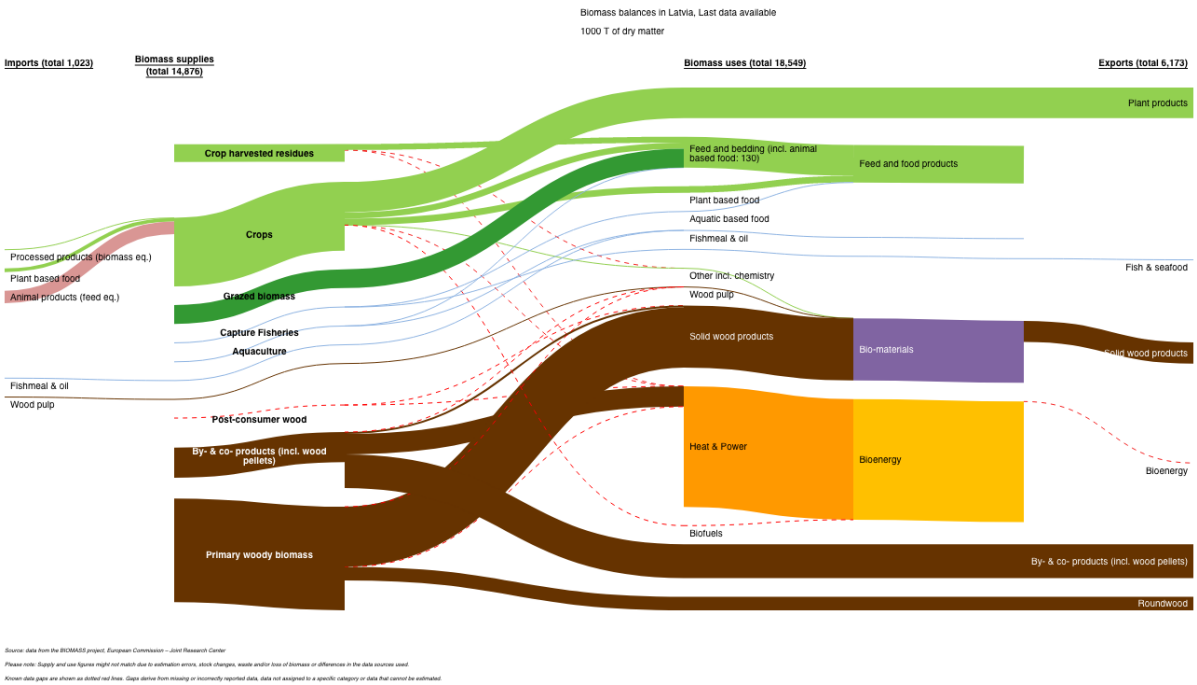
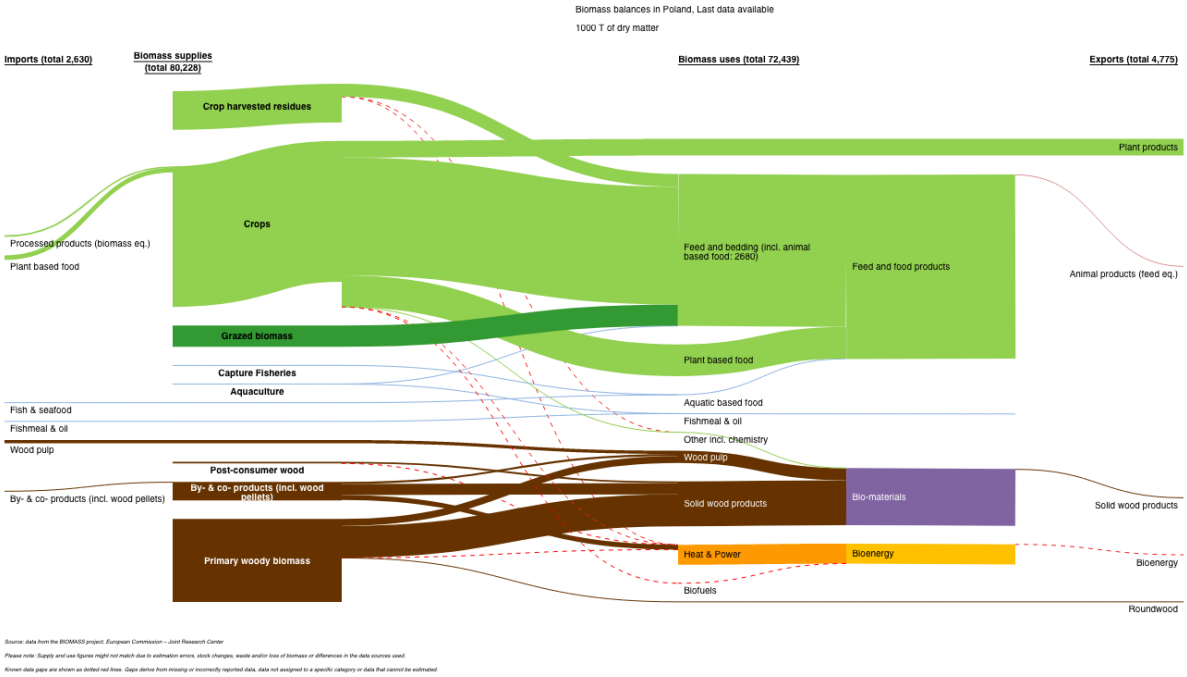


Figure 11: Overview of biomass flows in Poland



Source: Data portal of agro-economics research of the European Commission

While these statistics provide a general feel of the availability and flows of main types of biomass in BSR countries, the level of granularity of this data does not allow to draw out a very clear picture on the side stream and waste stream flows that are of particular relevance for circular bioeconomy. It would be helpful if such biomass flow overviews were available also at the regional level.

2.3.2 Data on major bioeconomy sectors

Looking at NUTS2 and NUTS3 level, there exists a broad pool of data on all major bioeconomy sectors. The RDI2Club project, a BSR Interreg initiative (2017-2020), has developed a dedicated database and statistical analysis dashboard for benchmarking the strengths of regional bioeconomy profiles.[24] Moreover, the dashboard also contains regional bioeconomy profile factsheets that rely on inputs from expert consultations. Unfortunately, the final product does not cover the entire BSR region, but includes only Norway, Finland, Estonia, Latvia and Poland and Western European comparator regions.

Currently the dashboard allows to compare regional statistical data drawn from Eurostat in the following areas:

- Biomass availability, including
    - Forestry land density (% of total land)
    - Agricultural & horticultural land density (% of total land)
    - Agricultural biomass production (kg/cap)
    - Blue biomass production (kg/cap)
    - Forestry biomass production (kg/cap)
    - Waste production (kg/cap)
- Land use indicators
- General indicators on demographics and quality of workforce
- General indicators on employment and cluster size in various bioeconomy sectors

[24] https://berst.databank.nl/dashboard/about-dashboard & https://berst.databank.nl/jive

- General indicators on innovation activities, including firm structure.

While Eurostat data together with expert interpretations of the data provides a rich background for better understanding regional bioeconomy development potential, there is still **a lack of information on the value chain orientation** regarding the bioeconomy sub-area - circular bioeconomy.

2.3.3 Biorefinery mapping in the Baltic Sea Region

A vital piece of the CBE data puzzle is information on biorefineries. Biorefineries represent a key element in the implementation of bioeconomy. Biorefining is also one of the key enabling strategies of the circular economy, closing the loop in raw biomass materials (re-use of forestry, agricultural, aquatic, processing and postconsumer residues), minerals, water and carbon. Therefore, the **mapping of biorefinery distribution and an overview of their main feedstock sources and products in the Baltic Sea Region is especially important for understanding the potential of circular bioeconomy in the macro-region.**

A biorefinery is a facility that enables 'the sustainable processing of biomass into a spectrum of marketable products (food, feed, materials, chemicals) and energy (fuels, power, heat), using a wide variety of conversion technologies in an integrated manner'[25]. Biorefineries combine the necessary technologies of the bio-based raw materials with those of chemical intermediates and final products.

The European Commission's Joint Research Centre (JRC) has consolidated a wide range of sources on biorefineries in Europe establishing an interactive mapping dashboard[26] which is available for public use. EFIS team used this database to draw out key graphs that can characterise circular bioeconomy in the Baltic Sea Region. The extracts cover all EU Member States around the Baltic Sea per type of biorefineries and their main feedstock sources. As noted by the JRC, the mapping information 'includes a wide range of plants, from innovative, recently built biorefineries in which the newest principles of circular economy are applied, to very traditional, decades-old plants obtaining products from biomass (e.g. some timber, paper or starch plants). Certainly, they do not all fall within a definition of biorefinery, but many of them can be called biorefineries, depending on the chosen definition.'[27]

With respect to circular bioeconomy, probably the most interesting aspect is to look at **geographies where there is conversion capacity of waste**. Figure 12 shows that such biorefineries are mainly focusing on production of bio-based chemicals. These are located in Denmark, in German coastal regions, Finnish regions and near Stockholm. Only one such facility is identified in the Baltics and one in Poland. Bio-based composited and fibres from waste are produced only in Denmark and Sweden.

The capacities to produce bio-based chemicals from agricultural biomass are notable in German coastal regions, Denmark, Sweden, as well as Finland and Latvia (see Figure 13). Looking at the same capacities to produce bio-based chemicals, but from wood-based biomass, Sweden and Finland appears to lead heavily in this area, while Denmark, Estonia, Latvia and German coastal regions show only some sparse capacities (see Figure 14).

While an absolute majority of biorefineries included in this database are commercial facilities, it is also interesting to explore where most R&D and pilot biorefineries are located across the Baltic Sea Region. Figure 15 shows that the majority of R&D and pilot facilities in BSR focus on liquid biofuels, which are not included in the focus area of circular bioeconomy. Helsinki appears as the main research hub on bio-based composite and fibre biorefining. Research on bio-based chemical refining is also visible in Swedish, Finnish, German regions, as well as across all three Baltic States.

[25] de Jong, E., Higson, A., Walsh, P., Wellisch, M., 2012. Bio-based Chemicals. Value Added Products from Biorefineries - Task 42 Biorefinery. http://www.ieabioenergy.com/publications/bio-based-chemicals-value-added-products-from-biorefineries. IEA Bioenergy - Task 42 Biorefinery

[26] https://datam.jrc.ec.europa.eu/datam/mashup/BIOBASED_INDUSTRY/index.html.

[27] Parisi, C. (2018) "Research Brief: Biorefineries distribution in the EU". European Commission - Joint Research Centre.

