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# The bioeconomy in the Baltic Sea region

## Some recommendations for policymakers

*By Anna Berlina*

CENTRUM BALTICUM

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By Anna Berlina, Research Fellow, Nordregio

Anna Berlina is a Research Fellow at Nordregio, and works within the broad field of regional development in the Nordic and Baltic Sea Region. Her areas of research include circular economy, bioeconomy, social innovation and rural mobility solutions. Anna holds a Master's Degree in Sustainable Development from Linköping University (Sweden).

anna.berlina@nordregio.se

### Summary

Bioeconomy is currently among the key components for promoting smart and green growth in the Nordic and Baltic Sea Region (BSR). In a bioeconomy, the materials, chemicals, and energy are derived from renewable biological resources, such as forestry, agricultural, marine biomass and bio-waste streams. The BSR has a good potential for developing a bioeconomy thanks to diverse land-based and marine resources, high innovation potential in areas crucial for the bioeconomy and a well-developed infrastructure, technological and environmental knowledge. The study draws upon the lessons learned from the regional bioeconomy case studies in the Nordic countries (Örnsköldsvik biorefinery in Sweden, Lolland municipality in Denmark, North Karelia and Kemi-Tornio regions in Finland). Among the main findings is that the success of a bioeconomy is often attributed to an extensive collaboration across different levels of government, disciplines, business, science, stakeholders and individuals. High level of collaboration and partnership in both formal and informal arrangements is crucial for fostering innovation, building trust and relationships. Transition to a bioeconomy may be accelerated by building innovative support structures that help to facilitate innovation, as well as develop, test and realize bioeconomy projects. For instance, building networks, innovation platforms and cluster development may yield many positive results, such as supporting the development of new business opportunities and identifying new value chains. The regional case studies also show the potential of industrial symbiosis in promoting a circular bioeconomy. Overall, the bioeconomy development requires place-based, localized and decentralized approaches as there is no 'one-size-fits-all' solutions to the bioeconomy.

### Keywords

Bioeconomy, regional, industrial symbiosis, Nordic, Baltic Sea Region

## 1. Introduction

With the growing realization of resource depletion, food insecurity and environmental degradation, sustainable utilization of resources and reducing the use of fossil resources are becoming increasingly important for the society as a whole. Bioeconomy is currently among the key components for promoting smart and green growth.

This study draws upon the findings, learnings and outcomes of several studies conducted by Nordregio in recent years, among those are Bioeconomy in the Nordic region: Regional case studies (2014)[1]; regional bioenergy cases in the framework of TRIBORN project (2017)[2]; Sustainable Business Development in the Nordic Arctic (2016)[3] and Green Growth in Nordic Regions-50 ways to make it happen (2016).

This study illustrates several good practice cases of bioeconomy in the Nordic regions and provides examples of how bioeconomy can be a driver for regional growth. It presents some overall lessons learned from the forerunner regions in the Nordics with regard to the key success factors for bioeconomy development. The study concludes with some policy-relevant findings and recommendations.

## 2. What constitutes a bioeconomy

In a broad interpretation, a bioeconomy could be defined as an economy where the basic building blocks for materials, chemicals, and energy are derived from renewable biological resources, such as forestry, agricultural and marine biomass, bio-waste, etc. (Lindberg et al., 2016). Bioeconomy does not only refer to the economic activities but also to the transformation process of the society as a whole into becoming a more sustainable by promoting e.g. changes in consumption and production patterns and enhancing the circularity of the use of the waste streams (Grundel and Dahlström, 2016).

The Nordic Council of Ministers (2017) defines bioeconomy as "responsible use of renewable biological resources from the land and water for the mutual benefit of business, society and nature". The transformation to a bioeconomy encompasses a transition from a fossil fuel-based economy to a more resource-efficient economy that contributes to combating climate change, reducing waste and creating new jobs, but also lead to new economic activities in and around rural regions. New products from biomass can replace many goods and services that are currently produced from fossil-fuels. The renewable biological resources may be converted into food, feed, biofuels, bioplastics and biopharmaceuticals.

The bioeconomy promotes the optimized utilization of already exploited marine and land-based resources and the innovative use of underutilized resources and residual biomass, as well as innovation across value chains (Smed Olsen et al., 2016). Therefore, circularity is a key component of the bioeconomy.