Figure 12: Mapping of BSR biorefineries focusing on waste conversion

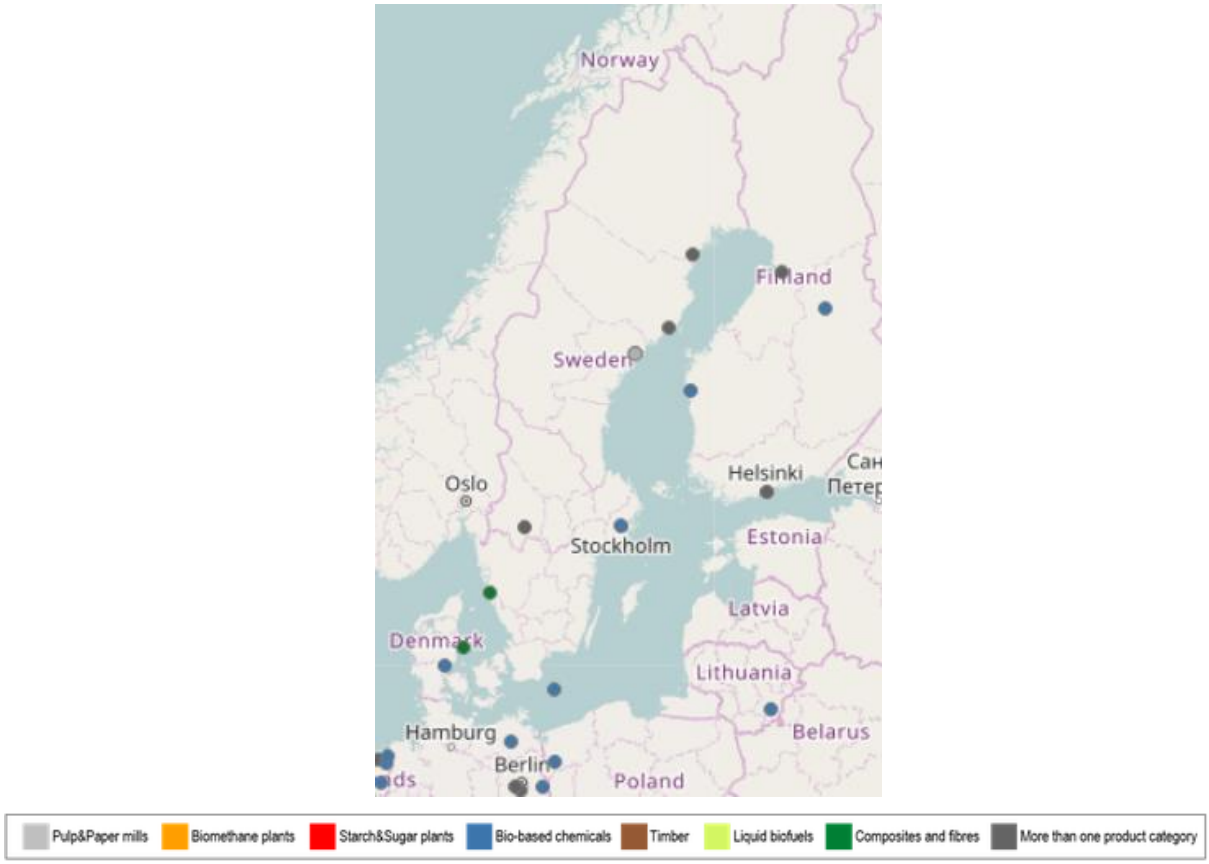


Figure 13: Mapping of BSR biorefineries focusing on agriculture conversion

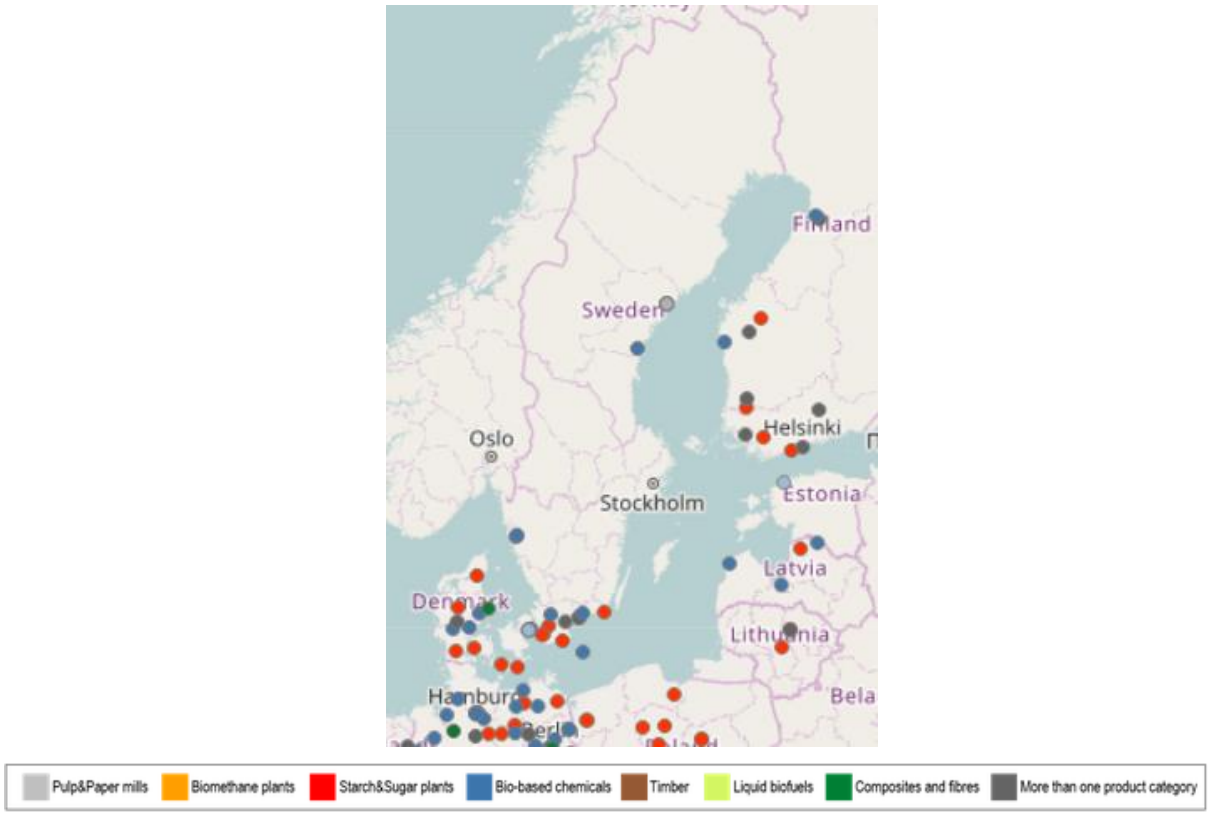


Figure 14: Mapping of BSR biorefineries focusing on wood biomass conversion

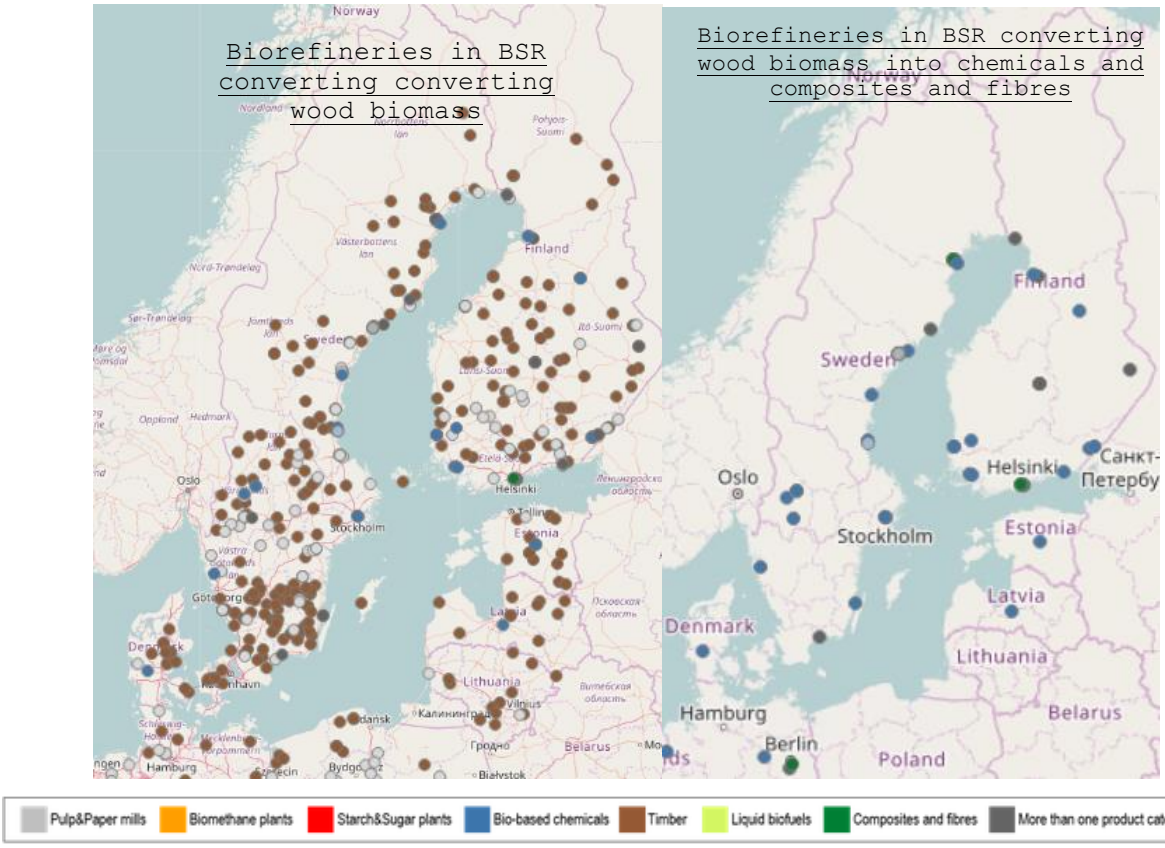
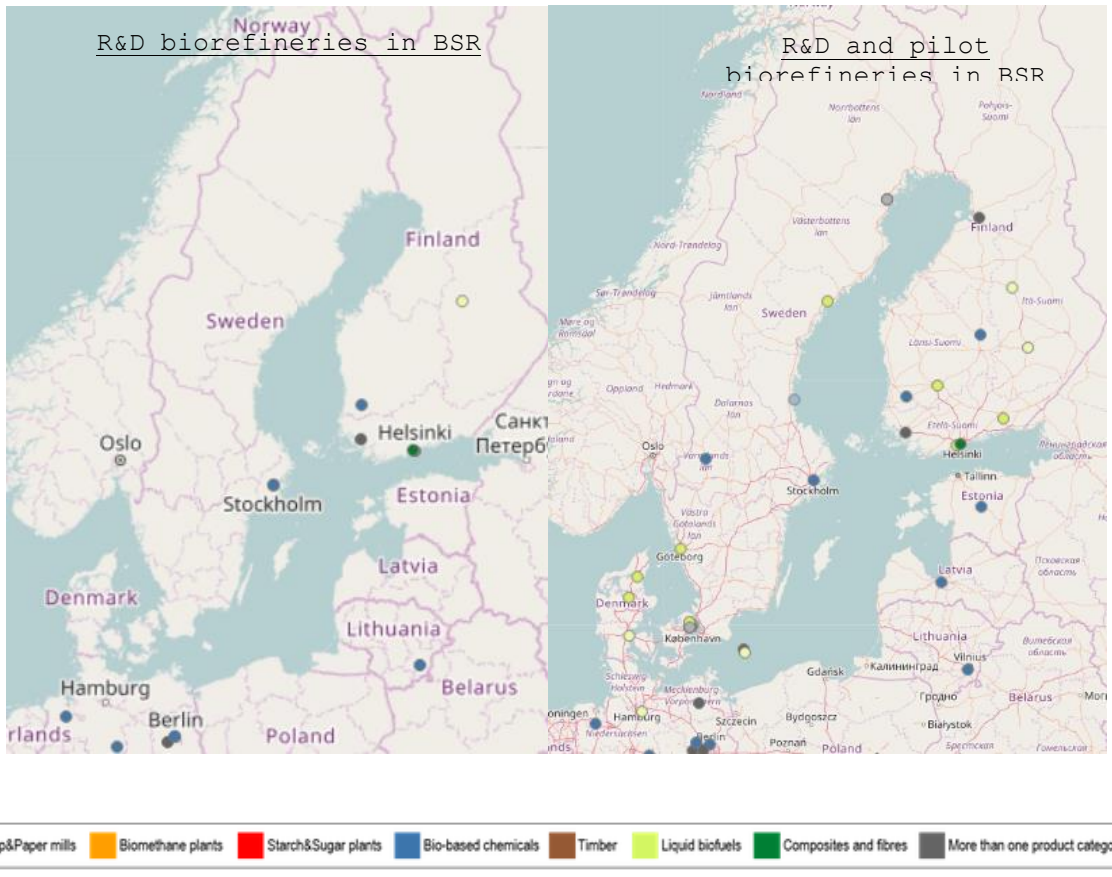


Figure 15: Mapping of R&D and pilot biorefineries in BSR



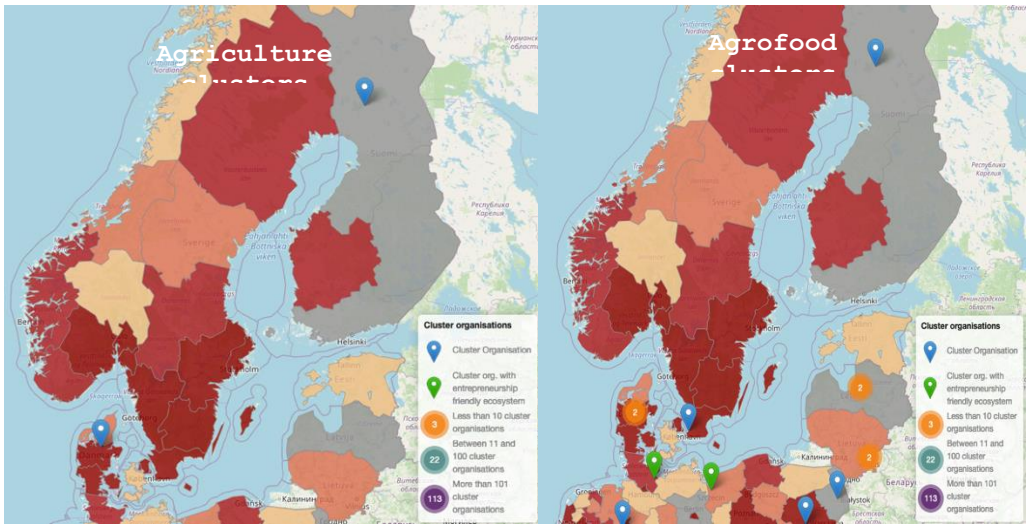
2.3.4 Industrial clusters and business ecosystems relevant for the CBE value chain

Cluster mapping helps to understand better the industrial strengths in CBE related fields across the BSR. The European Observatory for Clusters and Industrial Change offers an extensive cluster mapping dashboard[28] that allows visualisation of cluster locations per sectoral industries, including specified emerging industries, technology fields as well as dedicated S3 priority areas. EFIS team extracted a series of cluster mapping visualisations in specific CBE related thematic areas covering the entire BSR.

Figure 16 shows that agrofood clusters are more frequent in Denmark, Baltic States and the coastal regions of Germany and Poland. Similarly, it is possible to generate overviews of clusters in other traditional sectors like agriculture, forestry, fisheries, yet the degree to which these industrial capacities connect to CBE is not possible to determine from the mapping data alone. Targeting CBE focused clusters, perhaps more relevant it is to look at existing industrial capacities in waste management and industrial biotechnology. Cluster mapping data shows that strong industrial capacities in waste management are apparent only in Denmark and German coastal regions, while industrial biotechnology is concentrated in some clusters in German regions, as well as Norway and Latvia.

For a more encompassing view on industrial strengths in CBE, it is possibly best to view all clusters corresponding to the S3 priority of sustainable innovation (see Figure 17). From this cluster map it can be concluded that the most intensive industrial clustering is taking place around the urban areas of Copenhagen-Malmö and Helsinki, in East Middle Sweden, Småland and the islands, Lapland, as well as to some extent in the vicinity of the cities Riga and Kaunas of the Baltic States.

Figure 16: industrial capacities in waste management



[28] https://www.clustercollaboration.eu/cluster-mapping

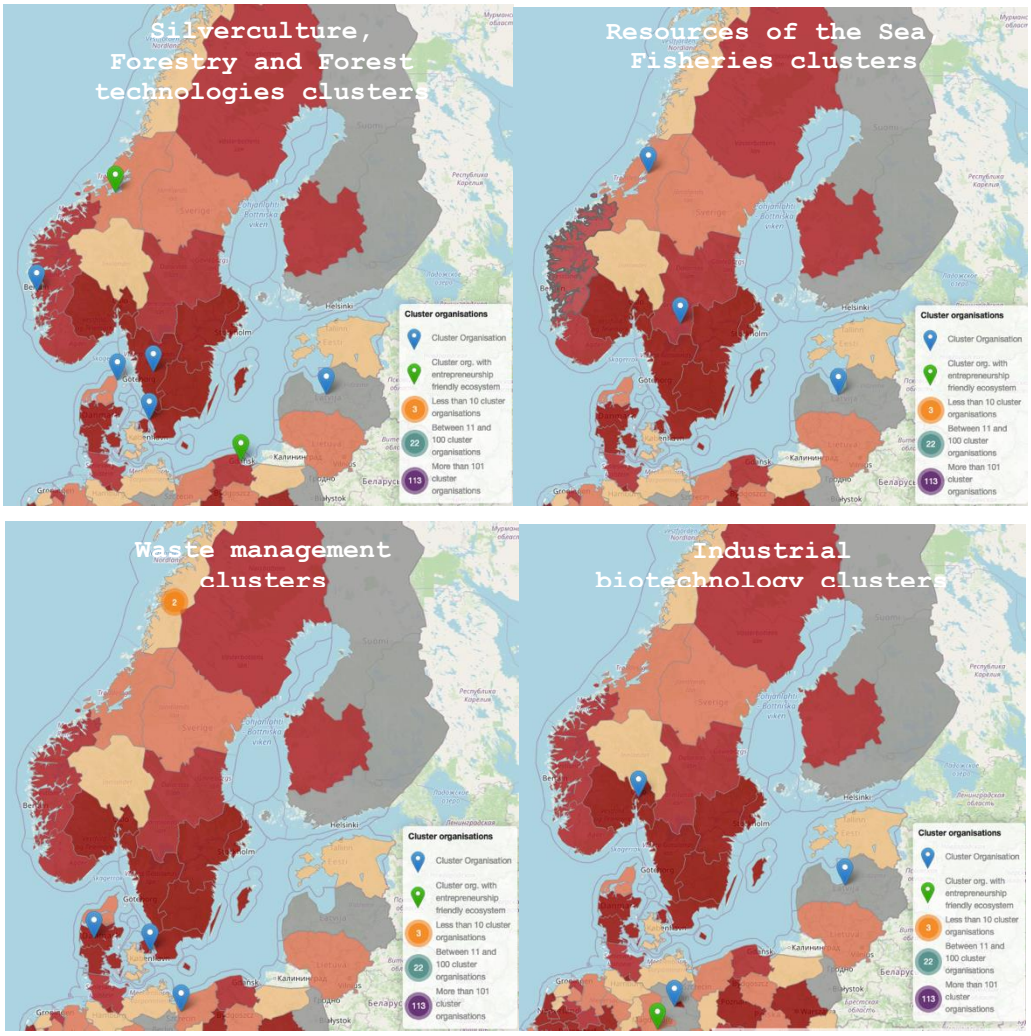
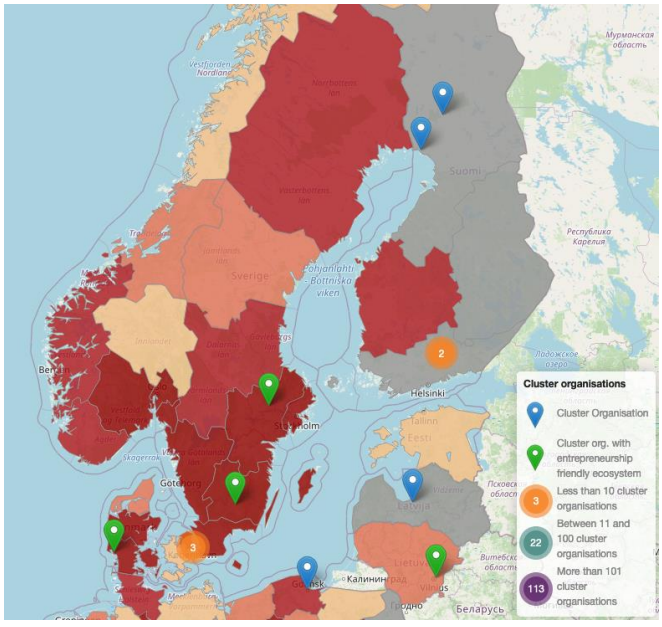


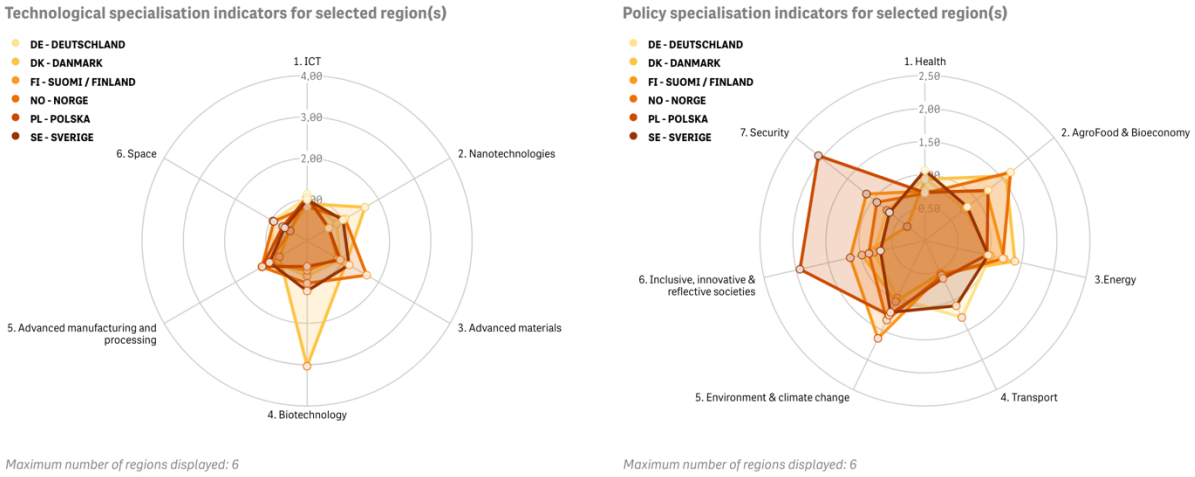
Figure 17: Clusters corresponding to S3 priority area 'Sustainable innovation'



2.3.5 Specialisation in and adoption of CBE technologies

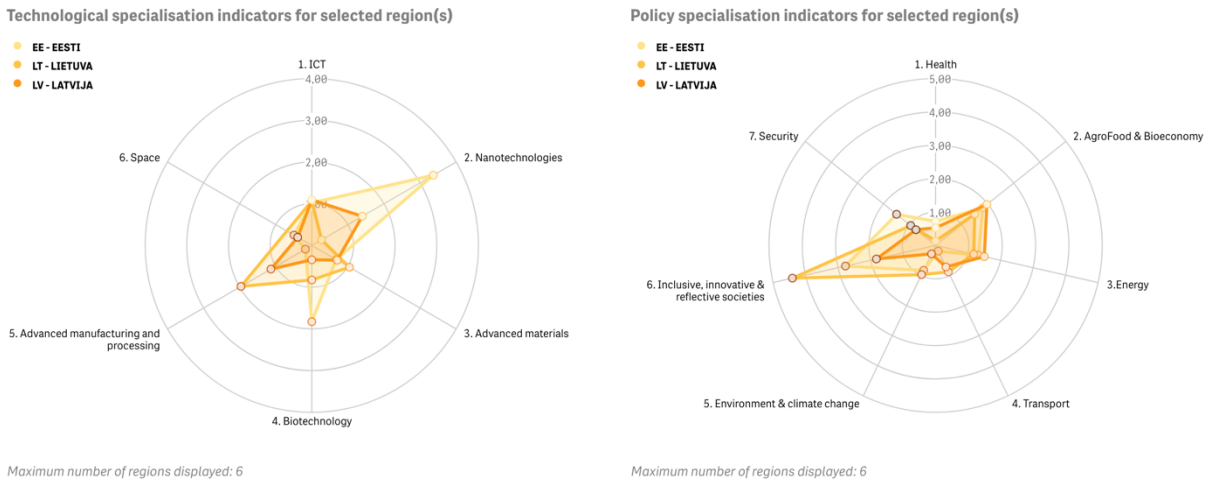
DG JRC's R&I Regional Viewer provides a structured, regionalised visualisation (at NUTS levels 1, 2 and 3) of two sets of data: the Horizon 2020 funding awarded to the participants of projects sourced from the DG R&I Grant database (as of October 2019) and the allocated R&I-related investments under the European Structural and Investment Funds (ESIF). Concerning H2020 funding, the two following figures summarise the results in terms of the broad specialisation categories for the nine BSR countries.

Figure 18: Horizon 2020 technological and policy specialisation of six BSR countries



Source: https://s3platform.jrc.ec.europa.eu/synergies-tool

Figure 19 : Horizon 2020 technological and policy specialisation for the three Baltic States



Source: https://s3platform.jrc.ec.europa.eu/synergies-tool

A degree of specialisation (based on location quotients compared to all European countries/regions) above 1 indicates a concentration of funding in specific areas. As can be seen, in terms of H2020 technological specialisation, Denmark stands out for technological specialisation in biotechnology, followed by Estonia (which is also particularly specialised in nanotechnologies). In terms of policy specialisation, the three Baltic States are relatively specialised in agrofood & bioeconomy (between 1.5 and 2); as are Norway, Denmark and to a lesser extent Poland. The three Baltic States have low specialisation in environment & climate change compared to Finland (1.64), Poland and Sweden which are relatively more specialised. Denmark and Norway also have a relative specialisation in Energy, as do Estonia and Latvia, and to a lesser extent Lithuania.

In order to add further granularity to these broad specialisation indices, an analysis of the main BSR actors and investments in the field of CBE was conducted using the EUPRO database[29]. 'EUPRO is a unique dataset providing systematic and standardised information on R&D projects, participants and resulting networks of the EU FP [Framework Programme], starting from FP1, and recently integrating H2020 (until 2016), and other European funding instruments, such as EUREKA, COST and selected Joint Technology Initiatives (JTIs)'.[30]

The data covers all BSR countries - Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden - at national and regional levels. The analysis covers information on projects starting from 2008 onwards (some lasting into 2020). Extracted was the data on projects with at least one participant from the BSR countries. For the search the following keywords were applied (to the "title" and project "objective").

> *HAVING (((projects.Objective) Like "*bio-based prod*" Or (projects.Objective) Like "*bio based prod*" Or (projects.Objective) Like "*remanufact*" Or (projects.Objective) Like "*re-manufact*" Or (projects.Objective) Like "*cascading use*" Or (projects.Objective) Like "*cascading-use*" Or (projects.Objective) Like "*reuse*")) OR (((projects.Objective) Like "*waste stream*" And (projects.Objective) Like "*organic*"));*

Furthermore, *circular* and *bioeconomy* were also added as keywords, but only if both appeared within the same field, otherwise 'circular' and 'bioeconomy' would have led to a huge number of false positives. The same applied for 'organic' and 'waste' stream. A query for *recyl* was not included as such a strategy would have led to a very elevated level of false positives.

In total, 243 EU funded FP projects were identified via the information on the project level; 90 projects were included because of the information on the call level; an additional 23 projects were detected as relevant on both the project and the call. In sum, 310 potentially relevant projects have been extracted. After a more in-depth examination of the thematic focus, **43 FP and 1 EUREKA project with a CBE focus were identified starting 2008 or later.**

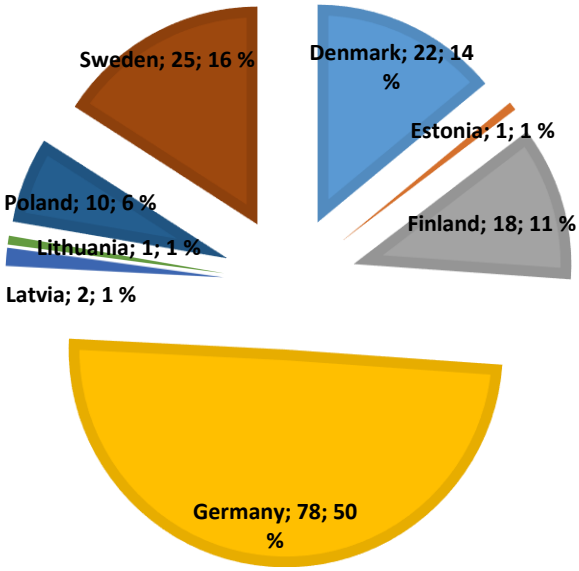
For the 43 FP projects there was a total of 157 participations and the EU granted € **53,678,041**[31] to the BSR regions/countries. In terms of the total participations by country (see Figure 18), half of all participations was by German organisations (50%), followed by Swedish (16%), Danish (14%), Finnish (11%) and Polish organisations (6%). Latvian, Lithuanian and Estonian organisations had only 1-2 participations (1% each). Some organisations showed multiple participations across the 43 FP projects.

The topic of 'waste' was the most frequent one mong the aforementioned 43 FP projects, as 38/43 (88%) projects mentioned it in their objectives' abstracts. Some other common CBE topics were much less represented:

- 'bioeconomy': 2 projects
- 'biomass': 7 projects mentioning only 'biomass' and 2 further projects mentioning 'biomass' and 'bioeconomy' together
- 'biotechnology': 2 projects mentioning 'biotechnology' and 1 project mentioning 'biotechnology' together with 'biomass'
- 'bioenergy': 1 project mentioning

[29] We would like to kindly thank Georg Zahradnik of the AIT Austrian Institute of Technology who patiently worked with us to extract the necessary data we needed for the exercise. We also owe him the methodological explanation.
[30] https://rcf.risis2.eu/dataset/4/metadata.
[31] Data for seven organisations are missing from the database.