Bioeconomy can contribute to creating jobs and diversification of rural economies, security of energy supply and food security. At the same time bioeconomy is not necessary sustainable in economic, social and environmental terms. It can, for instance, entail land use conflicts and competition over alternative uses of natural resources (Smed Olsen et al., 2016). In case of bioenergy production, the Intergovernmental Panel on Climate Change concluded that it can play a critical role in climate change mitigation, but involves risks related to greenhouse gas emissions from land, food security, water resources, biodiversity conservation and livelihoods (IPCC, 2014).

## 3. Bioeconomy in the Baltic Sea Region

The Baltic Sea Region (BSR) has a good potential for developing bioeconomy as it is largely self-sufficient in many agricultural, forest and some sea products that are mostly located in rural and coastal areas. The BSR also has a high innovation potential in areas crucial for the bioeconomy and a well-developed infrastructure, technological and environmental knowledge. Innovation and research are at the core of the transition to a bioeconomy, and with its cross-cutting nature, bioeconomy can address complex and interconnected challenges while achieving economic growth.

1 The Working Paper presents the results of five case studies on bioeconomy in Nordic regions and gives an overview of how the development of bioeconomy can be promoted in different settings. The Working Paper has been commissioned by the Nordic Working Group on Green Growth - Innovation and Entrepreneurship, established by the Nordic Council of Ministers.

2 TRIBORN was a 3.5-year inter-disciplinary project that studied how bioenergy systems can be designed to promote triple-bottom line outcomes in rural areas in the Nordic countries, financed by the Research Council of Norway, 2014-2017.

3 The working paper highlights opportunities in the bioeconomy in the Nordic Arctic regions. The study was commissioned by the working group on Sustainable Regional Development in the Nordic Arctic 2013-2016, established by the Nordic Council of Ministers.

Bioeconomy has become an increasingly popular concept addressed in regional, national and international policy discourse and policy-making in Europe. The EU has put up a European Bioeconomy Observatory and has chosen bioeconomy as a key area in its Horizon 2020 research program (the EU Framework Programme for Research and Innovation). In 2012, Europe's Bioeconomy Strategy was launched, that addresses the production of renewable biological resources and their conversion into vital products and bioenergy (European Commission, 2018). Bioeconomy is one of 13 Policy Areas of the EU Strategy for the Baltic Sea Region Action Plan. The policy dialogue is supported by the BSR Bioeconomy Council, the Nordic Bioeconomy Panel and other forums.

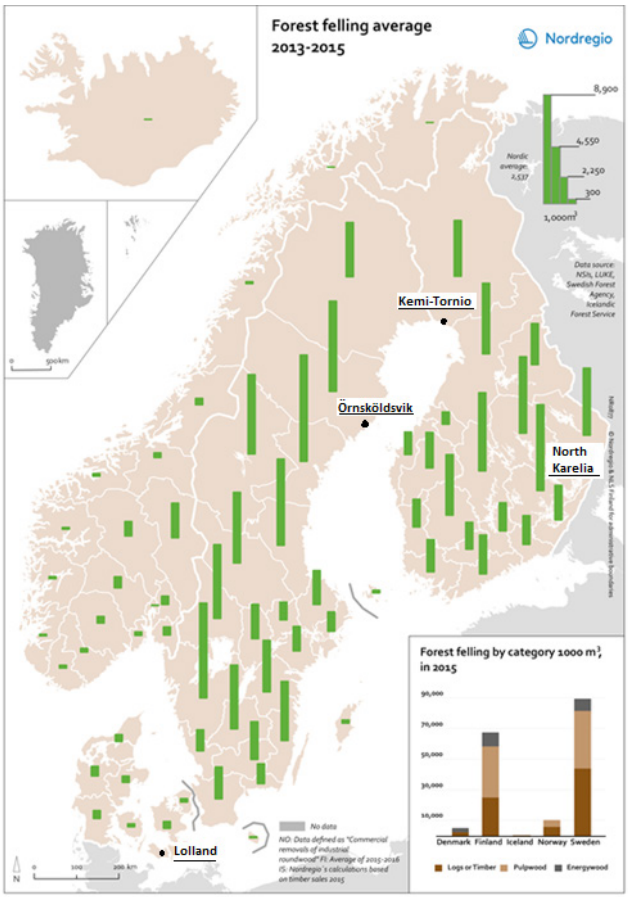
Bioeconomy is anchored in the national and regional policies of the Nordic and BSR countries. The report 'A Bioeconomy for the Baltic Sea Region: mapping of stakeholders, practices and opportunities' (2014) presents the most important Nordic and Baltic actors in the field of bioeconomy and results from interviews of 27 Nordic and Baltic informants (Winther, 2014).