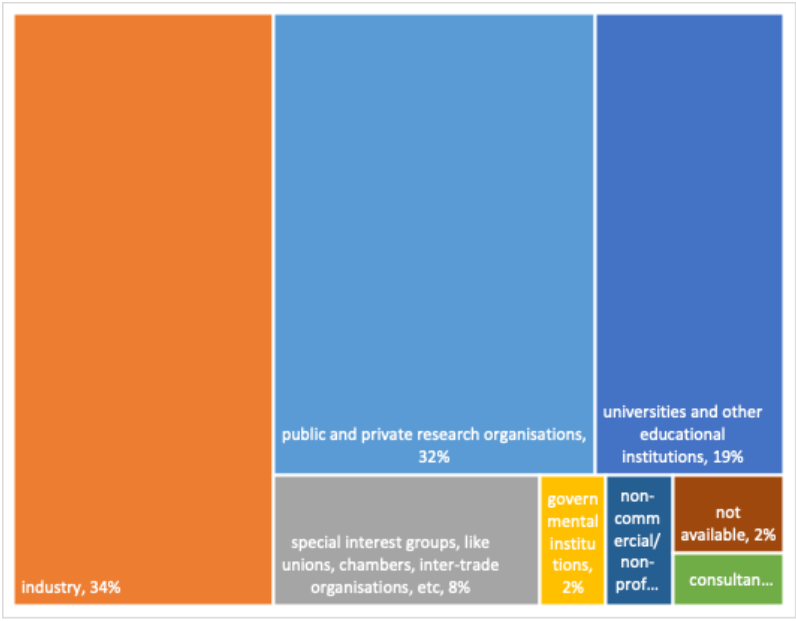
Figure 20: Country representation in Framework Programme projects on CBE



Source: EUPRO database, own calculation.

In 10 of the 43 CBE FP projects a BSR country was a coordinator. Denmark and Poland each had just one coordinator organisation. There was an organisation from Finland that was a coordinator two times. Sweden had two different coordinator organisations. An organisation from Germany figured as a coordinator four times (two times it was the same organisation acting as a coordinator). Concerning the type of organisation that participated in the projects, 34% were from industry and 32% were public and private research organisations. Again, some organisations showed multiple participations (see Figure 19).

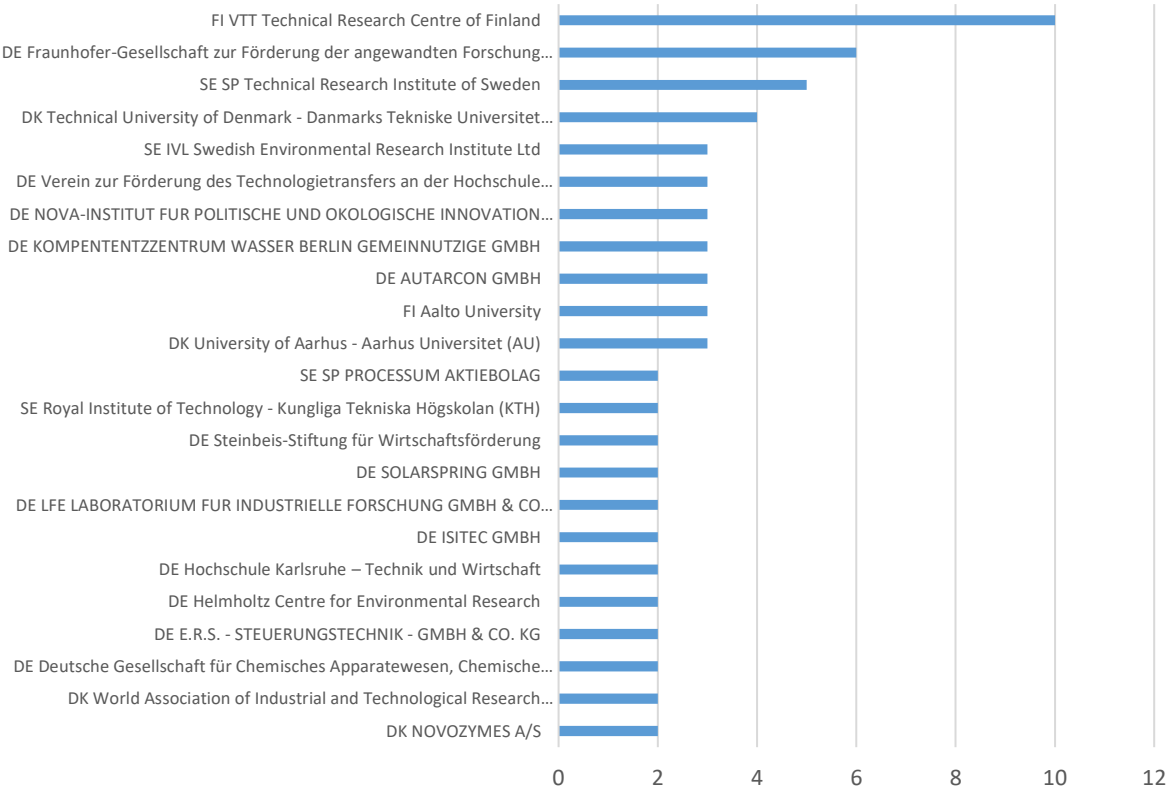
Figure 21: Type of BSR organisations involved in the FP projects on CBE



Source: EUPRO database, own calculation

Figure 20 lists the BSR organisations that participate most actively in EU level R&I projects in the field of CBE. VTT Technical Research Centre of Finland[32], Fraunhofer society (Germany)[33], SP Technical Research Institute of Sweden[34] and Technical University of Denmark[35] appear to be the key R&I drivers in the BSR.

Figure 22: Frequency of participation by BSR organisations in Framework Programme projects on CBE



Source: EUPRO database, own calculation

Note: each of the organisations with the same name, but two, are registered at the same address. The exceptions are Verein zur Förderung des Technologietransfers an der Hochschule Bremerhaven e.V. (one of the three participations from this organisation was from an address different from the other two) and VTT Technical Research Centre of Finland (one of the ten participations from this organisation was from an address different from the other nine).

Two of the top three BSR organisations involved in circular bioeconomy projects (**VTT from Finland and RISE from Sweden) signed, in May 2019, an agreement strengthening their collaboration in the bio- and circular economy.** The objective is to establish a framework for collaboration in the field of bio- and circular economy test and demo infrastructures. The purpose is to create a comprehensive infrastructure portfolio for the benefit of their customers, and to plan future investments. Both research organisations share the same goal to support sustainable development, change towards carbon neutral society and renewal of forest industry. VTT and RISE had previously signed an agreement to increase R&D co-operation in the field of forest bioeconomy. **The new agreement extends the collaboration to also include use and development of pilot and demo infrastructures**. The cooperation will focus especially on biomaterials, biofuel manufacturing processes and digitalisation of a biobased and circular economy.

[32] VTT is a Finnish, fully state-owned limited liability company' (https://www.vttresearch.com/en/about-us/what-vtt).

[33] Fraunhofer society is the largest research-oriented organisation in Germany specialising in applied research (see https://www.fraunhofer.de/en/about-fraunhofer.html).

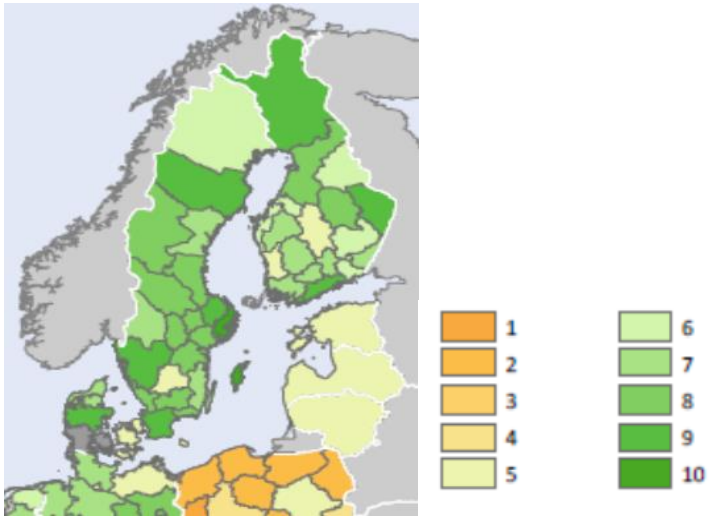
[34] RISE is an independent, State-owned research institute, which offers expertise and over 100 testbeds and demonstration environments for future-proof technologies, products and services in Sweden.

[35] See: https://www.dtu.dk/english/About/profile

Research infrastructures in pilot and demo scale in combination with experienced staff are a prerequisite for upscaling and implementing of new bio-based processes and products[36].

The information on the concentration of the main R&I actors in CBE reflect well the overall R&I system maturity levels across the BSR. A combined maturity index of the bioeconomy profiles of the EU regions has been developed by Spatial Foresight, et. al. in 2017. The index included four key variables: the general regional innovation capacity according to Regional Innovation Scoreboard ranking, the existence of specific bioeconomy strategies and/or bioeconomy related clusters and the intensity of bioeconomy related activities. There are likely to be new developments since then.

Figure 23: Maturity of Bioeconomy R&I



Note: Form 1 – least mature to 10 – most mature bioeconomy R&I profile
Source: Spatial Foresight, SWECO, OIR, t33, Nordregio, Berman Group, Infyde, 2017

Figure 21 visually depicts the distinctions between the Nordic countries regions as the most advanced in this domain, the three Baltic States have moderate R&I maturity levels and the Polish regions the least mature R&I structures to exploit the potential of bioeconomy development. These notable differences in the strength of R&I and industrial ecosystems needs to be taken into account for in any future BSR joint programming initiatives on CBE. Via the survey, the key CBE technologies in which the BSR regions are most advanced/specialised was explored. Regions ranked five technologies (relative to partner regions or from an EU perspective; from 1 - most specialised to 5 - least specialised). The regions that answered the question, using the default answers, declared they are most specialised in 'sustainable chemistry', followed by 'simulation and modelling', 'bioprocess development' and other options, as in Table 1[37].

Table 1: Key technologies for circular bioeconomy

Key technologies for circular bioeconomy	Average
Sustainable chemistry	1.71
Simulation and modelling	2.75
Bioprocess development (e.g. synthetic and systems biology) (does not apply to Latvia)	3.00
Thermochemical conversion	3.17
Plant biotechnology	3.38

[36] See: https://www.ri.se/en/press/vtt-and-rise-strengthening-collaboration-bio-and-circular-economy

[37] The answer for Lapland on sustainable chemistry is based on two completed questionnaires for the region.

Table 2: Technologies for circular bioeconomy in which regions are most advanced/specialised

Region / technology	**Biomass processing technologies**	**Biotechnologies**	**Forestry technologies & wood-based conversion technologies**	**Bioenergy**	**Life sciences**	**Organic recycling & nutrient cycling**	**Waste technologies**	**Waste separation / selection**
Helsinki-Uusimaa	X					X		
Lapland				X				
Pirkanmaa			X	X		X		
Kanta-Hame						X	X	
Paijat-Hame				X				X
Vasterbotten			X	X				X
Gavleborg			X	X				
Latvia	X	X						
Pomorskie				X				X
Brandenburg		X						
Hamburg				X	X			
TOTAL	2	2	3	7	1	3	1	3

Aside from default answers, 11 out of 15 regions (exceptions being Sør-Trøndelag, Lithuania, Southwest Finland and Northern Ostrobothnia) provided answers of their own. Based on those answers there are some specialisations emerging that we may classify as follows (see Table 2). **The most frequently shared specialisations are in the field(s) of bioenergy, with a total of 7 regions specialising in such technologies**. There are three regions specialising in forestry technologies & wood-based conversion technologies, three in organic recycling & nutrient cycling and three further in waste separation / selection. Furthermore, there are two regions specialising in biomass processing technologies and two in biotechnologies.

Only a few regions answered the question regarding the level of importance and the actual level of application of key technologies in regional businesses and whether support for the development of these technologies is accessed outside the region. From those that did answer, it is evident that CBE is linked inter-regionally and internationally, as it serves to achieve appropriate economies of scale and cooperation in technology development:

- Some Finnish regions (Pirkanmaa, Lapland and Päijät-Häme) stressed the importance of accessing programmes and/or technologies and/or projects outside the region. For instance, Pirkanmaa region (that mentioned Finland as a 'small market') stated: 'Active international business and RDI cooperation is implemented by CBE companies, for example, biogas technology comes from Germany'.
- Another example is the Gävleborg region, where '[t]he pulp and paper industries are large groups acting regionally, nationally and globally. They have research resources and global co-operation. Besides that, for clusters, SMEs and projects, research cooperation outside the region is mainly with Mid Sweden University in Sundsvall, Swedish University of Agricultural Sciences (SLU), Royal Institute of technologies in Stockholm, and Linköping University. For hydraulics for example, Linköping University is a main partner. For hydrogen, FCH JU and S3 platform Hydrogen Valleys.'

The above-mentioned **findings on levels of cooperation point to the conclusion that more analysis is needed to understand the full picture of cooperation and demand of main stakeholders to widen it.**

When it comes to the main challenges facing regional firms in adopting key technologies or introducing innovations in the area of CBE, the regions ranked options (1 - most important to 5 - least important) provided in the questionnaire, but they were free to add further ones as well. Table 1 shows the awarded average ranking of the answers from all the region that provided input.

The lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries) is perceived as the most serious challenge, overall (see Table 3). Slow establishment of a stimulatory framework for the new biobased industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion is also prioritised among the main challenges. Also, the issue of limited knowledge, skills and expertise in novel areas of bio-based economy is perceived as an important obstacle.

Table 3: Main challenges facing regional firms in adopting key technologies or introducing innovations in the area of CBE

Challenge	Average
Lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries)	2.36
Slow establishment of a stimulatory framework for the new biobased industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion	2.8
Limited knowledge, skills and expertise in novel areas of bio-based economy (in public research, business sector, universities, policy makers and regulators)	3
Lack of open access test facilities for facilitating the upscaling new processes and products	3.25
Lack of ambition in the political goals for level of upgrade of underexploited bioresources	3.33

Challenge	Average
Limited business access to international markets and integration in value chains, especially for niche products with high value added	3.33
Limited availability of various complementary actors in the regional business ecosystem	3.43

Furthermore, there is an issue with the **lack of open access test facilities**. This factor does not feature among the top three challenges of the regions that answered the questionnaire. Nevertheless, several regions - Päijät-Häme, Lithuania and Pomorskie – underlined it as the most serious factor[38]. As both lack of knowledge of test facilities as well as lack of demand in general may be the cause, the 2021 – 2027 programming period tools – like the Horizon 2020 Innosup programme[39] – are needed to not just inform but also incentivise innovation system stakeholders to use them.

2.4 CBE policies and investment trends

This section covers CBE strategies and policies in the BSR (2.4.1), Sources of funding for developing and implementing CBE technologies (2.4.2) and future priorities for inter-regional co-operation (2.4.3).

2.4.1 CBE strategies and policies in the BSR

The Knowledge Centre for Bioeconomy of the European Commission also draws together information on the current policy landscape in the area of bioeconomy[40]. Figure 22 shows that – currently - only **Finland, Latvia, Germany as well as Norway have developed dedicated bioeconomy strategies.** Such strategies are still under development in Lithuania and Poland. Demark, Sweden and Estonia have other policy initiatives dedicated to bioeconomy, but not an overarching national strategy document.

Higher participation of civil society and other quadruple helix stakeholders (government, industry, higher education and other research institutions, civil society) would definitely help support S3 in the BSR. There is a history and habit of communication and co-operation between different societal groups in Finland and Sweden, and also some recent efforts to strengthen the participation of societal groups (see Roman et al, 2020). Quadruple helix is nevertheless not that common in the EU (see e. g. Grundel and Dahlstöm, 2016 and Marinelli and Perianez Forte, 2017).

[38] There is a listing of certain test facilities in the BSR available at https://testfacilities.eu/.

[39] https://ec.europa.eu/easme/en/innosup.

[40] https://ec.europa.eu/knowledge4policy/visualisation/bioeconomy-different-countries_en.

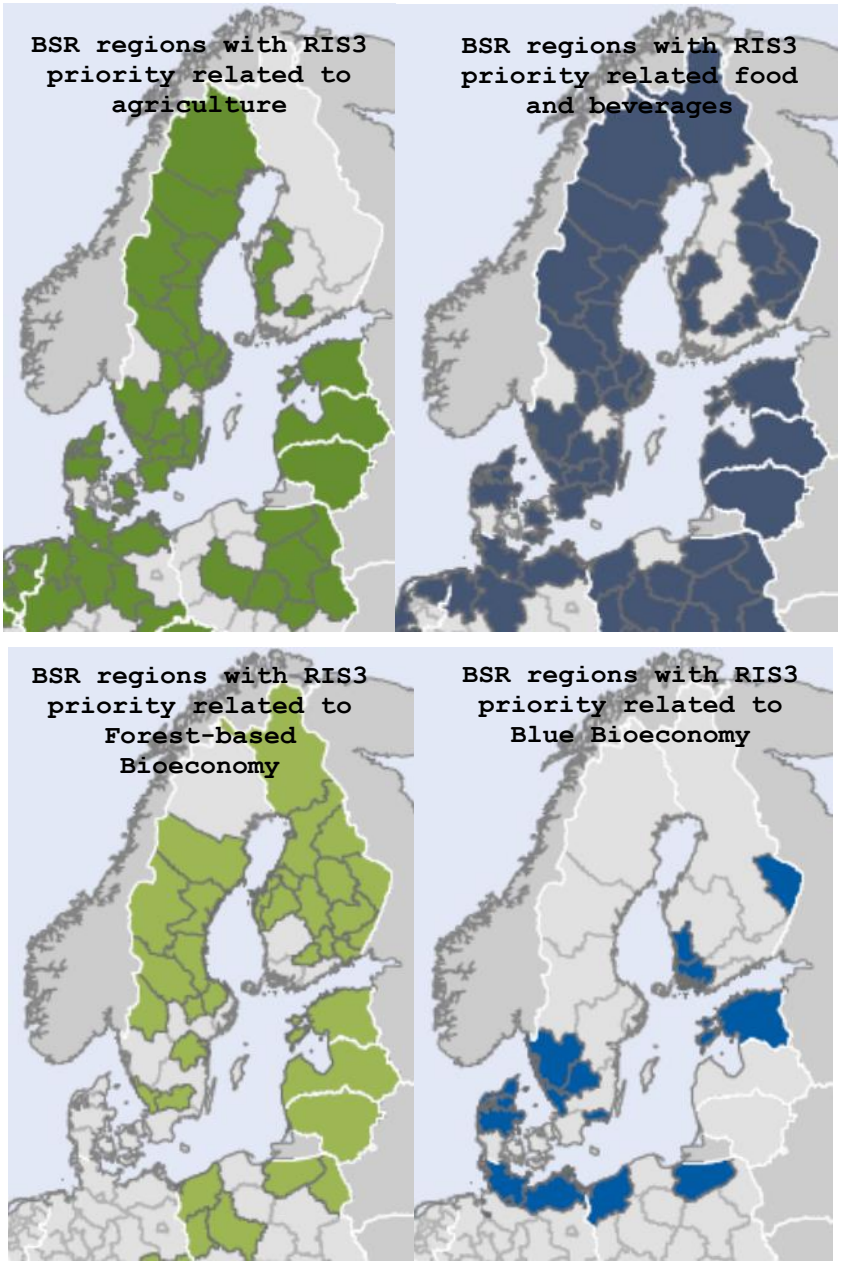
Figure 24: Strategies and other policy initiatives dedicated to the bioeconomy in BSR countries

Source: EC Knowledge Centre for Bioeconomy, extract from strategies and initiatives metadata

A study focusing on detailed S3 priority analysis performed in 2017[41] (see Figure 23) shows that the majority of BSR regions include agriculture and food production within their S3 priorities in the period 2014-2020. Forest-based bioeconomy is prioritised by the majority of Swedish and Finnish regions, as well as Polish regions and all three Baltic States. Blue Bioeconomy is singled out more by Danish and Swedish regions around the Kattegat sea area, as well as separate coastal regions of Germany, Poland, Finland and Estonia.

[41] Spatial Foresight, SWECO, OIR, t33, Nordregio, Berman Group, Infyde (2017): Bioeconomy development in EU regions. Mapping of EU Member States'/Regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020. Study commissioned by DG Research & Innovation, European Commission

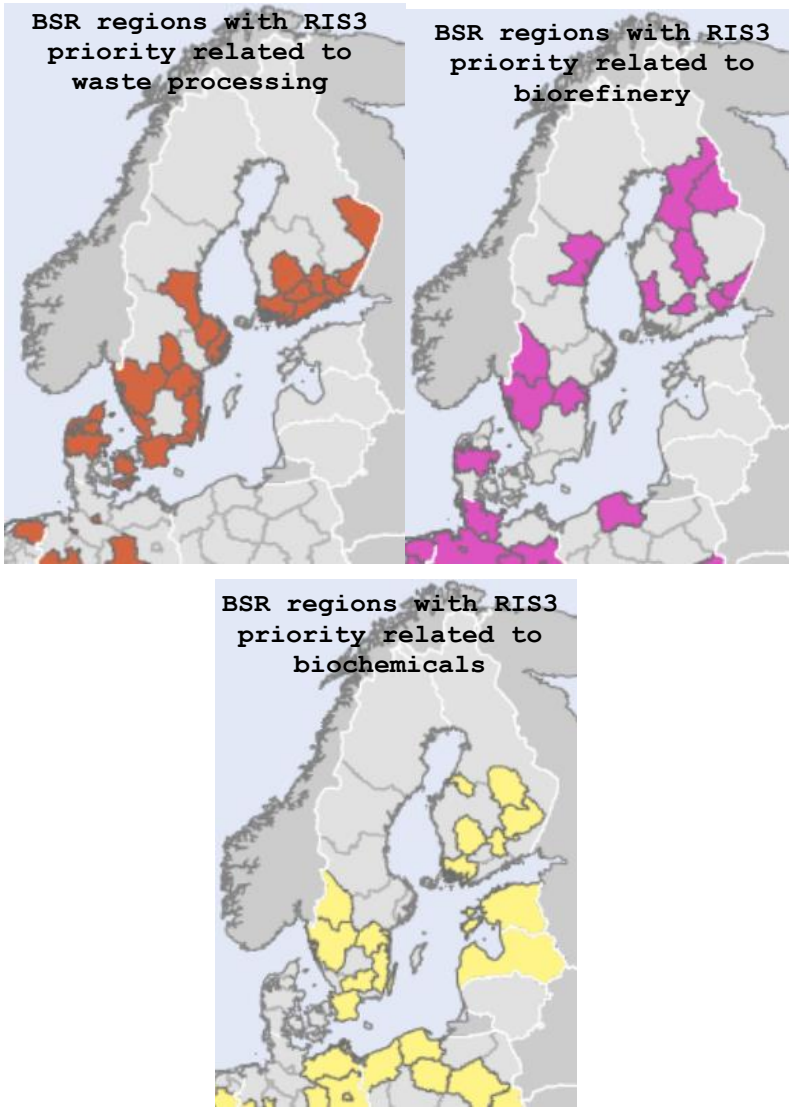
Figure 25: BSR regions with RIS3 priorities in different sectors



Source: Spatial Foresight, SWECO, OIR, t33, Nordregio, Berman Group, Infyde, 2017

It is interesting to note that **waste processing as a priority is put forward mainly by technologically more advanced Swedish, Finnish and Danish regions**. Biorefining features strongly in the chosen S3 priorities of most Finnish regions. This priority is also present in selected Danish, Swedish, Polish and German regions. Biochemicals as a policy priory is put forward by the regions of Southern Sweden, Finland, Estonia, Latvia, as well as German and Polish coastal regions (see Figure 24).

Figure 26: BSR regions with RIS3 priorities in waste processing, biorefinery and biochemicals



Source: Spatial Foresight, SWECO, OIR, t33, Nordregio, Berman Group, Infyde, 2017

To provide further granularity, the mapping survey explored further how the current regional strategies, including S3, address challenges related to CBE. In the Finnish and Swedish regions there is a variety of other strategies addressing CBE, which is probably making it easier for the regions to clearly specify and elaborate their priorities in CBE. Indeed, all of the regions have specified at least some priorities in this area, which is a good sign for future development of the field.

BSR countries are typically highly ranked on the Digital Economy and Society (DESI) Index[42]. Although digitalisation is important as a steppingstone towards more innovation and more effective and efficient business processes it seems not to be featuring highly on BSR countries' agendas. However, **only a minority of the regions have placed an emphasis in strategies on digitalisation as an accelerator of CBE. This is the case for Northern Ostrobothnia, Pirkanmaa, Sør-Trøndelag, to an extent with Pomorskie and with both Swedish regions: Gävleborg and Västerbotten**.

[42] https://digital-agenda-data.eu/datasets/desi/visualizations.

We can identify some Digital Innovation Hubs (DIHs)[43] that may help the BSR-based companies in digitalisation efforts from the dedicated EC's website.[44] A search of DIHs in the eight BSR countries (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden) that are fully operational and belong to seven chosen sectors (see Table 4 and the note below it) reveals the 45 DIHs for the BSR countries not including DIHs south of Berlin (Germany) and Poznan (Poland), and they are present in all BSR countries. Including 'bioeconomy' as the search term we only get one single DIH, under No. 16, Finnish Center for Artificial Intelligence.

Most value to be created by inter-regional co-operation in the area of CBE, given the challenges and the priorities at regional level, is found in different topics. While three regions (Västerbotten, Hamburg and Päijät-Häme) have not provided answers to that question, several groupings are visible. Some listed various (and specific) CBE topics for inter-regional cooperation, some others underlined specific needs. The needs of inter-regional co-operation in the area of CBE indicated here need to be taken into account when concrete planning and actions for widening CBE in the BSR are discussed:

- Latvia and Pomorskie emphasised **awareness raising networking/events for industry on the potential of circular economy**, while the latter underlined a need **to map and gain knowledge of this area.**
- The areas of potential value creation by inter-regional cooperation are similar also among Lapland (with some specific CBE fields, but also **industrial ecosystems to enhance CBE**), Lithuania (combining specific CBE field with an idea of development of CBE ecosystems) and Gävleborg (that combines an incentive and methods on how to do the transition with development and application of **new business models and industrial symbiosis for SMEs**).
- Finnish regions of Pirkanmaa and Kanta-Häme form another group. The former focus on **digital solutions and platform economy on CBE**, promotion of **solutions for systemic change, start-up acceleration activities and cooperation and co-creation on CBE.** While the latter region wants to **share good practices / benchmarking** with other regions, it is interested in new business solutions, new practices for information and knowledge sharing as well as information on **financial instruments**.
- On the other hand, Sør-Trøndelag region had very concrete topics that can only be kicked off in an advanced innovation/industrial ecosystem. The groupings laid out above correlate to a large extent with a level of development of each region, starting from awareness raising events over enhancing industrial ecosystems to support CBE to digitalisation and platform economy with regard to CBE.

While the BSR scope for a VC orientation is geographically quite limited, this geography was selected as a starting point, with the aim of better understanding and further engaging the interest of BSR regions and innovation actors in the CBE innovation ecosystem 'space'. In future, it is expected that VC developments will be further supported, to expand beyond regional and national borders in the BSR[45] and to support a wider EU VC orientation, in line with the ambitions outlined in the EU's Industry Strategy.

In terms of the related actions to address more depth CBE-focused,i nterregional engagement BSR regions should undertake further mapping and analysis of CBE potential as well as policy learning based on best practices – mostly the case with regions with below-average level of development in the BSR. For more developed regions, programmes should be able to expand capacities of industrial ecosystems serving CBE. The most advanced regions may be able to move beyond this exchange, and **work towards joint, CBE-focused investment programmes**, thus moving towards interregional innovation investment. A wider

[43] Digital Innovation Hubs, or 'DIHs are one-stop shops that help companies become more competitive with regard to their business/production processes, products or services using digital technologies' (https://ec.europa.eu/digital-single-market/en/digital-innovation-hubs).

[44] https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool.