Moreover, several regions in the EU have directed their smart specialization strategies (research and innovation strategies) towards the development of a bioeconomy (European Commission, 2017). In addition, the municipalities and regions have many tools at their disposal to promote bioeconomy in rural areas. There are numerous intermediary support organizations supporting the transition to a bioeconomy, e.g. Paper Province and SP Processum in Sweden and Digipolis in Finland.

## 4. Regional case studies

In this section, four regional good practices of the transition to a bioeconomy in the Nordic countries are presented and the factors behind the success of the initiatives are discussed. The bioeconomy initiatives in the Nordic regions capitalize on abundant local raw material, dominated by forestry-based initiatives in Finland, Sweden and Norway, agricultural biomass based bioeconomy in Denmark, and marine-based bioeconomy in Iceland and coastal Norway. This study illustrates four good examples of land-based bioeconomy; three of them in regions with high forest biomass and timber volume and one example of agriculture-based regional bioeconomy (Map 1).

*Map 1 Forest felling at the regional level, average 2013–2015 (main map), and forest felling by category in 1,000m3 at the national level 2015 (chart).*




Source: Grunfelder et al.(2018).

## 4.1 Biorefinery initiative in Örnsköldsvik, Sweden

Rural and forest-rich Västernorrland county in mid Sweden demonstrates good regional practice in the development of a bioeconomy enabled by both public and private efforts. The county is home to traditional pulp-and paper and chemical industries which have allowed for developing major industrial ventures based on bioeconomy centered around the city of Örnsköldsvik (Berlina and Mikkola, 2017).

During the 1990s, the Örnsköldsvik region suffered a serious decline when several businesses were closed, downsized, or relocated, triggered by structural changes in the pulp and paper industry and an economic downturn. Despite this, local actors decided to engage themselves in building up a cluster company and a technology park based on a novel biorefinery initiative (Berlina and Mikkola, 2017).

The 'Biorefinery of the Future' initiative in Örnsköldsvik is among the most interesting Nordic regional bioeconomy initiatives, not the least due to its governance structure involving both bottom-up and top-down integration. It was initiated as a joint effort by industrial innovators, the local authorities and the local power plant, which founded the cluster company SP Processum in 2003. Two years later SP Processum received national VINNVÄXT funding for 'Biorefinery of the Future' initiative for developing regional growth through dynamic innovation systems (Lindberg and Teräs, 2014; Berlina and Mikkola, 2017).

The Örnsköldsvik Biorefinery cluster has 20-member companies. Among the cluster companies are large forest and paper industries, chemical industry and the municipal energy utility, as well as smaller research and technology firms and Umeå university. The aim of the 'Biorefinery of the Future' is to accelerate development in the field of biorefining woody biomass. The intention is to maximize production and to create products of greater value.

The cluster companies develop, test and promote products (e.g. chemicals and new materials) and processes based on lignocellulosic feedstock in a triple-helix setup (Lindberg and Teräs, 2014). Some of the ongoing projects by the companies at the site include local production of bio-based plastics, methanol recovery from a sulphate mill, manufacturing materials containing nanocellulose. Another exciting project is single cell protein production from lignocellulose-derived residual stream from the Domsjö mill for use in fish feed. The technology and the process have been verified in the Demo Plant and the Icelandic partners of the project (Matís Ltd) have produced fish feed and carried out successful feeding trials (Berlina and Mikkola, 2017).

The Örnsköldsvik cluster is a vivid example of industrial symbiosis with a closed cycle and almost no residues. For instance, the process water from the near-by chemical industries and a pulp mill is utilized for biogas production, cellulosic ethanol is produced from pulp waste products from Domsjö Biorefinery, while surplus heat is used for district heating in the municipality.