[45] That is one of the tasks of the of the BSR Stars S3 - Smart Specialisation through Cross-sectoral Bio-, Circular- and Digital Ecosystems project (see Nordregio, 2019)

package of support actions should be envisaged, to create a new innovation ecosystem dynamic, which can reach out to wider EU CBE-oriented efforts, **creating value chain opportunities for BSR industry actors and the macro-region's wider innovation community**. including inter-regional ones.

In addition, the regions responding to the survey listed and ranked key challenges that should be taken into account for future strategy development. These are listed below in four groups:

Lack of knowledge and awareness in the field of CBE

- Limited knowledge, skills and expertise in novel areas of bio-based economy (in public research, business sector, universities)
- Limited knowledge, skills and expertise in novel areas of bio-based economy (policy makers and regulators)
- Insufficient public awareness and focus on sustainability topics
- Limited business integration in value chains due to lack of knowledge of how our regional value chain steps can be combined with those from other regions
- Lack of common holistic view on CBE (with cross-cutting, strategic initiatives and solutions, enabling systemic change); currently, efforts and initiatives too strongly based on separate pilots and platforms
- Capability to present regional ecosystem, its capabilities and achievements internationally

Fragmented market and lack of economies of scale

- Lack of networks to connect existing players and industries
- Small markets for many existing solutions (scale challenge)
- Too weak connection between CBE initiatives and solutions and climate goals (all industrial CBE solutions not useful, no matter how innovative they are)
- Insufficient cross-sectoral collaboration and fragmented tech transfer system

Financial reasons

- High input costs
- Lack of the financial incentives such as taxes
- Lack of investment funds / sources of funding (direct public funding)
- Limited national R&I funding in general which restricts the design of new tailored support measures
- Lack of incentives to take greater leap in the transition – low levels in value chains and so far in good economic times

Other reasons

- Low political pressure to establish a new circular system (no prioritised funding and no 'green' public procurement)
- Customers are not wiling/have not been willing to pay more for biobased/sustainable/circular products
- Structural rigidities in the labour market
- Demographical problems (emigration, ageing of the population, etc.).

Many of the mentioned challenges are a variant of some of the factors listed in the table above. However, a **group of factors around 'fragmented market and lack of economies of scale' represents a cluster that is not visible from the default options above**. Hence, in addition to the aforementioned financial, regulatory, political and other reasons, the reality the regions are facing also concerns fragmented CBE markets with the issues of (lack of) economies of scale.

2.4.2 Sources of funding for developing and implementing CBE technologies

Several initiatives have been taken to map funding available for bioeconomy and circular economy projects and enterprises. At European level, the Bio-based Industry Consortium (BIC) published a report on funding instruments for supporting projects and business growth of the European bioeconomy[46] in 2018. While strictly speaking focused on only the bioeconomy angle, the BIC report proposes a typology of funding available during the current 2014-20 period which is relevant for the more specific circular bioeconomy topic as well.

Figure 27: Financial Solutions for Bio-based Industry Projects

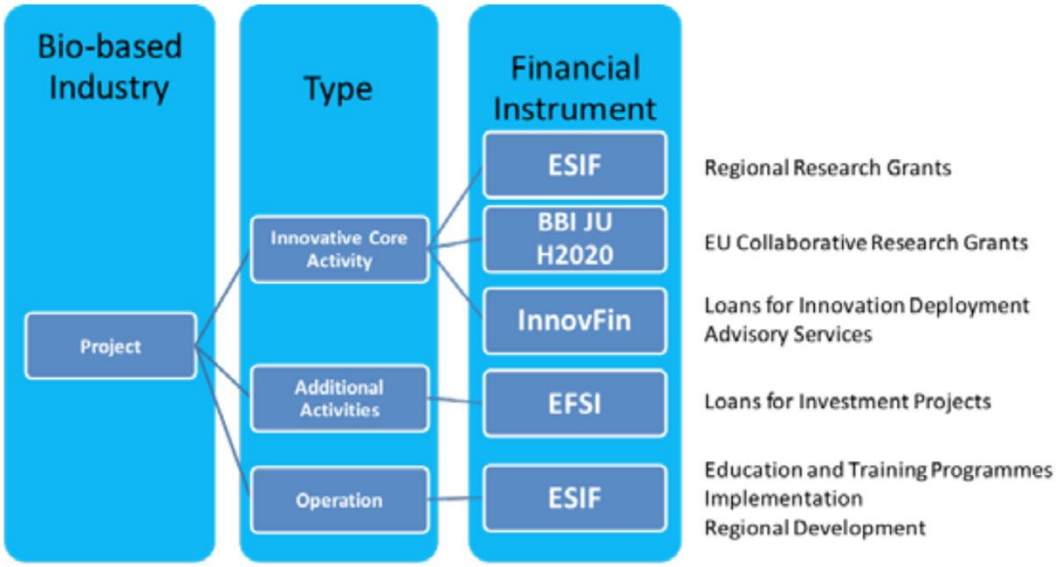
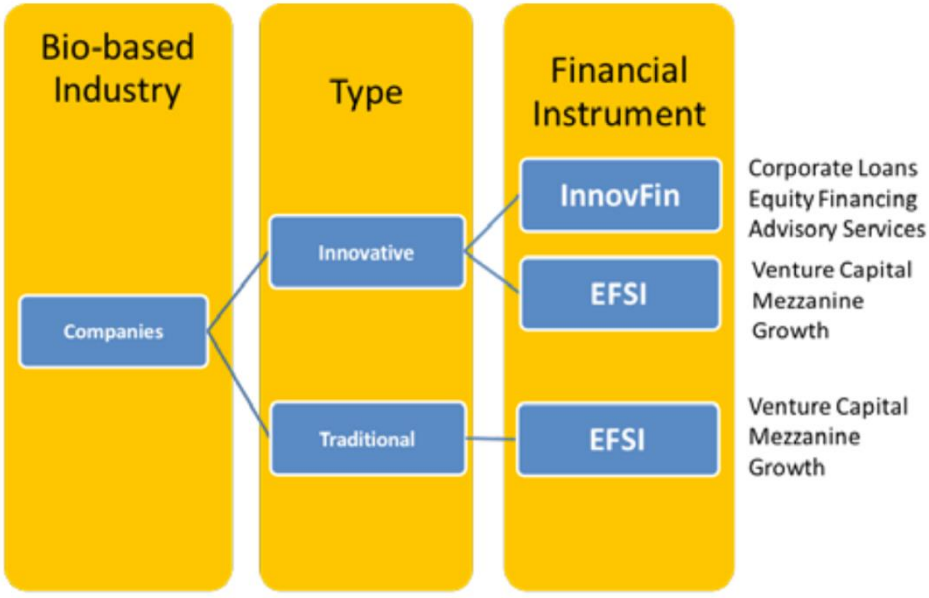


Figure 28: Financial Solutions for Bio-based Industries



Source: Bio-Based Industries Consortium

A 2015 report also addressed the topic of "Financing the Bioeconomy in the Baltic Sea Region" (Winther, 2015) and identified a number of financial barriers for projects and companies seeking funding in the bioeconomy area. The report took a similar approach to the BIC report in distinguishing between financing

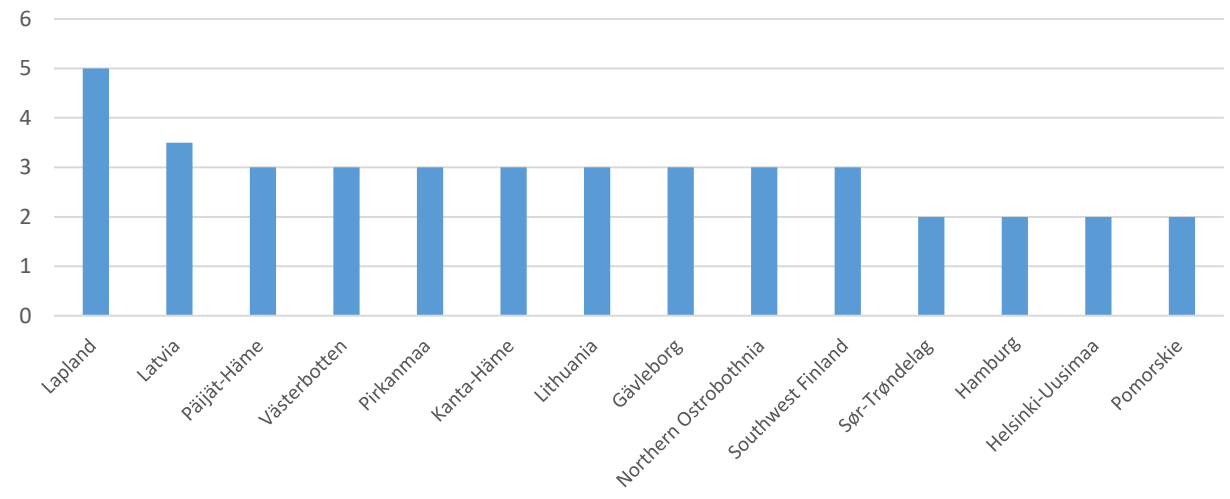
[46] https://biconsortium.eu/sites/biconsortium.eu/files/downloads/BIC_Financial_Instruments_web.pdf

for the bioeconomy through two types of delivery mechanisms, either directly into companies ("company-level finance" such as Angel finance, venture capital and private equity, tax incentives, innovative public procurement, etc.) or indirectly into organisations, institutions and/or companies via a "project-level funding" (grants and soft loans, etc.). Although there exist a number of public and private sources for funding the bioeconomy in the BSR, Winther (2015) concluded that the challenges and bottleneck relate to:

- Behavioural barriers – in the form of e.g. producer and consumer information failures, human capacity, budget cycles, and non-economic (emotional) decisions
- Structural barriers – in the form of e.g. fragmented macro-regional markets, different and sometimes conflicting policy incentives, and lack of data for targeting policies.
- Legal and regulatory barriers–in the form of e.g. regulatory distortions, burdensome procedures, and issues related to ownership of intellectual property; and
- Financial barriers– in the form of e.g. upfront investment costs vs. payback time, insufficient pricing of negative externalities for non-bio alternatives, lack of awareness about business cases, and lack of scale leading to an emphasis on the low hanging fruits that may provide small immediate results but that may also lead to lock-in on small-scale benefits rather than structural change enabling big leaps with much larger societal benefits.

For the current study, the survey gathered views from BSR regions on "How difficult is it to mobilise financial support for investments/projects in the area of circular bioeconomy?" (see Figure 25). On a scale from 1 – easy to 5 – very difficult, the average ranking for all the regions is just below 3 (2.89), suggesting that **it is moderately difficult to mobilise the relevant financial support**. A somewhat differentiated picture emerges when considering the rankings by region. Lapland has the most difficulties in mobilising financial support, followed by Latvia. It is **unclear though how much private financing is available for CBE-related investment in the BSR**, which is a topic area for follow-up work.

Figure 29: Difficulty in mobilising financial support for investments/projects in the area of CBE



Note: Scale from 1 – easy to 5 – very difficult

The respondents highlight a number of specific issues. For instance, the Finnish region of Päijät-Häme remarked that "*financial support for projects in the area of circular bioeconomy is available and accessible but the challenge is to get risk capital for firms for adopting new technologies. Investment money for new technologies is available but it still includes a financial risk for the company. These investment funds are more used by large companies for whom it is easier to carry the risk (compared to SMEs)*". Another issue was highlighted by the Brandenburg region: '[w]e do not know about the investment aspect. When we look at public funding, there are a lot of options be it on national or European level. Theoretically it is not difficult to get funding. In practice however, there is quite a bit of competition and our SMEs are mainly

small, not medium-sized, which means they do not have the personnel and time resource to apply on a European level'. On the other hand, the Finnish region of Pirkanmaa identified the biggest challenge as being able: "to recognise and select the highest potential projects, as there is quite a lot of funding available in Finland and in the region for CBE development projects".

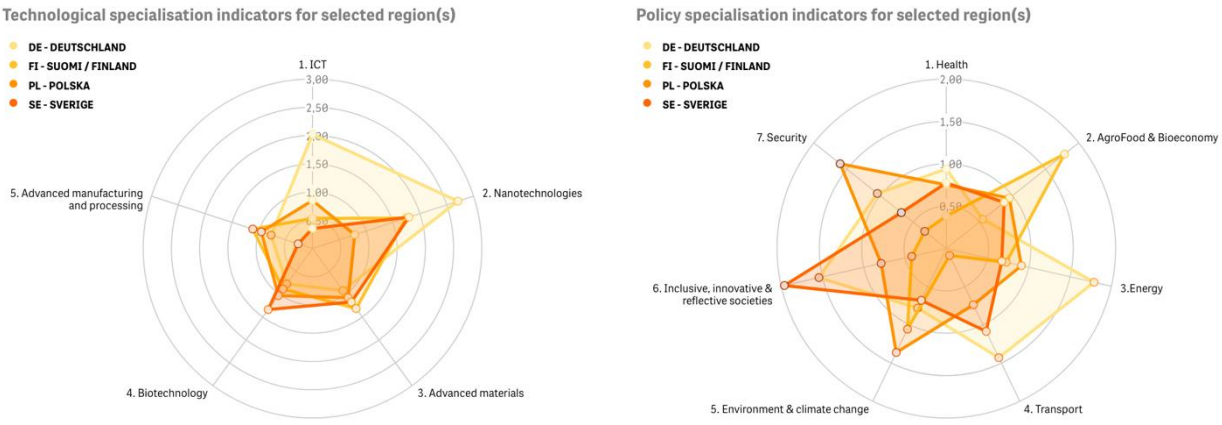
There is limited data available (at least at an inter-regional – cross-country level and at the level of disaggregation required) on funding and investment for the CBE topic in the BSR region. Considering the instruments identified above for project funding, data on the H2020 funding has been assessed earlier in this report. Further data mining may provide more insights into opportunities for linking up actors involved in technology development and demonstration.

The mixed responses regarding financing also point to different perspectives on priorities for financing. Regions who are more advanced in the CBE area are likely to be seeking out risk-based financing, relating to industrial technologies, which is much less readily available, compared to more abundant sources of public sector financing that support inter-regional learning exchange.

EFSI loans and investments in the bioeconomy are managed via the EIB. A consultation of the projects listed on the EIB website for the 8 BSR countries identified only 2 (out of 185) signed projects in the field of bioeconomy and 4 (out of 50) approved projects. Moreover, the projects appear to be more classic industrial projects (e.g. plywood production investment in Latvia or dairy sector modernisation and expansion in Estonia and Poland). This suggests gaps in both supply and demand for more innovation and technology-based bioeconomy projects, especially where these have a trans-national / interregional focus.

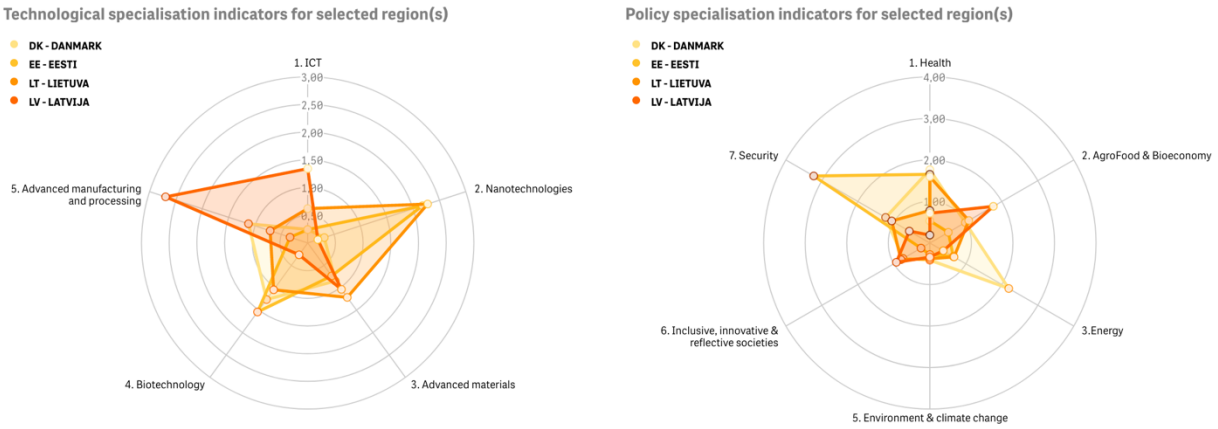
The survey responses suggest that in most of the BSR countries, CBE actors have access to funding programmes that could be mobilised to support their projects, this includes, typically making use of EU Structural and Investment Funds (ESIF). In terms of ESIF funding, the DG JRC's R&I Regional Viewer categorises projects funded under selected ERDF categories of intervention covering R&I, clusters and SME business development support.

Figure 30 : ERDF technological and specialisations indicators for four larger BSR countries



While the technological and specialisation categories only provide a broad indication of where countries may be investing (concentrating) relatively more of their ERDF funding, they do suggest that Sweden and Estonia have invested relatively more in biotechnology and that Finland and Latvia have given a stronger policy focus to agrofood and bioeconomy while Denmark has focused on Energy and Poland relatively more than others on environment and climate change. Although project databases are available in all countries, the data mining required to extract information on the share of CBE related funding was beyond the remit of the current study.

Figure 31: ERDF technological and specialisations indicators for four smaller BSR countries



Source: https://s3platform.jrc.ec.europa.eu/synergies-tool

In addition, there are national programmes in place such as the Business Finland programme Bio and Circular Finland[47] or Vinnova's Circular and Biobased economy initiative[48]. Regional level funding initiatives, e.g. in Sør-Trøndelag and Gävleborg, also exist. Again, a more detailed mapping of these programmes and initiatives would help to identify specific clusters of projects in each country and region and the potential to match up companies working on related parts of the CBE value chain[49].

Concerning equity type funding, while there is a strong Nordic cleantech sector[50] with related investment activities, there is no comprehensive dataset on innovative financial or equity type funding for CBE companies (or even more generally bio- or circular economy). A 2017 EIB study[51] concluded that a majority of bio-based industry (BBI) projects surveyed (77%) faced access-to-finance issues. Moreover, 79% of respondents reporting access-to-finance issues indicated that the **lack of interest from private financial market participants is related to the specificities and associated lack of understanding of the BBI industries.** Based on such findings, the EIB developed the concept of a European Circular Bioeconomy Fund (ECBF)[52] which will target investments within the following industry subsectors:

- Circular economy technologies and new business models including digitalisation which enables resource efficiency and supply chain optimisation, re-usage, reduction and recycling of waste streams as well as carbon capture
- Biomass/feedstock production, i.e. increase of output and/or decrease footprint of agriculture, farming, forestry and blue economy
- Technologies to enable biomass/feedstock processing, e.g. biorefineries and conversion technologies
- Bio-based chemicals & materials, e.g. monomeric building blocks, polymers, fibres and composites
- Performance biologicals, i.e. applications in nutrition, personal care and other industry verticals.

ECBF management will raise funds from public and private investors with a target fund volume of EUR 250 million (with the EIB investing up to EUR 100 million). Given the focus on CBE in the BSR identified via the current pilot mapping study, **this fund should offer opportunities for scaling up later stage BSR**

[47] See: https://www.businessfinland.fi/en/for-finnish-customers/services/programs/bio-and-circular-finland/

[48] See: https://www.vinnova.se/en/calls-for-proposals/circular-and-biobased-economy/circular-and-biobased-economy-from-2019-05390/

[49] For instance Business Finland has a database of all organisations that have received funding : https://tietopankki.businessfinland.fi/anonymous/extensions/fundingawarded/fundingawarded.html

[50] For instance: https://cleantechscandinavia.com/

[51] See: https://www.eib.org/en/publications/access-to-finance-conditions-for-financing-the-bioeconomy

[52] See: https://www.ecbf.vc/

based companies (i.e. the underlying technology has at least been demonstrated in a relevant environment, i.e. Technology Readiness Level from 6 to 9). It may be also of interest at BSR level to examine how to develop a pipeline of projects by combining national business angel networks[53] and private equity actors that can be brought forward to the ECBF for additional investment. The proposed post-2020 instrument for interregional innovation investments is intended to incentivise this type of joint, industry-led investment effort. It will be important for the BSR regions to remain vigilant in tracking the progress of this instrument towards the post-2020 period.

2.4.3 Future priorities for inter-regional co-operation

Finally, the regions were asked to identify and rank (from 1 - top priority to 5 - lowest priority) the top five priority activities for inter-regional co-operation and, where relevant, comment on their ranking (see Table 5). It is noteworthy that **'mapping specialist expertise in relevant technologies in each region' is, on average, the top priority among the regions**. It is closely followed by 'co-development of technological and innovation infrastructures (biorefineries, testing sites, pilot facilities, etc.)' and 'cooperation on mobilising financial support for investments/projects e.g. pooling of regional funds through a joint programme initiative, development of an investment platform', 'co-investment in pilot applications, technology validation actions, etc.' and then other options The average rankings are shown in Table 5.

Table 4: Top five priority activities for inter-regional co-operation

Type of activity	Average
Mapping specialist expertise in relevant technologies in each region	1.86
Mapping leading regional firms in circular bioeconomy value-chains to identify potential synergies	2.45
Partner search, matchmaking and brokerage services for partnership development	2.75
Sharing of best practices with regard to the implementation of new technologies in circular bioeconomy	2.35
Co-development of technological and innovation infrastructures (biorefineries, testing sites, pilot facilities, etc.)	2.15
Create an inter-regional network of research and innovation centres that businesses can access (e.g. using an inter-regional innovation voucher)	2.71
Co-investment in pilot applications, technology validation actions, etc.	2.27
Cooperation on mobilising financial support for investments/projects e.g. pooling of regional funds through a joint programme initiative, development of an investment platform (this option was deleted from the range of answers that came in from Brandenburg)	2.2

Note: Scale from 1 - highest priority to 5 – lowest priority

Priorities seem to closely follow areas in which the regions see most value to be created by inter-regional co-operation in the area of CBE, as shown in the previous section. **Top priorities in the above table also reflect a lack of information that regions currently have on CBE activities across the BSR**.

[53] See: https://www.nordicban.net/

3 Conclusions and recommendations from the pilot exercise

Overall, the **lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries) appears to be the most serious challenge in CBE development** as identified by the BSR regions. Nevertheless, it seems that it is only moderately difficult to mobilise financial support for investments/projects in the area of CBE, at least from the public sources and for large companies. These answers may suggest the need for a **more targeted funding line to support the emergence of stronger collaboration mechanisms among the key CBE infrastructures**. Although financial needs of the CBE actors in the various regions vary, there seems to be gaps in financial coverage between larger and smaller companies, the latter being disadvantaged. The European Commission's proposed Interregional Innovation Investment instrument may help fill this gap[54].

The challenges related to slow establishment of a stimulatory framework for the new biobased industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion and issues related to new skills for CBE implementation are noteworthy aspects to take into account in the design of inter-regional support measures. Furthermore, the reality of the regions is one of fragmented markets in which CBE faces issues related to economies of scale. Hence, **overall supporting conditions for CBE development in the region remain a priority.**

Moreover, the survey analysis suggests that the need for new data and their better overviews are increasingly prioritised given the complexity of CBE value chains. The mapping of specialist expertise in relevant technologies, as well as identification of leading firms across CBE value chains in BSR are particularly highlighted. **Gaining more fine-grained data and better intelligence on the complex cross-sectoral field of CBE should be supported** by joint BSR collaboration mechanisms.

Only a minority of the BSR regions seem to have placed an emphasis on digitalisation as an accelerator of CBE. New data and digital opportunities may aid the improvement of value chains by helping to identify the missing links or potentially beneficial new links e.g. new products emerging from biomass that was previously defined as waste or new industrial symbiosis connections among previously unrelated industries. Data generated from **digitalisation is a promising avenue of how to foster the interlink of the highly complex CBE value chains across the diverse BSR regions**.

[54] https://www.earto.eu/wp-content/uploads/Joint-Statement-on-Interregional-Innovation-Investments-for-European-value-chains-June-2019.pdf.

References

- *Birdlife Europe and the European Environmental Bureau (n.d.), "Cascading use of biomass: opportunities and obstacles in EU policies. Policy briefing by BirdLife Europe and the European Environmental Bureau", available at http://www.birdlife.org/sites/default/files/attachments/cascading_use_memo_final.pdf.*
- *Carus, M. and Dammer, L. (2018) The "Circular Bioeconomy" - Concepts, Opportunities and Limitations, available at: http://bio-based.eu/downloads/nova-paper-9-the-circular-bioeconomy-concepts-opportunities-and-limitations*
- *de Jong, E., Higson, A., Walsh, P., Wellisch, M. (2012) Bio-based Chemicals. Value Added Products from Biorefineries - Task 42 Biorefinery. http://www.ieabioenergy.com/publications/bio-based-chemicals-value-added-products-from-biorefineries. IEA Bioenergy - Task 42 Biorefiner*
- *Grundel, I. and M. Dahlström (2016), „A Quadruple and Quintuple Helix Approach to Regional Innovation Systems in the Transformation to a Forestry-Based Bioeconomy", Journal of the Knowledge Economy volume 7, 963–983.*
- *Lokesh, K., Ladu, L and Summerton, L. (2018) Bridging the Gaps for a 'Circular' Bioeconomy: Selection Criteria. Bio-Based Value Chain and Stakeholder Mapping. Sustainability (10), 1695; doi:10:3390/su10061695*
- *Marinelli, E. and I. Perianez Forte (2017). Smart specialisation at work: The entrepreneurial discovery as a continuous process (S3 Working Paper Series No. 12/2017). Luxembourg: Publications Office of the European Union.*
- *Newton, A. et al. (2017) Expert Group Report: Review of the EU Bioeconomy Strategy and its Action Plan*
- Nordregio (2019), Smart Specialisation in the Baltic Sea Region - Good practices from the Bio-, Circular- and Digital Innovation project BSR Stars S3: Policy Brief, available at http://www.diva-portal.org/smash/get/diva2:1325147/FULLTEXT01.pdf.
- *OECD (2018) Realising the Circular BioEconomy. Working Party on Biotechnology, Nanotechnology and Converging Technologies.*
- *Parisi, C. (2018) "Research Brief: Biorefineries distribution in the EU". European Commission - Joint Research Centre*
- *Roman, M., H. Varga, V. Cvijanovic and A. Reid (2020), "Quadruple Helix Models for Sustainable Regional Innovation: Engaging and Facilitating Civil Society Participation", Economies 2020, 8, 48; doi:10.3390/economies8020048.*
- *Spatial Foresight, SWECO, OIR, t33, Nordregio, Berman Group, Infyde (2017): Bioeconomy development in EU regions. Mapping of EU Member States'/Regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020. Study commissioned by DG Research & Innovation, European Commission*
- *Winther, T. (2015), Financing the Bioeconomy in the Baltic Sea Region. Copenhagen: Nordic Council of Ministers, Interreg Baltic Sea Region, InnoGate, available at http://bsrbioeconomy.net/resources/Financing_the_Bioeconomy_in_the_Baltic_Sea_Region.pdf.*

Annex 1: Questionnaire of the mapping survey

Introduction

This survey is carried out as the next step in the development of a high-level Baltic Sea Region (BSR) value chain mapping exercise with a focus on the **circular bioeconomy**. The exercise forms a critical element of an Interreg BSR project[55], exploring the potential for a stronger interregional approach to innovation across the BSR, by aligning smart specialisation and innovation priorities.

With the European Commission's focus on an EU 'Green Deal' and the associated linkages to this with the post-2020 Smart Specialisation agenda, there are significant opportunities for new, innovation-focused collaborative efforts, for the BSR.