Producing higher value added products at the biorefinery in Örnsköldsvik enables to take advantage of waste streams from pulp production in Domsjö and using them as substitutes for raw materials which contributes to an increased resource productivity and elimination of waste, and enables to deliver a low carbon and environmental footprint (Berlina and Mikkola, 2017).

Among the key enablers for the development has been a strong commitment from both public, private and academic partners and the existing close ties between people in the area, who shared common ideas, visions and long-term thinking for developing new forest-based value chains for production of chemicals and materials.

## 4.2 Agriculture-based bioeconomy in Lolland, Denmark

Lolland is a municipality located in Region Zealand, Denmark. The region was renowned for its strong agricultural industry, including sugar beet production, as well as its shipbuilding industry. When the EU subsidies to the sugar beet were drastically reduced in the early 2000s, farmers started to increasingly focus on the production of renewable energy and agro-industries. Local politicians saw early the potential of a bioeconomy that triggered the first investments and support activities, leading the region out of recession through the creation of jobs and business opportunities.

Lolland has several small and large-scale biogas production projects, biofuel production including rapeseed oil and bioethanol from agricultural residues, and R&D projects in the field of algae biomass. Today, focus in the region is on the production of second-generation biofuels.

Lolland's success in the bioeconomy development can be attributed to a strong local and regional political backing and support, to close cooperation among different stakeholders, access to funding for R&D, project development and other support activities, and the evolvement of innovative cooperation structures through networking, innovation platforms and industrial synergies.

There are several instruments developed in the region to support the collaboration, develop and test ideas and realize new projects in the region, such as the Lolland Community Testing Facility (CTF), the Regional Sparring Group on the Bioeconomy and the Green Committee (Mikkola et al., 2016).

The CTF was established in 2007 with an objective to provide opportunities for the industries to test new technologies on a full scale and in real communities and create synergies between the industries, research institutions, municipality and the local community. CTF attracted new firms and funding to the region.

The Regional Sparring Group on Bioeconomy comprises all key actors in the field of bioeconomy and regional business advisory activities. The Group contributes to the development of new bioeconomy projects and imagining possible regional bioeconomy futures. The Green Committee brings together 50-60 key actors from the research and business sector, as well as from local, regional and national governments with an objective to support collaboration among the actors in the region (Mikkola et al. 2016).

Moreover, to help farmers foster innovation within food and agroindustry the Green Center and the Algae Innovation Center were established in Lolland. The Green Center fosters cooperation with the municipalities, utilities, farmers, food industry suppliers, knowledge institutions, citizens and the financial sector.

### 4.3 North Karelia forest region, Finland

North Karelia is a remote and forest-rich region in Eastern Finland, where the forestry industry plays an important role in the regional economy. There are around 500 companies involved in the regional bioeconomy, generating about 6 000 jobs and about EUR 1.7 billion turnover. Renewable energy accounts for 63% of the regional energy mix, of which 82% comes from wood-based biomass (Berlina and Mikkola, 2017).

The long-term commitment and strategic approach to advancing the regional forest-based bioeconomy from the Regional Council of North Karelia is among the success factors for North Karelia's progress in the bieoconomy. Among the focus areas of the Regional Council of North Karelia have been the development of local value chains, R&D and attracting investment, while ensuring a close collaboration with the private companies, forest owners, universities and citizens (Mikkola et al., 2016).

Moreover, the success of bioeconomy in North Karelia is attributed to strong inter-sectoral linkages and the local ownership of the value-chain, as majority of the forestry industries is locally-owned and create value locally. Moreover, there is a strong support for bioenergy and bioeconomy activities among the local population, due to employment and environmental benefits (Berlina and Mikkola, 2017).

### 4.4 Kemi-Tornio industrial symbiosis, Finland

Although not purely bioeconomy related case, this example illustrates the benefits of circular business models in pursuing bio- and circular economy. The Kemi–Tornio industrial symbiosis involves companies in the field of forestry, mining and steel industry, research and educational organizations and intermediaries. The cooperation reached a new level with a project on mapping the industrial side streams in the Kemi-Tornio region, coordinated by the Digipolis Technology Park in 2014. The existing (unutilized) side streams from mainly forestry, mining and steel industries and their qualities were thoroughly documented in order to facilitate creating new connections between companies in the region. A regional actor network was created in order to match companies whose raw material needs and waste were compatible. More than 1.3 million tons of annual by-products and waste streams were identified in the region and compiled in a databank. This initiative aims at facilitating companies to exchange industrial by-products with other companies that can use them as a substitute for raw materials, and result in energy and resource efficiency (Mikkola et al., 2016).

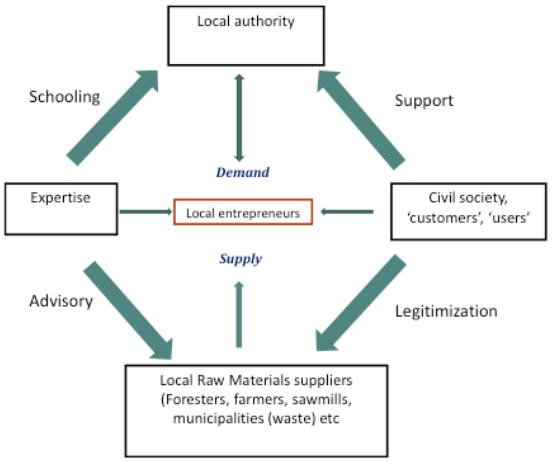
## 5. Lessons learned from the Nordic cases

The regional bioeconomy examples in the Nordic countries demonstrate that utilizing all different resources available in the bioeconomy (side-streams, by-products etc.) requires an extensive collaboration across different levels of government, disciplines, stakeholders and individuals.

High level of collaboration and partnership in both formal and informal networks between actors are at the core of many good practices in bioeconomy in the Nordic countries. The successful practices are often based on a 'quintuple helix' model and involve collaboration between biomass producers (farmers, foresters, fishermen, municipal waste companies), companies in the value chain, entrepreneurs, local and regional governments, knowledge institutions and residents (see Figure 1) (Berlina and Mikkola, 2017; Refsgaard et al., 2017).

These actors bring resources and specific knowledge, and represent different interests that are necessary for building long-term trust and relationships and fostering innovation (Refsgaard et al., 2017). Quintuple helix approach promotes bioeconomy development in a way that ensures positive environmental, social and economic outcomes. The involvement of civil society in the transition to a bioeconomy contributes to a larger societal transformation aiming at changing norms and values, consumer behavior and production and consumption patterns (Grundel and Dahlström, 2016). Moreover, it helps to ensure legitimacy at the community level.

*Figure 1: Typical forms of local partnerships involved in a transition to bioeconomy in the Nordic regions*




Source: (Refsgaard et al., 2017).

In addition to the multi-stakeholder collaboration in embracing the opportunities in the bioeconomy, the collaboration across different sectors is not the least important. The bioeconomy requires a cross-sectoral integration involving sectors such as forestry, agriculture, fishery, food and feed, biotechnology, bioenergy and biofuels. Industrial symbiosis is one of the tools for fostering cross-sectorial industrial collaboration and for realising circular economy.

From the case studies, we note that the industrial symbiosis presents substantial opportunities for promoting circular bioeconomy, by reducing waste, increasing recycling and developing new bio-businesses (e.g. fish farming). In industrial symbiosis, waste or by-product of one actor becomes a resource for another actor (Johnsen et al., 2015). An effective coordination across the actors is a vital success factor for these types of initiatives. There are several outstanding examples in the Nordic countries, where through cooperation and exchange of by-products the companies were able to achieve environmental benefits and develop new bio-businesses. Moreover, industrial symbiosis also allows to achieve costs reduction and increase production efficiency by combining different production processes, sharing equipment and staff.

In addition to the industrial cross-sectoral collaborations there is a high potential for synergies between the fisheries, agriculture, the food industry and tourism that do not necessarily require high technology and R&D in developing successful bioeconomy initiatives. Small-scale bioeconomy initiatives relying on knowledge and competence of the local people may present particularly good solutions for small rural regions.

Another common feature of Nordic regional bioeconomy good practice cases is a strong public support for bioeconomy initiatives alongside public finance instruments. The regional case studies illustrate that a solid anchoring in the regional policies and development programs and the long-term commitment of key operational and financial actors in developing a regional bioeconomy (e.g. VINNVÄXT program) have played a crucial role (Lindberg et al., 2016). Moreover, local and regional authorities play a central role in supporting bioeconomy through providing motivation (e.g. 'green branding' of the municipality), facilitating the development of networks and value chains, building local markets for bioeconomic products (e.g. through green public procurement), and

ensuring local acceptance and support among the residents (Refsgaard et al., 2017). These activities are important for stimulating action in the regions, companies and knowledge institutions.

Development of innovative structures to support collaboration and synergies among the stakeholders in order to develop, test and realize bioeconomy projects and facilitate innovation has proved to be an important success factor in fostering bioeconomy in the Nordic regions (read more: Lolland case). In this regard, the regional case studies emphasize the importance of cluster structures, networking and innovation platform in pursuing bioeconomy.

The regional bioeconomy case studies presented in this study rely on the accumulated infrastructure, know-how and strong expertise in bioeconomy related activities (e.g. forestry industries and agriculture) which paves the way for additional bioeconomy investments and initiatives.

At the same time there are significant differences among the Nordic regions in the degree of innovation in the bioeconomy. There are different preconditions in the regions when it comes to the availability of skilled personnel and the R&D infrastructure varies between larger urban regions and smaller rural regions. It is clear, that there is no 'one-size-fits-all' model of bioeconomy fitting every region.

The regions without universities and knowledge institutes often remain as actors in lower parts of the value chain, with a low degree of innovation. Moreover, the smaller regions often lack the critical mass needed to build up bioeconomy clusters with significant impact and complementary skills. Attracting companies with bio-based expertise to set up activities in the region and attracting qualified labor force especially to smaller and rural regions are among the important challenges in developing regional bioeconomy.

Moreover, bioeconomy in smaller regions may capitalize on the increased and better utilization of biological resources to ensure local value creation. While enhanced local processing is being promoted as means to ensure local value creation, it may be problematic in smaller regions due to large competition on price in the global market.

Future opportunities for regions lacking skilled and educated labour force are within niche products and small-scale innovations developed using the local knowledge and competence of the local people (e.g. food innovation, bioenergy production and cross-sectoral collaboration). Focusing on niche production instead of bulk production, and on qualities such as ethical production, organic products and strict environmental standards could also present good opportunities in regions with small critical mass and small economies. These products may appeal for a steadily increasing number of conscious consumers.

## 6. Policy recommendations – national and regional level

Although the policy recommendations are drawn upon the lessons learned from the Nordic regions, the key messages are also relevant for a wider BSR area. The following messages are important to put forward to decision-makers:

- Bioeconomy development requires place-based, localized and decentralized approaches as there is no 'one-size-fits-all' solutions to the bioeconomy. Local and regional authorities are normally best placed to ensure that bioeconomy development benefits local economies, the environment and the residents, by developing local agendas based on local priorities, interests and strengths rather than national level needs. In this connection, the policy makers should develop enabling frameworks for bioeconomy where specific regional and local conditions can be considered. Utilizing smart specialization within circular- and bioeconomy offers good opportunities for fostering regional bioeconomy. In promoting bioeconomy, the policies and incentives should include triple bottom line criteria in order to encourage more inclusive local and sustainable development of bioeconomy in economic, social and environmental terms.
- Transition to a bioeconomy may be accelerated by using methods and tools that enable cross-sectoral cooperation between the public sector, companies and educational institutions. For instance, building networks, innovation platforms and cluster development may yield many positive results, such as supporting the development of new business opportunities and identifying new value chains.
- Innovation in the bioeconomy should be developed in a quintuple helix set-up. It prescribes innovation in the bioeconomy through government, science, business, local authorities and civil society cooperation. Thereby the quintuple helix stresses the importance of the legitimizing role of civil society and the empowering role of decentralized democratic authorities in developing bioeconomy systems (Bryden et al., 2017).

- Green public procurement can be used more effectively by public authorities as an instrument for driving the development of bio- and circular economy through active policy that gives priority to green solutions. However, public procurement should not merely stipulate environmental criteria in allocating the agreements for public goods or services to private suppliers, but should also consider social and economic impacts (Lindberg et al., 2016).
- Facilitate industrial symbiosis, as it allows to increase efficiency of the utilization of existing resources and contribute to development of new business opportunities and innovative products based on collaborations across industries. This can be done, for instance, through identifying industrial symbiosis exchanges for which there is a good business case, e.g. by mapping existing bioeconomy value-chains, industrial side streams and by-products, and conducting studies on the related markets, technology and logistics (read more 4.4).
- Lack of harmonized data is a challenge for monitoring and evaluation of the bioeconomy progress and impact. Supplying additional statistics and data is essential for monitoring the actual impact of bioeconomy on the regional development (e.g. in jobs, greenhouse gases reduction and economic growth).

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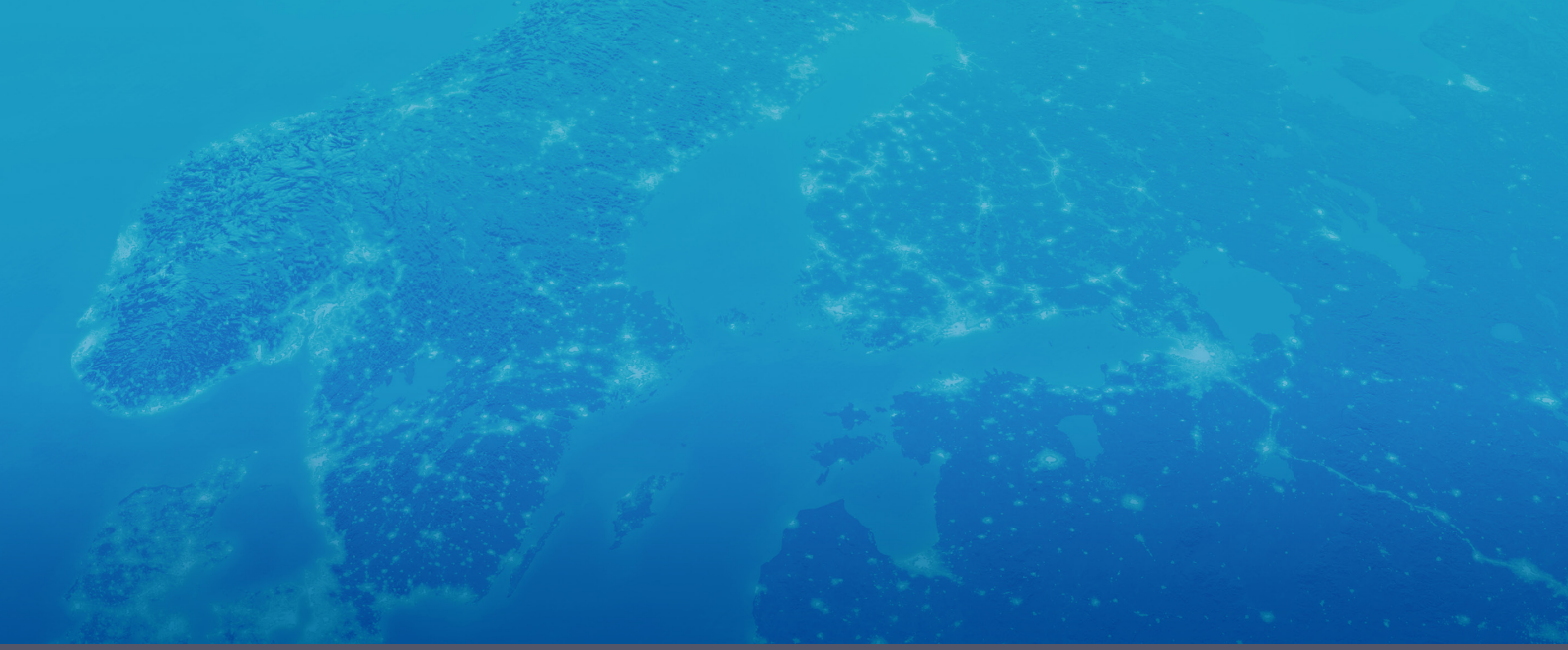

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