This survey seeks to generate key insights into important projects, actions, plans and strategies across Baltic Sea regions, as well as details about key clusters, industry associations, networks, knowledge and technology institutions. We are also keen to learn more about the the nature of your region's **innovation investment environment**, in the circular bioeconomy environment (e.g. public and private sector sources of funding / investment). Please inform us about emerging, new and on-going activities.

In addition, we are seeking to **identify key technologies** which are being developed and deployed in your region. These could provide important opportunities for diversification and upgrading of industrial strengths.

The combined analysis of the survey returns will contribute to the identification of opportunities for innovation-focused, macro-regional cooperation in the area of circular bioeconomy. This will help us to highlight and target new interregional opportunities for innovation / smart specialisation collaboration.

We recommend that the questionnaire is completed through a consultation process that gathers views of a core group of regional experts (e.g. cluster managers, companies, technology experts, policy experts, etc.) to discuss the challenges and priorities for the region in the field of circular bioeconomy and related technological and skills needs.

Circular bioeconomy can be defined as a sphere of bio-economic activities at the intersection of bioeconomy on the one hand side and circular economy on the other and it includes 1) bio-based products, 2) share, reuse, remanufacture, recycling, 3) cascading use, 4) utilisation of organic waste streams, 5) resource-efficient value chains, and 6) organic recycling, nutrient cycling[56].

Where a recent analysis (survey, study) of regional technology know-how and needs exists, this can be used to inform the survey responses.

This template requires only one response per region (or per country, when the whole country belongs to the Baltic Sea Region area) comprising the Baltic Sea Region area.

We would be grateful if you could return us the survey by 20 March 2020. The analysis will be provided by 3 April 2020.

If you need clarification on questions or how to complete the survey, please contact Elina Griniece (griniece@efiscentre.eu) and Vladimir Cvijanovic (cvijanovic@efiscentre.eu).

[55] https://projects.interreg-baltic.eu/projects/bsr-s3-ecosystem-214.html

[56] Carus, M. and L. Dammer (2018), „The "Circular Bioeconomy" – Concepts, Opportunities and Limitations", nova paper #9 on bio-based economy 2018-01, p. 4., as in Pursula & Carus 2017, in: Newton et al. 2017.

We look forward to receiving your responses and to sharing with you the analysis and results of the exercise.

Contact information

	Region (Country):	
	Person(s) responsible*	
	Organisation	
	Type of Organisation:	**Select one**
Government department		
Public agency (e.g. regional development, enterprise or innovation agency)		
Cluster organisation		
Research and technology organisation		
Other (please specify):		
	Email:	
	Website:	

** i.e. the person who has completed the questionnaire and/or the designated representative of the regional authority*

Regional strategic priorities in the field of circular bioeconomy challenges

Circular bioeconomy supports sustainability-driven innovation in creating new local value from waste and biomass. It focuses on helping develop sustainable and climate-neutral technologies and replacing non-renewable fossil and mineral resources with biomass and waste to obtain renewable products and nutrients. Innovations that form the potential for new value chains in circular bioeconomy cut horizontally through the traditional sectors.

1. What are the main challenges facing regional firms in adopting key technologies or introducing innovations in the area of circular bioeconomy? A number of options are suggested but please feel free to list others that you consider important. You should then rank the top 5 challenges for your region (1 - most important to 5 - least important).

Rank	Challenge
	Lack of ambition in the political goals for level of upgrade of underexploited bioresources
	Slow establishment of a stimulatory framework for the new biobased industries which allows introduction of products from new value chains based on biomass, waste and side stream conversion
	Lack of open access test facilities for facilitating the upscaling new processes and products
	Lack of investment and collaboration mechanisms between key matching infrastructures (e.g. biorefineries)
	Limited knowledge, skills and expertise in novel areas of bio-based economy (in public research, business sector, universities, policy makers and regulators)

	Limited business access to international markets and integration in value chains, especially for niche products with high value added
	Limited availability of various complementary actors in the regional business ecosystem

NB: please specify others if necessary

2. On what evidence is the selection and ranking of challenges based – e.g. background study, statistical survey of enterprises, workshop/discussion with cluster managers or representative companies, etc.? Please provide details of the evidence base and explain your ranking.

Strategies and policies addressing the circular bioeconomy

3. In your region, are there public or public-private strategies that address the challenges related to innovation and technological adoption in circular bioeconomy?

Strategy document	**Title of document**	**Year adopted**
Smart specialisation strategy		
Circular bioeconomy strategy		
Specific technology strategies		
Other strategies (please specify):		

4. Please summarise (briefly) the main regional priorities concerning circular bioeconomy and the application of key technologies and concepts (e.g. biorefineries, cascading use, utilisation of waste and side streams, nutrient cycling, bio-based products, etc.). Please specify if there is any emphasis in regional strategies on digitalisation as an accelerator of circular bioeconomy.

Policy measures in support of innovation and technological change in circular bioeconomy

5. Please list up to five major regional or national programmes/initiatives that support the development or deployment of new technologies and their application in circular bioeconomy? These can either be (co-)funded by public funds or supported through public-private partnerships.

Name of initiative	Annual funding	Source of funding	URL (if available)

Regional expertise and know-how in key technologies: Existing expertise in relevant technologies

6. In which of the relevant technologies for circular bioeconomy is your region most advanced/specialised? Rank the 5 technologies in which you consider your region to be specialised in (relative to partner regions or from an EU wide perspective). (1 - most specialised to 5 - least specialised).

Key technologies for circular bioeconomy	**Rank**
E.g. Bioprocess development (e.g. synthetic and systems biology)	
E.g. Plant biotechnology	
E.g. Sustainable chemistry	
E.g. Thermochemical conversion	
E.g. Simulation and modelling	

NB: Add lines as required

7. Please comment your ranking and provide examples – you may alternatively or in addition provide a web link to a study or analysis of regional specialisation in these fields.

8. Please rank the level of importance and the actual level of application of the identified key technologies in regional businesses.

Key technologies for circular bioeconomy	**Importance for regional businesses to adopt technologies** *Rank 1 - critical to 5 - low priority;* *Otherwise: don't know*	**Actual application of key technologies in regional businesses** *1 - state of the art (3 - average with respect to other partner or EU regions) to 5 - not currently used;* *Otherwise: don't know*

*Add lines as required

9. You may comment or provide examples of specific issues in applying key technologies in regional firms. NB: You may provide evidence of your scoring or examples/issues.

10. Is support for development of these key technologies accessed outside the region? If so please comment on where and which type of support.

Technology providers and demonstration or piloting facilities in your region

11. Please list up to 10 organisations (in your region) involved in the development and demonstration or piloting of key technologies relevant for circular bioeconomy.

Name	Type*	Field of expertise

NB: add more lines as required.

* manufacturers, technology suppliers, university or public research centres, innovation or applied industrial R&D centres, technology training centres, living labs, demonstration centres, pilot facilities, etc.

12. How difficult is it to mobilise financial support for investments/projects in the area of circular bioeconomy? (from 1 – easy to 5 – very difficult).

Ranking	Comment

Existing regional involvement in European, inter-regional or international partnerships in circular bioeconomy

13. Please list existing involvement (on-going projects) of regional organisations (public, private, research, clusters, etc.) in European (ERA-NETs, Horizon 2020, COSME, etc.) as well as inter-regional such as INTERREG and international programmes.

Name of project (duration yyyy-yyyy, e.g. 2014-2016)	Organisations involved	Objective / topic

NB: add more lines as required.

Regional priorities for co-operation

Priority topics for inter-regional co-operation

14. Given the challenges and the priorities at regional level, in which specific topics do you consider there is the most value to be created by inter-regional co-operation in the area of circular bioeconomy?

Topics (describe briefly the proposed topic)	**Rank from 1 to 5 in order of importance**

15. If you wish to propose additional topics, please use the box below.

Type of joint actions or activities

16. Please identify and rank (from 1 - top priority to 5 - lowest priority) top five priority activities for inter-regional co-operation and where relevant comment on your ranking.

Type of activity	**Ranking**	**Comment**
Mapping specialist expertise in relevant technologies in each region		
Mapping leading regional firms in circular bioeconomy value-chains to identify potential synergies		
Partner search, matchmaking and brokerage services for partnership development		
Sharing of best practices with regard to the implementation of new technologies in circular bioeconomy		
Co-development of technological and innovation infrastructures (biorefineries, testing sites, pilot facilities, etc.)		
Create an inter-regional network of research and innovation centres that businesses can access (e.g. using an inter-regional innovation voucher)		

Co-investment in pilot applications, technology validation actions, etc.		
Cooperation on mobilising financial support for investments/projects e.g. pooling of regional funds through a joint programme initiative, development of an investment platform		
Others (please add details):		

NB: You can add more lines as required

Thank you for your time!

Annex 2: DIHs in eight BSR countries in four chosen sectors

No	**DIH Name**	**Location**	**City**	**Country**
1	Aarhus University Centre for Digitalisation, Big Data and Data Analytics (DIGIT)	Finlandsgade 22	Aarhus	Denmark
2	Advanced Manufacturing Digital Innovation Hub	Savanorių pr. 176c-804	Vilnius	Lithuania
3	AgriFood Lithuania DIH	Mokslininku st. 2A	Vilnius	Lithuania
4	Agro Space DIH	Mokslininku 6A	Vilnius	Lithuania
5	Arctic Drone Labs	Yliopistokatu 9	OULU	Finland
6	Baltic Maritime Digital Innovation Hub	Liepu street 83	Klaipeda	Lithuania
7	Bron Innovation	Storgatan 73	Sundsvall	Sweden
8	Competence Centre Mittelstand 4.0 Berlin	Potsdamer Straße 7, Potsdamer Platz	Berlin	Germany
9	Danish Technological Institute, Robot Technology	Forskerparken 10F	Odense	Denmark
10	DigiCenterNS	Microkatu 1, Kuopio	Kuopio	Finland
11	DIGITAL INNOVATION HUB „Smart Society“	NEMUNO STREET 2	KLAIPEDA	Lithuania
12	Digital Media Innovation Hub	T.Sevcenkos 16A	Vilnius	Lithuania
13	DIH Tartu	J. Liivi 2	Tartu	Estonia
14	EDI DIH	14 Dzerbenes street	Riga	Latvia
15	Eliko	Mäealuse, 2/1	Tallinn	Estonia
16	Finnish Center for Artificial Intelligence (FCAI)	Vuorimiehentie 3, Espoo	Espoo	Finland
17	Future Position X	Drottninggatan 18 80320 Gävle	Gävle	Sweden
18	HPC4Poland	10 Jana Pawla II st.	Poznan	Poland
19	INFOBALT DIH	Mokslininku str. 2A-128	Vilnius	Lithuania

No	DIH Name	Location	City	Country
20	Intelligent Industry ecosystem	Eteläranta 10	Helsinki	Finland
21	IoT Compass Hub (DIH)	SeAMK, School of Technology, Kampusranta 9 A	Seinäjoki	Finland
22	Laser Digital Innovation Hub (LaserLT DIH)	Savanorių ave. 231	Vilnius	Lithuania
23	Latvian IT Cluster	Skolas 11	Riga	Latvia
24	LIFE SCIENCES DIH LITHUANIA	Vismaliukų g. 34, LT-10243 Vilnius	Vilnius	Lithuania
25	Lithuanian robotic DIH (LTroboticsDIH)	Lakunu, 3	Vilnius	Lithuania
26	LTU AI Innovation Hub	Luleå University of Technology	Luleå	Sweden
27	MADE - Manufacturing Academy of Denmark	Vesterbrogade 1E 2nd floor	Copenhagen	Denmark
28	Mälardalen Industrial Technology Center	John Engellaus Gata 1	Eskilstuna	Sweden
29	Mittelstand 4.0 Competence Centre Ilmenau	Gustav-Kirchhoff-Platz 2	Ilmenau	Germany
30	One Sea - Autonomous Maritime Ecosystem	Lemminkäisenkatu 30	Turku	Finland
31	PrintoCent	Kaitoväylä 1	Oulu	Finland
32	ROBOCOAST	Prizztech Ltd, Puuvilla, PO Box 18, Siltapuistokatu 14, Pori, FINLAND	Pori	Finland
33	Santaka Artificial Intelligence DIH	Baršausko str. 59 Kaunas	Kaunas	Lithuania
34	Santaka Digital Innovation HUB	Ulonų str. 5	Vilnius	Lithuania
35	Smart Energy Digital Innovation Hub	Mokslininkų str. 6A, LT-08412 Vilnius, Lithuania	Vilnius	Lithuania
36	Smart Industry Centre (SmartIC)	Ehitajate tee 5	Tallinn	Estonia

No	DIH Name	Location	City	Country
37	Stena Industry Innovation Hub at Chalmers - SII-Hub	Forskningsgången 6	Goteborg	Sweden
38	Sunrise Valley Digital Innovation Hub (SV DIH)	Sauletekio ave. 15	Vilnius	Lithuania
39	Super IoT	University of Oulu Pentti Kaiteran katu 1	Oulu	Finland
40	The Alexandra Institute - ICT-based innovation	Åbogade 34	Aarhus	Denmark
41	The KTH Innovation Hub of Digital Industrialization	Brinellvägen 85	Stockholm	Sweden
42	Ventspils High Technology Park (VHTP)	Ventspils Augsto tehnoloģiju parks, 1	Ventspils	Latvia
43	ViDIH Visoriai Digital Innovation Hub	Mokslininkų st. 2a	Vilnius	Lithuania
44	Vitus Bering Innovation Park	Chr. M. Østergaards Vej 4a	Horsens	Denmark
45	5G Test Network Finland (5GTNF)	Kaitoväylä 1	Oulu	Finland

Note: The sectors chosen are: 1) agriculture, hunting and forestry, 2) manufacture of food products, beverages and tobacco, 3) manufacture of textiles and textile products, 4) manufacture of wood and wood products), 5) manufacture of pulp, paper and paper products, publishing and printing, 6) manufacture of chemicals, chemical products and man-made fibres, and 8) other manufacturing.

Source: https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool.