

TEN TRENDS

FOR THE SUSTAINABLE BIOECONOMY

in the Nordic Arctic and
Baltic Sea Region



Five bioeconomy trends
and five macrotrends

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Foreword

The bioeconomy is a cornerstone for sustainable development

The bioeconomy is set to play a significant role in the green transition, as it facilitates a shift from a fossil fuel-based economy to one based on renewable and biological resources. The fact that it has already gained traction in numerous sectors and industries shows that it is possible to build great products, services, businesses, and careers in a much more sustainable way.

We are now at the start of a new decade, and there are strong signs that the bioeconomy will be one of the key drivers that shape it. Along with circular economy principles, the bioeconomy is a focal point for EU strategy discussions and will be central to many sustainable development efforts. For this reason, the Nordic Council of Ministers is proud to coordinate the bioeconomy policy area under the EU Strategy for the Baltic Sea Region.

Hopefully, this report on bioeconomy trends will encourage policy-makers across the Baltic Sea Region and Nordic Arctic to take stock of the benefits that the bioeconomy has to offer and support its growth with a clear focus on sustainable development.

The report was commissioned by the Nordic Council of Ministers, in its role as Policy Area Coordinator for Bioeconomy in the EU Strategy for the Baltic Sea Region, and funded jointly by Interreg Baltic Sea Region. Nordic Sustainability managed the project in collaboration with Nordregio.

In recent years, the Nordic Council of Ministers has focused on developing the sustainable bioeconomy through numerous initiatives and a Nordic Bioeconomy Strategy, which brings together environmental, social, and economic ambitions for a more sustainable future. This has opened up exciting and significant new opportunities for an economy based on renewable resources. For example, the recent report *State of the Nordic Region 2020* shows how the Nordic region has become the European leader in terms of renewable energy share per capita.

The evidence shows that society is slowly but surely embarking down the path towards more sustainable options. The bioeconomy will enable more effective and innovative use of resources and create new industries and opportunities.

Our analysis of recent trends shows that the development of the bioeconomy presents a range of opportunities – and some challenges, too. The Nordic Council of Ministers is committed to the United Nations Sustainable Development Goals and to addressing the climate crisis and therefore supports the Nordic goal of becoming the world's first climate-neutral region. We cannot achieve this without replacing fossil fuels with biological resources to a far greater extent, and without ensuring a sustainable supply of renewable biological materials.

Paula Lehtomäki,
Secretary General,
Nordic Council of Ministers

This report highlights key trends in 14 countries that policy-makers should be aware of in their work on the bioeconomy as a means to achieve our common goals for the planet and our responsibilities to each other.



Executive summary

This report identifies ten bioeconomy trends in the Baltic Sea Region and Nordic Arctic. The aim is to equip policy-makers with an in-depth understanding of where the bioeconomy is heading and help them to navigate its potentials and pitfalls.

Of the ten trends, five are specifically part of the bioeconomy and show us some of the most prominent ways in which it develops. The other five are macrotrends – more overall societal or technological trends that influence the development of the bioeconomy. To provide context for these trends, the report analyses a number of conditions that support the bioeconomy, as well as the expected impact of the COVID-19 pandemic.

This report's findings are based on a review of available literature on the bioeconomy, 25 expert interviews, four stakeholder workshops, and a survey of more than 200 bioeconomy stakeholders. A total of 350 bioeconomy professionals across the region participated in the process.

The report covers 14 countries surrounding the Baltic Sea Region and Nordic Arctic, namely Denmark, Estonia, Finland, Latvia, Lithuania, Iceland, Germany (Northern part), Greenland, Norway, Poland, Russia (North-Western provinces), Sweden, the Faroe Islands and the Åland Islands.

FIVE TRENDS DRIVING THE BIOECONOMY

The five trends presented in this report were identified as significant and developing areas for the future of the bioeconomy in the region. The trends were selected for their potential for value generation on each of the three bottom lines: **social, environmental and economic**.

#1 The safe bet: Closing material loops in industry

There has always been a strong business case for utilising "leftover" or waste materials from industrial processes to make new products. Respondents see considerable untapped potential in using bio-based "sidestreams" for new or for more valuable products, and they consider this trend as the safe bet for improving the economic, social, and environmental bottom line of the bioeconomy.

#2 The divider: Biofuels

Biofuels have received considerable investment and political support due to their potential to replace fossil fuels. However, the respondents' comments indicate that opinion on biofuels is divided. Some see them as a necessary part of a transition from fossil fuels; others assert that biofuels are a dead end that risks diverting biological resources from other industries in which they could generate greater value.

#3 The fast track: Local branding

Branding based on a unique story about its origins has for centuries been used to add value to a wide range of products. Local branding offers the opportunity to find a market niche for bioeconomy products, particularly food, both locally and globally. Survey respondents rate this trend highly, with the overall second-highest value generation potential and the highest potential for creating social value. Perhaps the most striking finding is that respondents see this trend as the one that can fulfil its potential the fastest since it requires little to no research or infrastructure development.

#4 The slow starter: Seaweed and algae

Algae and seaweed can grow at several times the pace of terrestrial plants and are gaining attention as useful inputs for industries as diverse as energy and human food production. Some algae have a very high natural oil content, which makes them ideal for producing products ranging from cosmetic oils to biofuels. This trend has significant potential, particularly in terms of environmental impact, but it is still at an early stage.

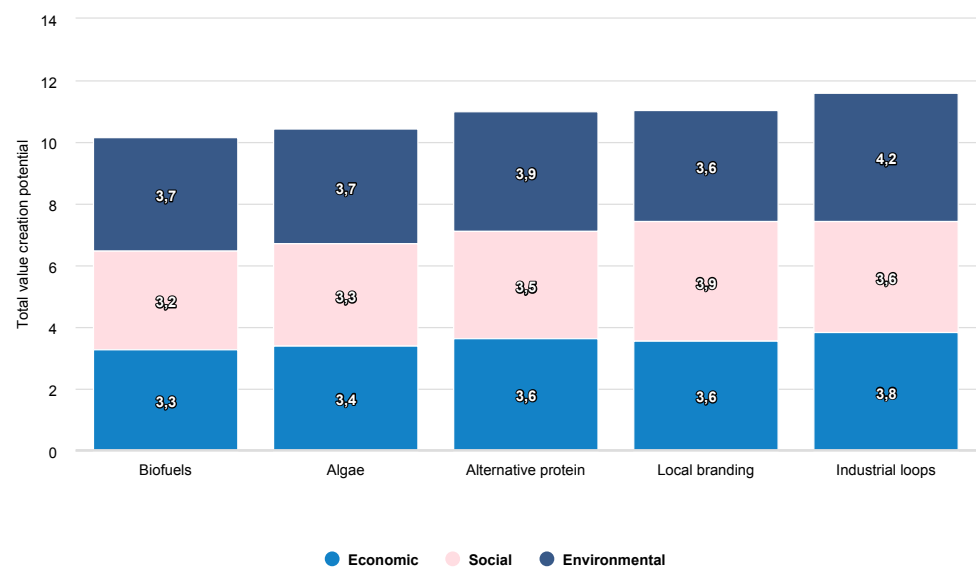
Respondents acknowledge the potential to create more biomass without increasing the competition for land. However, they see it as a slow starter, and few respondents believe that this trend will reach its full value potential within the next ten years.

#5 The newcomer: Alternative protein sources

Alternative and new sources of proteins for food and animal feed are part of a relatively new field, and research is still being conducted in many areas. Protein-rich plants such as legumes and grasses, as well as insects and seaweed, are among the raw materials that have the potential to replace meat for human consumption and imported soya for animal feed. New protein sources perform well in the survey, primarily due to strong expectations among respondents of the environmental benefits of shifting to new protein sources.

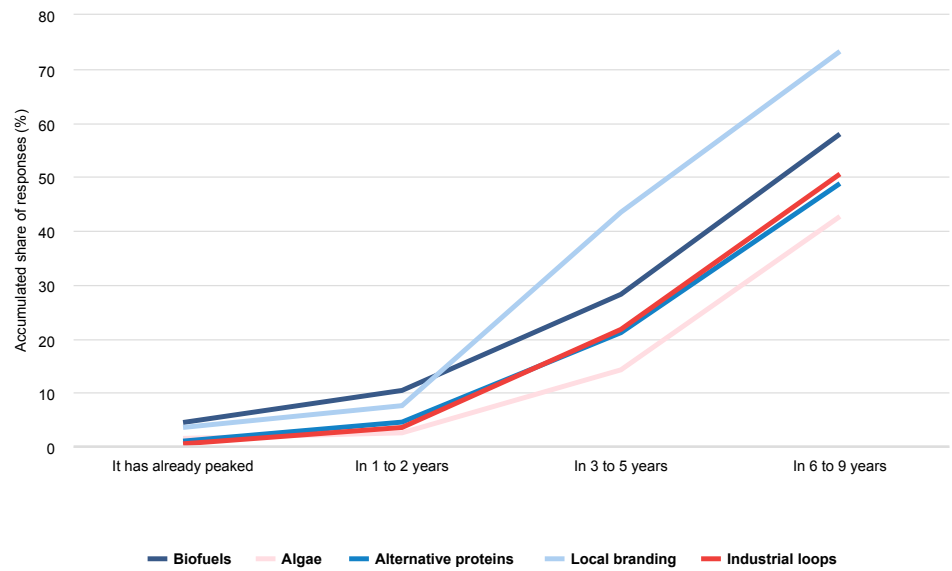
The respondents generally believe that these trends have the potential to boost the economic, social, and environmental bottom lines substantially (see Figure 1). However, with the exception of the local branding trend, respondents believe that the trends are expected to generate only about half of their value-creation potential in this decade (see Figure 2).

Figure 1: Total value-creation potential across all trends



Responses to the survey question: "How do you see the value-creation potential of [trend]? Please give 1 to 5 points (with 5 being most value-added) for each of the three value categories below." N=198 –202

Figure 2: Value-creation potential reached within 10 years



Responses to the survey question: "When do you believe [trend] will reach its full value-creation potential?" N=198-202

FIVE MACROTRENDS INFLUENCING THE BIOECONOMY

The bioeconomy is not developing in a vacuum. The potential of an economy based on the sustainable sourcing of biological resources is highly dependent on wider societal and technological trends. Five macro trends that will influence the development of the bioeconomy have therefore been identified.

#6 Digitalisation

Digitalisation can provide new revenue and value-producing opportunities and influence the bioeconomy in several ways: resources can be more efficiently grown, transported, utilised and cascaded; and investments can be planned for the optimal use of resources. Most respondents see this trend as being a driver for the bioeconomy, with 98.9 per cent of respondents rating it as either a major or minor driver (see Figure 3).

#7 Green investments

Pension funds and other large institutional investors are shifting their money into long-term investment in sustainability. This opens up new funding opportunities for the bioeconomy, especially large-scale projects, as large investors tend to favour fewer and bigger investments over multiple small ones. Of the five macro trends, green investment has the highest percentage of respondents (74.9 per cent) who expect it to be a major driver for the bioeconomy.

#8 Urbanisation

Many rural and already sparsely populated areas in the Nordic region and around the Baltic Sea are expected to see further falls in their population up to 2030. This may be an obstacle to the growth of the bioeconomy in rural areas. Urbanisation is expected to have a less positive impact on the bioeconomy than the other macro trends. Respondents are split almost 50/50 on whether it will be a driver or a brake for the bioeconomy.

#9 Green New Deals

The idea of a new political “contract” between politicians and voters favouring

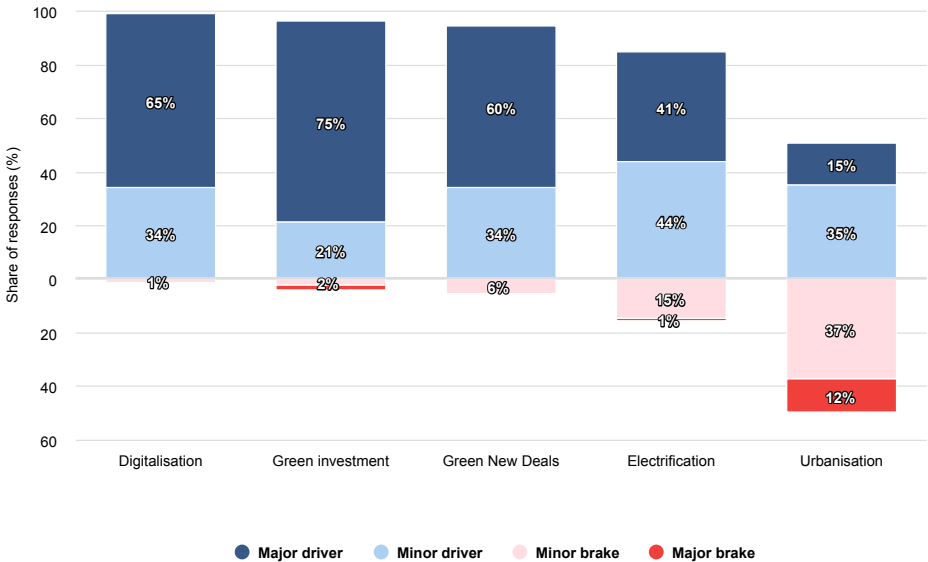
sustainability – a Green New Deal – has emerged in a series of elections in 2019 that focused on the climate agenda. Most recently, this trend has been seen in the focus on sustainability in many European policy initiatives aimed at rebooting the economy after the COVID-19 lockdown. This is reflected in the respondents seeing this trend as a major (60.4 per cent) or minor driver (34.1 per cent) for the bioeconomy.

#10 Electrification

Electricity is replacing combustion in many aspects of the energy system, from district heating to cars. This affects the bioeconomy by reducing the need for biomass in heating, electricity generation and biofuels, while also potentially delivering cheap renewable energy that can reduce the cost of refining biomass into high-value products. Respondents rate this macrotrend as slightly less influential than the others, with the exception of urbanisation. 40.9 percent of respondents see electrification as a major driver for the bioeconomy.

Most respondents believe that four of the five macrotrends will act as positive drivers of a growing bioeconomy. Urbanisation is the only one not seen as clearly supportive. The five macrotrends are described below.

Figure 3: Influence of macrotrends on the bioeconomy



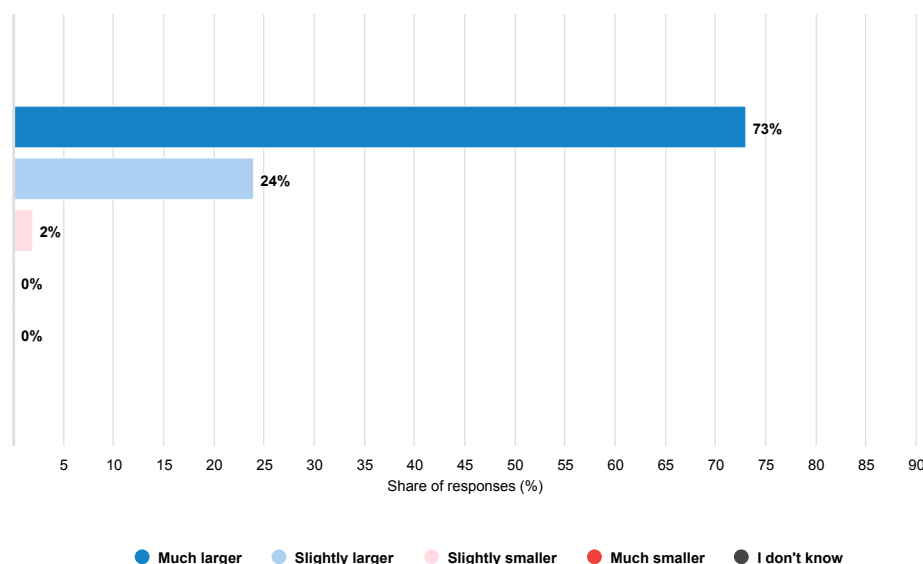
Responses to survey question: “How do you believe [macrotrend] will influence the development of the bioeconomy?” N=189–192

Conditions for the development of the bioeconomy in the region

The bioeconomy already represents a significant share of our economies. Depending on definitions and geography, it is estimated to account for 10–20 per cent of the overall economy in the region covered by this report. However, its potential appears to be much larger.

The survey results clearly show strong expectations of growth in the bioeconomy in the region. Three out of four survey respondents believe the bioeconomy will grow “significantly” faster than the general economy, and become a “much larger” part of the economy of their country over the next 10–20 years. A further 24 per cent also see faster growth in the bioeconomy compared to overall economic growth but anticipate that it will only become a “slightly larger” part of the economy.

Figure 4: Bioeconomy as anticipated share of the overall economy over the next 10 to 20 years



Responses to the survey question: "How important do you believe the economy based on biological raw materials (the 'bioeconomy') will be in the country where you live over the coming 10 to 20 years?" N=211

Bioeconomy experts and stakeholders have great expectations for the environmental and social benefits of an economy based on sustainable bio-resources, compared to one based on fossil materials. In this perspective – sometimes referred to as the triple bottom line of people (social), planet (environmental) and prosperity (economic) – the survey tells a story of a growing bioeconomy that generates economic growth while reducing its environmental footprint. This, in turn, generates additional socio-economic benefits, such as job creation and rural development.

One major finding from the survey is that conditions in the region are generally supportive of bioeconomic growth, albeit to varying degrees. In particular, respondents express a strong belief in the available natural resources – more than 80 per cent indicate that the natural resources in their country are either "supporting" or "very supporting" of a growing bioeconomy.

When asked about support from "bioeconomy stakeholders", roughly two-thirds of respondents expect the stakeholder group of businesses, consumers and politicians to support initiatives to grow the bioeconomy. No stakeholder group is seen as "very limiting".

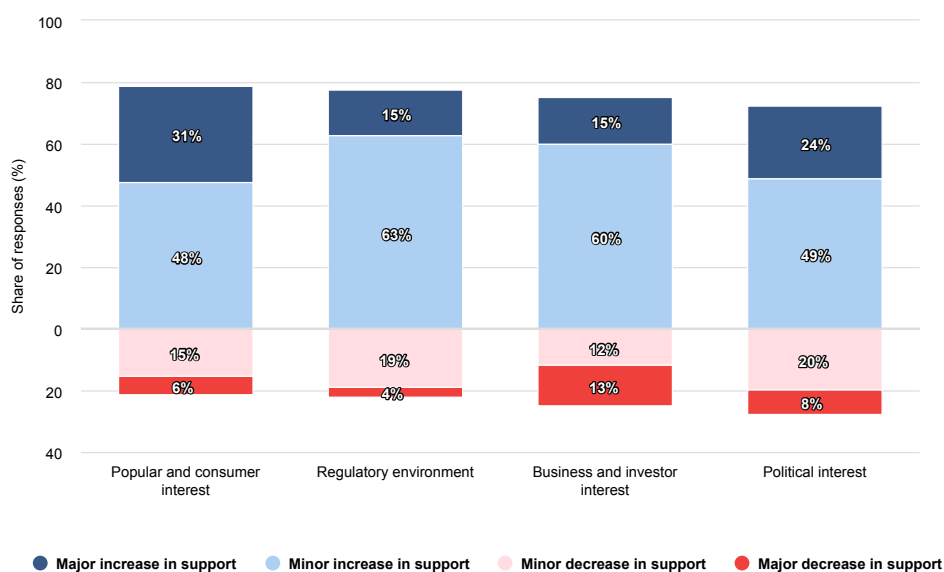
The impact of the COVID-19 pandemic on the bioeconomy

Between April and May 2020, a survey was conducted to understand the impact of the COVID-19 pandemic on the bioeconomy and its role in economic recovery. Respondents were asked to reflect on the future of sustainable bioeconomic development in light of the pandemic and to offer their perspective on its potential impact on the identified bioeconomy trends.

The respondents express mixed views on how the pandemic and ensuing economic crisis might affect the growth of the sustainable bioeconomy. However, 60 per cent of respondents believe it will strengthen the case for the bioeconomy: that a bio-based economy will be less susceptible to new pandemics or other international crises that risk shutting down global supply chains.

All four stakeholder groups expect growing support. In particular, the respondents' comments focus on an expectation of a political ambition to boost the bioeconomy, to ensure that it remains relevant after the COVID-19 outbreak. The respondents expect this because they see the bioeconomy as an obvious area for investment aimed at generating new growth.

Figure 5: Expected influence of COVID-19 on support for the bioeconomy



Responses to the survey question: "How do you expect the support for the bioeconomy to change, as compared to before the COVID-19 pandemic? Please rate each of the aspects below." N=113

Approach to data-gathering and analytical setup

The analyses conducted in this report are based on multiple data sources. In order to identify the trends, a literature review was conducted, 25 experts were interviewed and four stakeholder workshops were conducted.

A survey of 223 bioeconomy professionals in the region was also carried out, the objective of which was to test the identified trends against respondents' expectations. In addition, an updated survey relating to the impact of the COVID-19 pandemic was issued to the respondents. The analysis integrates insights from all of the above-mentioned data sources.



Introduction

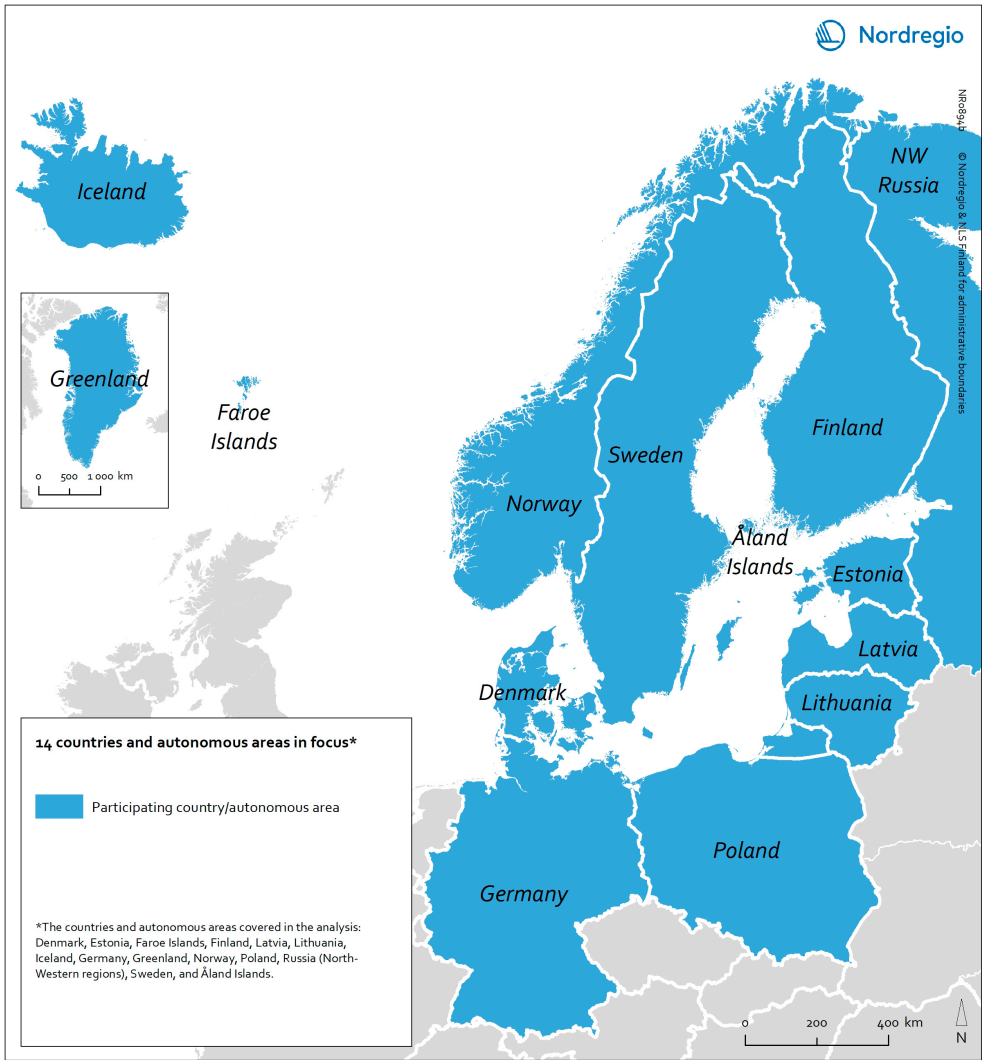
The development of a sustainable bioeconomy has never been more important. In times of climate change, a growing biodiversity crisis, the COVID-19 pandemic, and a sustained focus on achieving the Sustainable Development Goals by 2030, the idea of an economy that is partly or wholly based on biological raw materials – grown and harvested within the carrying capacity of the ecosystem – has attracted growing political and commercial attention. Whether the ambition is to achieve growth with a smaller environmental footprint, create jobs and opportunities in rural areas, or build an economy that is less dependent on fragile global value chains, stakeholders are looking to the bioeconomy.

However, the bioeconomy comes with its own set of challenges. Just because resources can be regrown, it does not mean they are limitless – only a certain amount can be grown in a sustainable way. Globally, we already see competition for land and biomass between, for example, the energy sector and the food sector. Similarly, when we start to cultivate areas that have until now been relatively untouched, it raises questions regarding who has the right to use those areas and how we protect biodiversity.

The purpose of this report is to support decision-making that realises the potential of the bioeconomy and balances the needs of multiple stakeholders within the boundaries set by the ecosystems. The report identifies five trends in the bioeconomy and five macrotrends that influence it and examines a number of supporting conditions. The overall ambition is to equip policy-makers with an in-depth understanding of where the bioeconomy is heading and help them to navigate its potential and pitfalls.

The report covers 14 countries surrounding the Baltic Sea Region and the Nordic Arctic, from North-West Russia to Greenland. They face very different conditions, and not every trend is seen in every area, but hopefully this report will spark greater interest in the bioeconomy from policy-makers across the region. The multiple benefits of the bioeconomy may prove even more important as the global economy recovers from the COVID-19 pandemic and resulting economic recession. The need for a post-crisis green recovery must be rooted in the bioeconomy.

Figure 6: Countries and autonomous areas covered in the analysis



Countries covered in the analysis: Denmark, Estonia, Finland, Latvia, Lithuania, Iceland, Germany, Greenland, Norway, Poland, Russia (North-Western regions), Sweden, the Faroe Islands, and the Åland Islands.

Definition of bioeconomy trends

For the purpose of this report, the bioeconomy is defined as the "production, utilization, and conservation of biological resources, including related knowledge, science, technology, and innovation, to provide information, products, processes, and services across all economic sectors aiming toward a sustainable economy" (European Commission, 2018a).

The focus on sustainability is important because it underpins the overall ambition of building an economy that will not undermine its own biological or social foundation. However, it is difficult to define in general terms what is sustainable and what is not. For example, depending on the circumstances, a specific type of forestry practice might be sustainable in one area, but not in another. In other words, although sustainability is crucial, the sustainability of a given activity is hard to assess out of context.

For the same reason, it is difficult to provide a clear statistical overview of the sustainable bioeconomy. Statistics for employment in the bioeconomy range between 9.5 per cent of the working population in the European Union (Ronzon et al., 2017) to 17.1 per cent in the Nordic Countries (Refsgaard et al., 2020). Differences in definitions and in the geography of the studies make it hard to compare the numbers directly. Nonetheless, the main point – that the bioeconomy is an important part of the overall economy – is clear.

Approach to identifying and qualifying trends

The analysis utilised a three-step process to identify the trends that are shaping the bioeconomy and the potential for new growth.

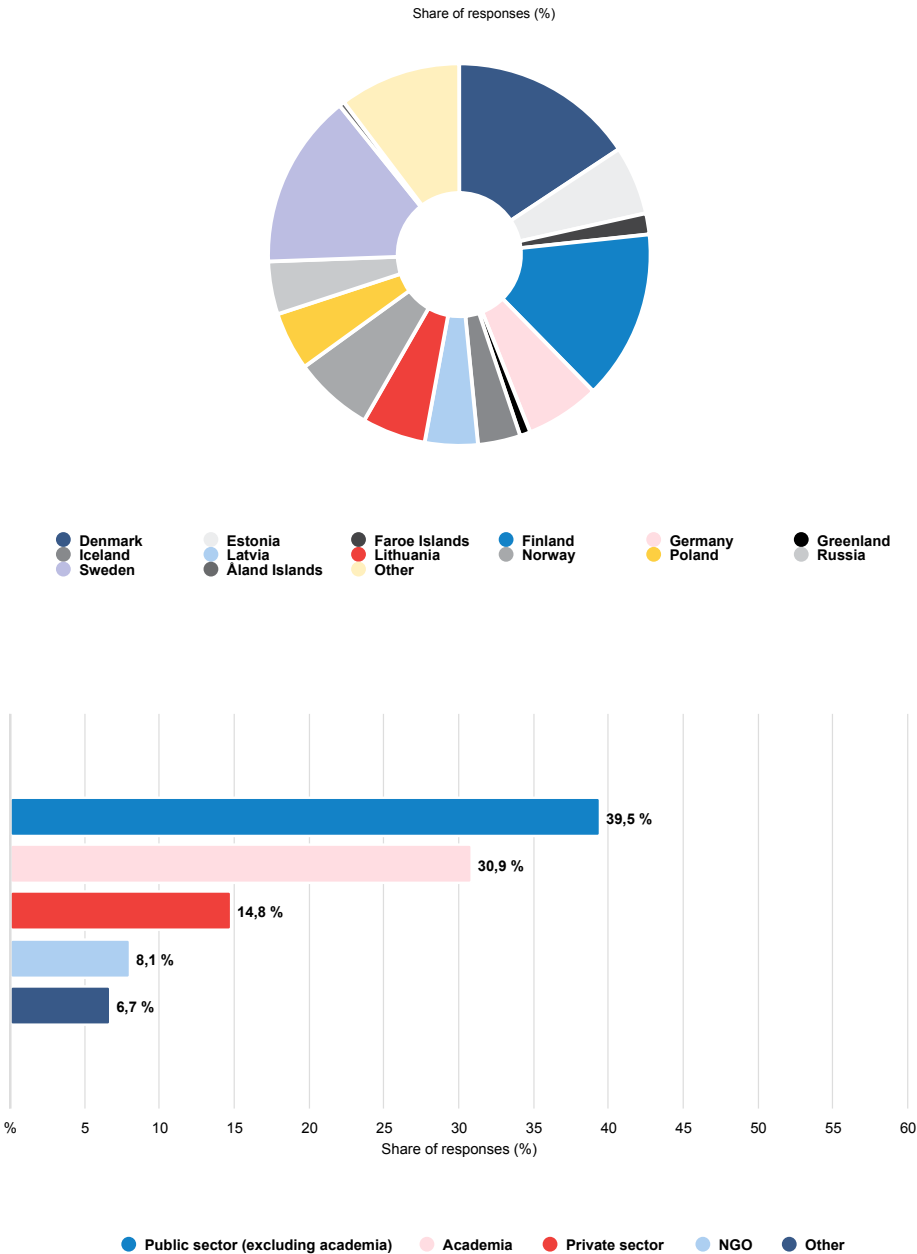
First, a literature review identified potential trends. Secondly, through four workshops and 25 interviews, involving bioeconomy stakeholders and experts, the potential trends were narrowed down to five sector specific trends and five macrotrends that required further investigation. Finally, a survey was conducted to gather insights into the value-generation capacity of the trends. Through these activities, more than 350 stakeholders, representing diverse groups across the region, have contributed to the report.

Expert	Organisation	Country
Agnė Dapkuvienė, <i>Head of Internal Audit</i>	Ministry of Agriculture	Lithuania
Alberto Giacometti, <i>Research Fellow</i>	Nordregio	Sweden
Anton Shcherbak, <i>Research Associate</i>	Institute of Economics Karelian Research Centre RAS	Russia
Āris Ādlers, <i>President</i>	Partnership for Rural Europe	Latvia
Astrida Miceikiene, <i>Professor</i>	Vytautas Magnus University	Lithuania
Camilla Widmark, <i>Researcher</i>	Forest Bioeconomy Network/SLU	Sweden
Christian Patermann, <i>Former Programme Director</i>	European Commission	Germany
Geir Oddsson, <i>Senior Adviser</i>	Ministry for Foreign Affairs	Iceland
Irīna Kulitāne, <i>CEO</i>	Konso Ltd.	Latvia
Janis Brizga, <i>Former Chair</i>	ANPED Northern Alliance for Sustainability	Latvia
Jonas Rönnerberg, <i>Associate Professor</i>	Nordic Forest Research	Sweden
Katrin Kepp, <i>Head of the Centre of</i>	Estonian University of Life Sciences	Estonia

<i>Bioeconomy</i>		
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Liisa Saarenmaa, <i>Deputy Head</i>	Ministry of Agriculture and Forestry	Finland
Margareth Øverland, <i>Professor</i>	Norwegian University of Life Sciences	Norway
Martin Rümmelein, <i>Youth Representative</i>	Baltic Sea States Subregional Co-operation	Denmark
Minna Hakaoja, <i>Food Industry and Retail Consultant</i>	ProVeg International	Germany
Niels Gøtke, <i>Head of Division</i>	Danish Agency for Science and Higher Education	Denmark
Per Hansson, <i>General Secretary</i>	The Nordic Joint Committee for Agricultural and Food Research	Sweden
Santa Vītola, <i>Project Manager</i>	Vidzeme Planning Region	Latvia
Sergey G. Rebtsovskiy, <i>Vice-Director</i>	The Foundation of Participants of the Presidential Programme, Arkhangelsk region	Russia
Sirpa Kurppa, <i>Research Professor Emerita</i>	Natural Resources Institute / MTT Agrifood Research	Finland
Sveinn Margeirsson, <i>Former CEO</i>	Matís	Iceland
Tróndur Gilli Leivsson, <i>Managing Director, CEO</i>	Búnaðarstovan - Agricultural Agency	Faroe Islands
Vidar Skagestad, <i>Director</i>	Research Council of Norway	Norway

The survey was conducted between January and March 2020. It was populated by outreach through relevant newsletters, mail groups and social media groups focused on the bioeconomy, as well as by direct outreach to relevant organisations and individuals. The survey gathered answers from 223 respondents, with good representation across the countries covered, although most respondents were from the Scandinavian countries. The public sector and academia stand out as the sectors with the highest response rates, accounting for 70 per cent of respondents, while the private sector comes in third with a sizeable representation (see Figure 7).

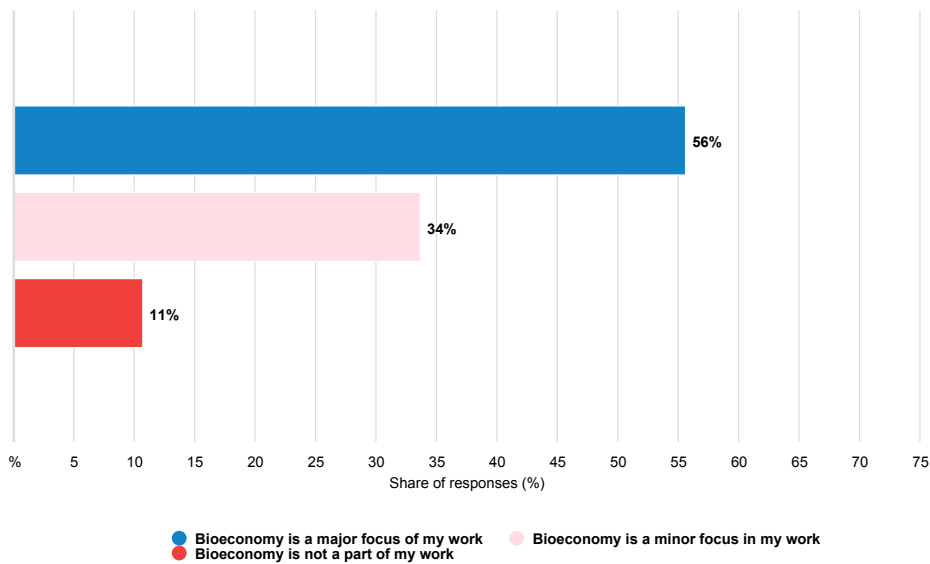
Figure 7: Survey respondents by country of origin and sector



Responses to the survey questions: "In which country is your main workplace located?" (left) and "Which sector do you work in?" N=223 (both)

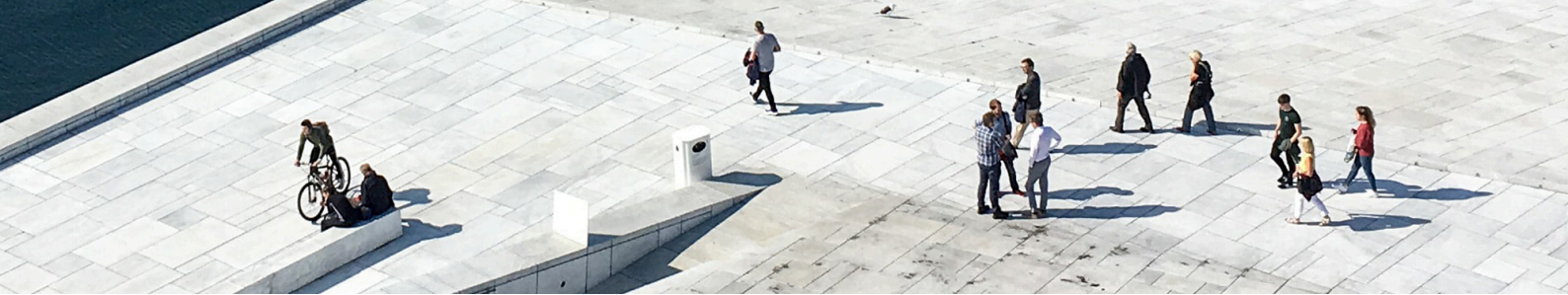
The target audience for the survey comprises individuals with professional knowledge of the bioeconomy, which is the case for 90 per cent of respondents. Job titles indicate that most respondents have a senior or managerial role. Although the survey cannot be said to be representative of a wider population of bioeconomy experts, it does present the insights of a relatively large group of professionals within a specific topic and a specific geographical range.

Figure 8: Survey respondents' engagement with the bioeconomy



Survey responses to the question: "To what extent is your work related to the bioeconomy?". N=223

In April, the decision was taken to contact respondents again with additional questions relating to the COVID-19 crisis and its potential effects on the bioeconomy. This additional survey was sent out in late April, concluded in early May and received 122 responses, also with a reasonable geographical distribution.



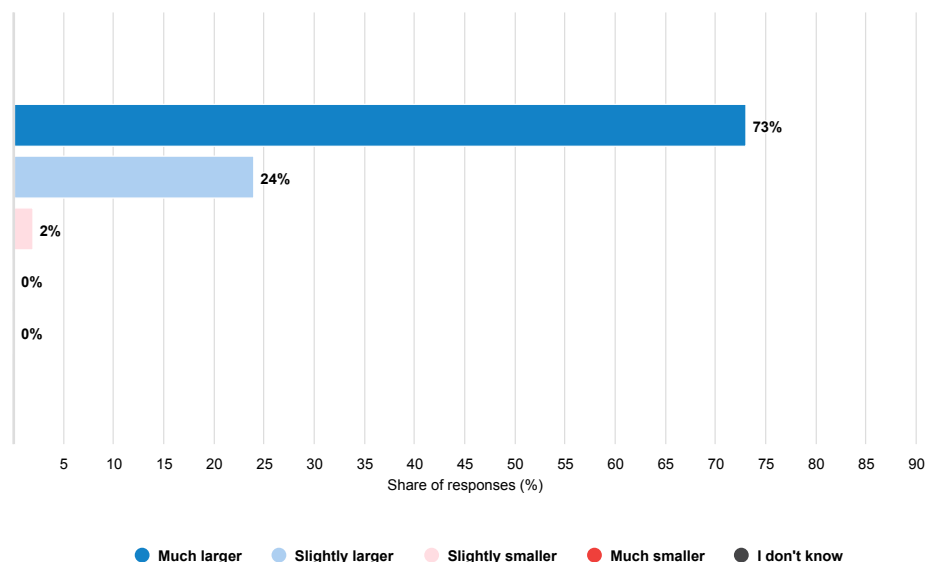
Conditions for the bioeconomy in the region

Strong expectations for growth in the bioeconomy

The European Union Updated Bioeconomy Strategy (European Commission, 2018a) refers to a job creation potential in the bioeconomy of 1 million new jobs in member states. It also expects significant benefits in a range of policy areas, from climate change to land degradation. Ambitions are also high in the region covered by this report – for example, Finland anticipates economic growth of €100 billion and 100,000 new jobs in the bioeconomy over a ten-year period (Finnish Ministry of Employment and Economy, 2014).

These expectations for growth in the bioeconomy are reflected in the expert interviews and are signalled strongly throughout the survey. Seventy-three per cent of respondents believe that over the coming 10 to 20 years, the bioeconomy will significantly outgrow other economic sectors in their respective countries, and become a "much larger part" of the general economy. A further 24 per cent also see the bioeconomy outpacing other parts of the economy, but only to become a "slightly larger part" of it. Just two per cent of respondents expect the bioeconomy to grow at a slower pace than the general one.

Figure 9: Bioeconomy as anticipated share of the overall economy over the next 10 to 20 years



Responses to the survey question: "How important do you believe the economy based on biological raw materials (the 'bioeconomy') will be in the country where you live over the coming 10 to 20 years?" N=211

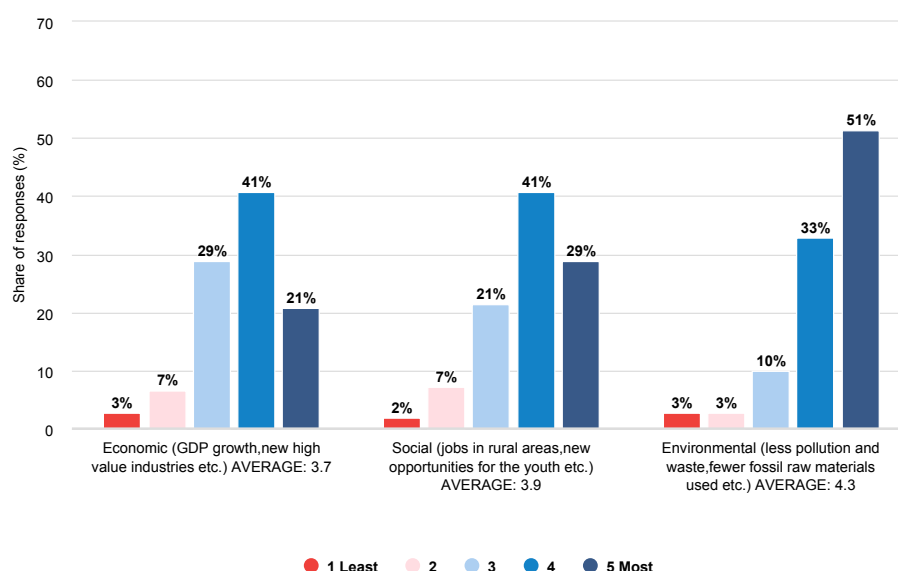
The bioeconomy creates value for the triple bottom line

Both the survey and the expert interviews revealed considerable ambitions for the environmental and social benefits of an economy based on sustainable bio-resources, compared to one dependent on fossil materials.

To capture these aspects, respondents were asked to rate the value-creation potential of the bioeconomy in three separate categories: economic, social, and environmental value (see Figure 10). In this perspective – often referred to as "the triple bottom line" – respondents saw the bioeconomy both as adding economic value and as a driver for environmental and social values.

The survey tells a story of a growing bioeconomy, one that generates revenue while also reducing environmental footprint and bringing about social benefits like job creation and rural development. The responses from experts in various fields testify to these benefits, as do the qualitative comments from survey respondents. The bioeconomy is not seen as business-as-usual growth, but business-above-usual growth, which supports a strong triple bottom line for people, planet and prosperity.

Figure 10: Value-creation potential for the bioeconomy



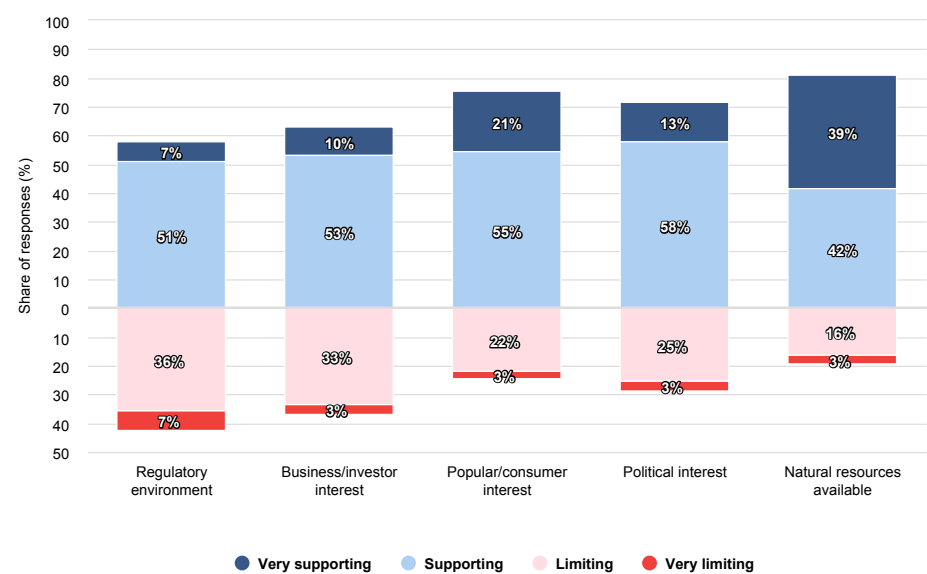
Responses to the survey question: "What value do you see the bioeconomy creating for society? Please rate the impact of a growing bioeconomy on a scale from 1 to 5 (with 5 being most value-created) for each of the three value categories below." N=211

The supporting conditions for the bioeconomy are in place

A third major finding in the survey is that important conditions for growth in the bioeconomy in the Baltic Sea Region and Nordic Arctic are already in place. More than 80 per cent of respondents indicate that the available natural resources in their country are either "supporting" or "very supporting" of a growing bioeconomy. This can indicate both unused resources and untapped economic potential in existing resource streams.

When asked about the support from "bioeconomy stakeholders", roughly two-thirds of respondents expect stakeholders to support initiatives to grow the bioeconomy. The only area in which the level of support approaches neutral is existing regulation, where 43 per cent of respondents deem regulation to be limiting. This raises questions concerning whether regulation is lagging behind stakeholder interest in harvesting the opportunities offered by the available natural resources, or if some respondents see regulation that protects the environment as a limiting factor.

Figure 11: Supporting conditions for bioeconomy development



Responses to survey question: "How do you see the conditions for developing a larger bioeconomy in your country? Please rate each of the aspects below."
N=211

The Bioeconomy in NW Russia:

Policy development is needed to capitalise on natural resource wealth

NW Russia is a large land area comprising vast forests and rich mineral deposits. The Barents, White and Baltic seas, as well as interior water bodies, offer strong possibilities for blue bioeconomy development. Large softwood forests are already being used for extensive pulp, paper, and pellet production. Despite abundant natural resources, the sustainable bioeconomy is not a major focus in the area, and expert interviews suggest only a small but growing narrative around sustainability.

According to expert interviews, a strong federal governance structure and little regional control of natural resource management limit NW Russia's ability to respond to local conditions and establish cross-border linkages with other northern neighbours. These structural conditions are further challenged by a lack of a unified strategy for bioeconomic development. Experts also express concern about market forces being the main driver for natural resource practices. The availability and low cost of Russian petroleum products suggest a lock-in effect that prevents substitution with more sustainable and bio-based alternatives.

However, some initiatives may galvanise bioeconomic growth in the region. More collaborative policy initiatives, e.g. the Barents Euro-Arctic Working Group, may sharpen political focus and lead to positive changes. Research and technology can also play a major role: "the key to the development of bioeconomics is to increase the investment in research and sponsorship of the research in this area" (Shcherbak et al., 2019). Tourism is also seen as a strong incentive to develop sustainable practices and infrastructure (M. Viktorovna & S. Viktorovna, 2015).

Experts express optimism in these and other initiatives, but also say that more work is needed. In particular, establishing new bioeconomy organisations or networks in the region could lead to closer international collaboration, alignment with business interests, and greater political influence, according to Sergey Rebtsovskiy, a bioeconomy expert in Arkhangelsk province.



BIOECONOMY TREND #1

The safe bet: Closing material loops in industry

Respondents see considerable untapped potential in using sidestreams of raw materials in industry. They consider this trend as the safest bet for improving the economic, social, and environmental bottom line of the bioeconomy.

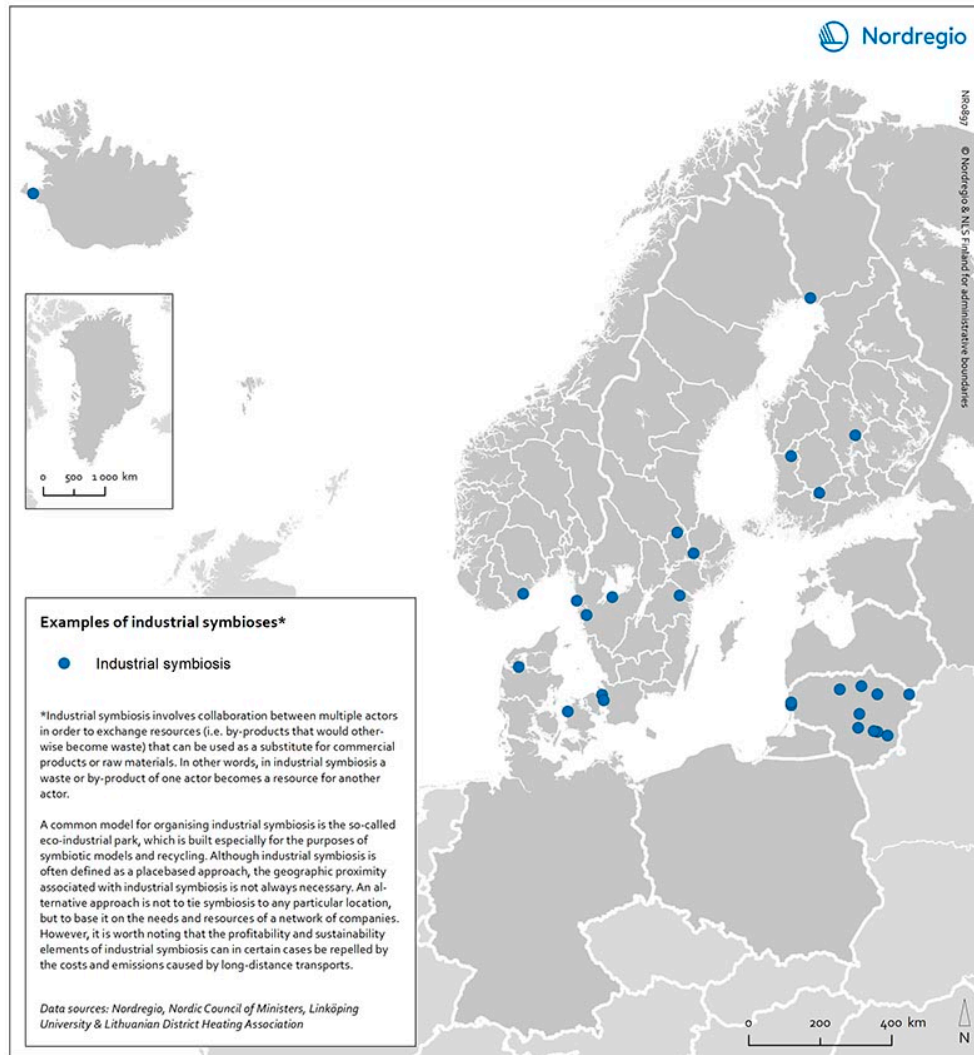
One of the limiting factors for a growing bioeconomy is the availability of raw material. Even though materials can be regrown, they are far from unlimited. The trend of closing material loops in industry is based on the fact that increasing both the availability of raw materials and the efficiency of their use will create a competitive advantage.

The total annual production of biomass in the European Union has been estimated at roughly 1.8 billion tons (European Parliament, 2018). The available biomass sidestreams are estimated at 314 million tons for agriculture and forestry alone (Cabeza et al., 2019). The term “sidestreams” describes the parts of the raw material that are not used for the main products, such as tree branches and sawdust from timber production, or the parts of fish that cannot be sold as fillets and portions. The value generated by utilizing these sidestreams is what drives this trend.

Industrial symbiosis is when one industry’s waste is used as another industry’s raw material. One of the best-known examples of this in the Baltic Sea Region is from Kalundborg in Denmark. The businesses in this partly bio-based industrial symbiosis

exchange water, energy, and raw materials, resulting in great economic and environmental benefits. A lifecycle analysis showed that the nine partners in the symbiosis collaboration saved more than €24 million and created socio-economic benefits worth an additional €14 million per annum (Ellen MacArthur Foundation, 2019).

Figure 12: Examples of industrial symbioses

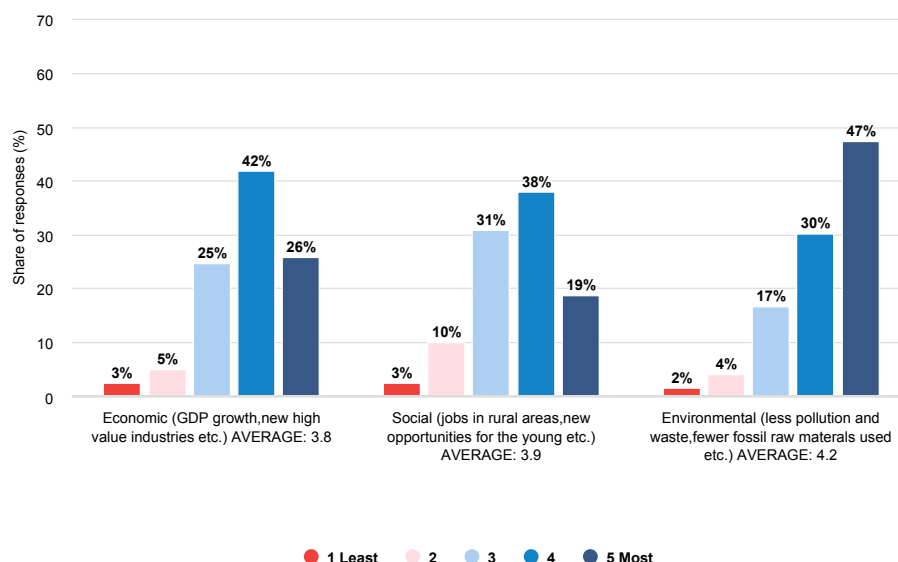


In recent years, companies in markets ranging from dietary supplements to biodiesel have demonstrated that there are profits to be made from closing material loops and utilising industrial sidestreams for new or more valuable products. While this is not a new trend, expert interviews and survey results indicate considerable capacity for continued growth.

The trend with the greatest value potential

The survey identifies the closing of industrial material loops as the trend with the greatest potential to create value across all three categories. What stands out is the environmental benefits of this trend. With an average of 4.2 out of 5, this is the single highest score in any value category for any of the trends. It is also ranked first for economic potential and second for social value. The respondents, therefore, send a very strong signal that closing material loops in bio-based industries will drive potential new growth on all three bottom lines.

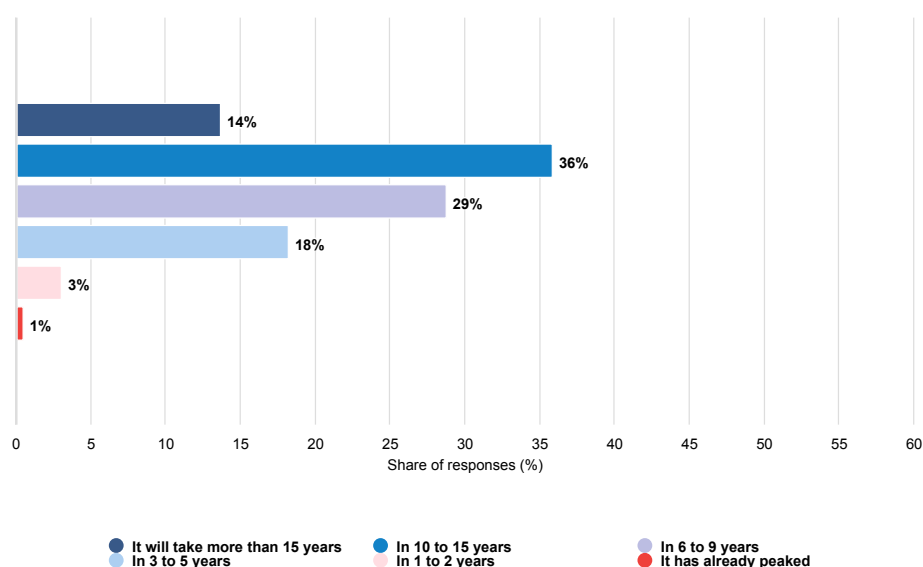
Figure 13: Value-creation potential of closing material loops in industry



Responses to the survey question: "How do you see the value-creation potential of closing the industrial loops? Please give 1 to 5 points (with 5 being most value added) for each of the three value categories below." N=198

Despite the focus on the circular economy in recent years, the trend is not considered close to reaching its full potential yet. Half of the respondents estimate that "closing material loops" is a trend that will come to fruition in the coming decade, while the other half expect it to peak after 2030.

Figure 14: Value-creation potential over time for closing material loops



Responses to the survey question: "When do you believe closing industrial loops will reach full value-creation potential?" N=198

Circular material use is stagnating

The circular economy concept has attracted growing political attention in Europe, with the European Commission developing Circular Economy Action Plans in 2015 and again in 2020. Closing material loops in industry has an obvious relation to the concept of a circular economy, and the EU's focus on the circular economy is, therefore, a driver for this trend. However, it differs from a broader circular economy perspective in that it focuses on waste and sidestreams in industry only. This has the advantage of utilising large amounts of relatively uniform materials compared to the generally mixed materials produced from recycling products.

However, despite good examples and political goodwill, only a small proportion of materials are used in a circular manner. In the region covered by this analysis, Germany is in the lead, at just over a tenth of materials (see Figure 15). Circularity rates have also been falling in several countries in recent years (see Figure 16). According to the OECD's Global Material Resources Outlook, most global economies face a challenge in reducing material intensity to levels that make up for their growth in GDP (OECD, 2019). This indicates that greater circularity in an established economy is a complex and long-term task. The bioeconomy has unique advantages in that it supports circularity, primarily because all biomaterials can be repurposed in some way, including in energy generation.

Untapped potential in the Baltic countries and NW Russia

Despite the slow rate of progress towards a more circular economy, respondents have a generally positive view of this trend. In their comments, some respondents stated that there are still untapped sources of materials, especially to the East in the Baltic Nations and North-West Russia. However, as one respondent points out, there could be challenges associated with the fact that countries with unused materials may not have an industry that is currently well equipped to utilise sidestreams. This could imply the potential for transnational approaches worthy of further study.

In terms of sectors, food is mentioned as one with especially great potential for closing loops. The large proportion of food waste is seen as an obvious potential source of material that could be used better, as reflected in the 2020 EU Circular Economy Action Plan. Respondents also point to digitalisation as a key enabling technology for this trend to reach its full potential.



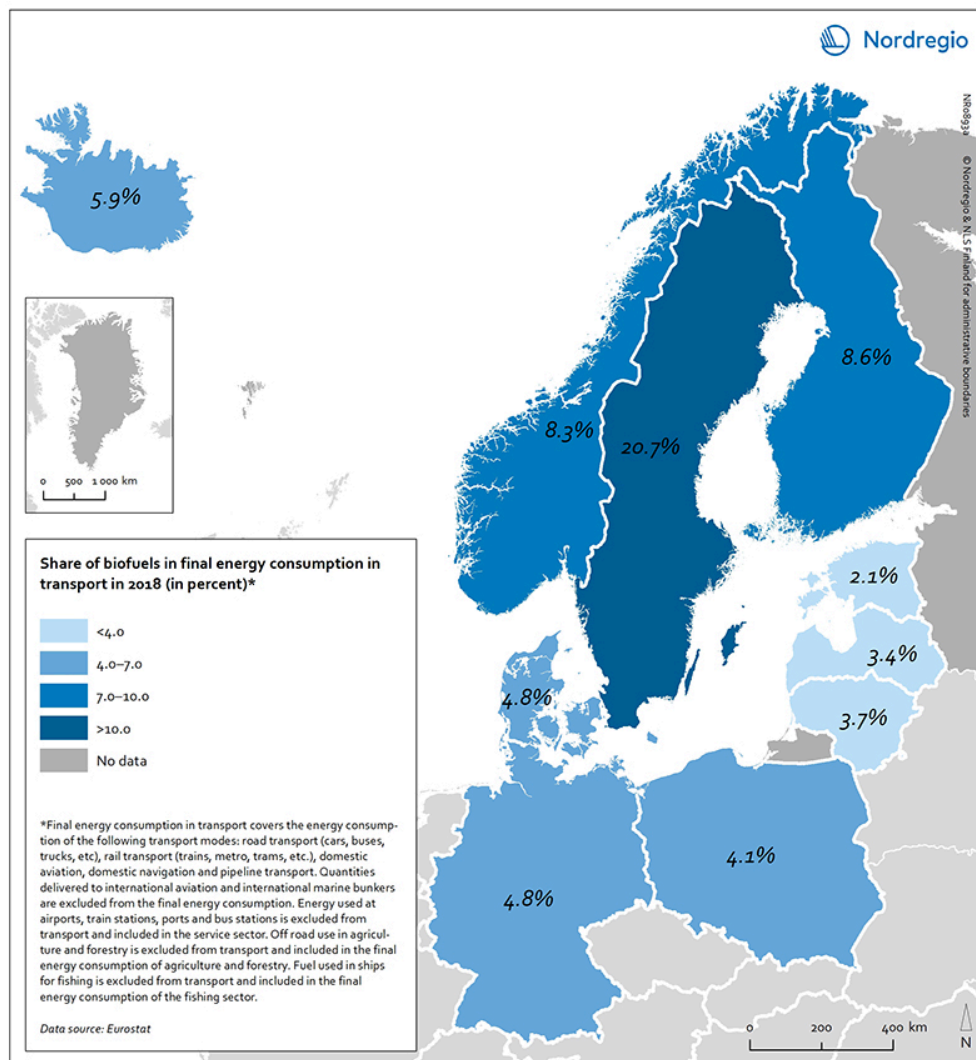
BIOECONOMY TREND #2

The divider: Biofuels

Biofuel consumption is growing in some parts of the region, but falling in others. Both the expert interviews and survey results indicate a divide between those who see them as a necessary part of a non-fossil energy system and those who believe biofuels are a dead end.

There has been considerable political support for biofuels. In the EU, this has been driven by the aim of reducing dependency on imported fuels – for example, 10 per cent of transport fuel should be produced from renewable sources. However, even though a target for greater use of biofuels has been EU policy since the Renewable Energy and Fuel Quality Directives of 2009, development has been slow. Of the EU countries covered in this analysis, only one country (Sweden) has reached the 10 per cent target (Figure 15).

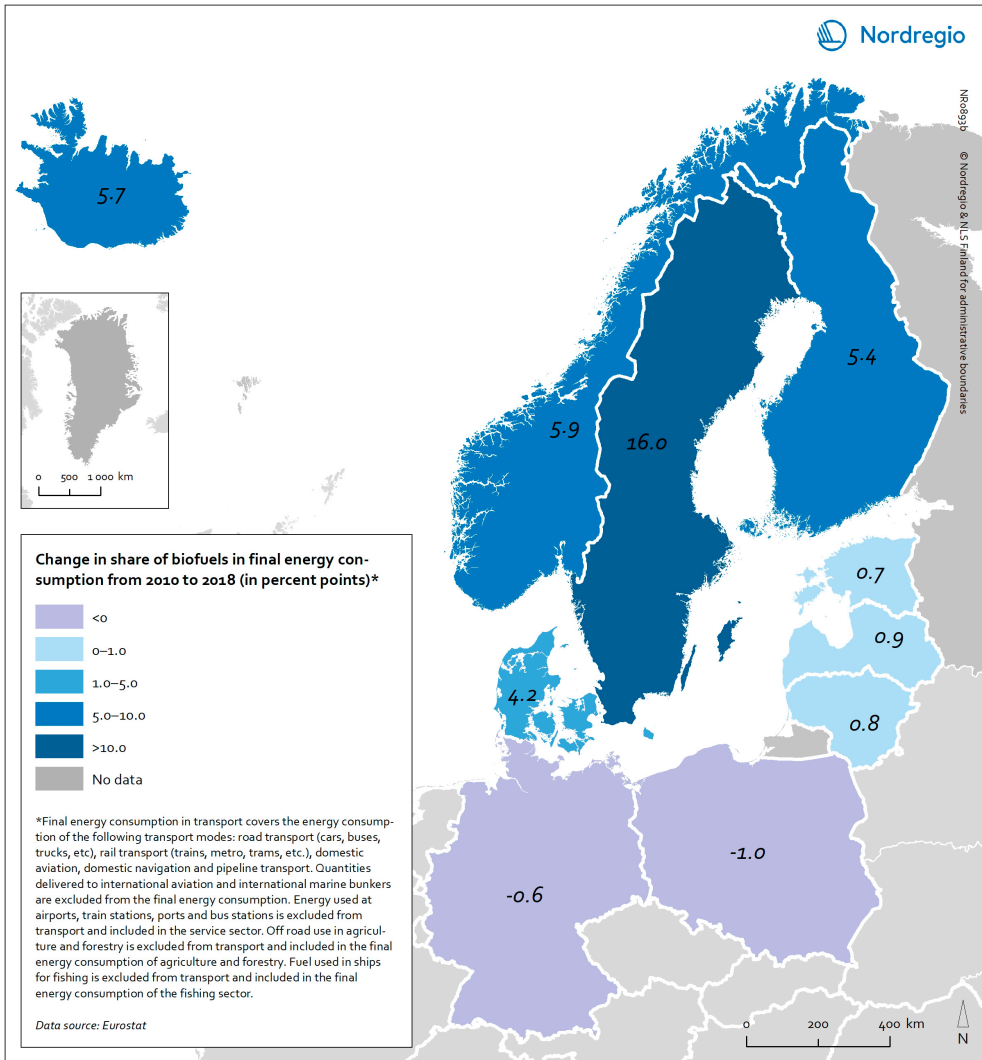
Figure 15: Share of biofuels in final energy consumption in transport in 2018



For transport, total renewable energy consumption will be higher due to, e.g. electric vehicles and trains also partly running on renewables.

The Baltic Sea represents a divide in the region, with countries to the north and west experiencing growth in the use of biofuels for transport in recent years (see Figure 16). Here, again, Sweden stands out, with 16 per cent growth. However, to the south and east, the use of biofuels for transport has largely stagnated.

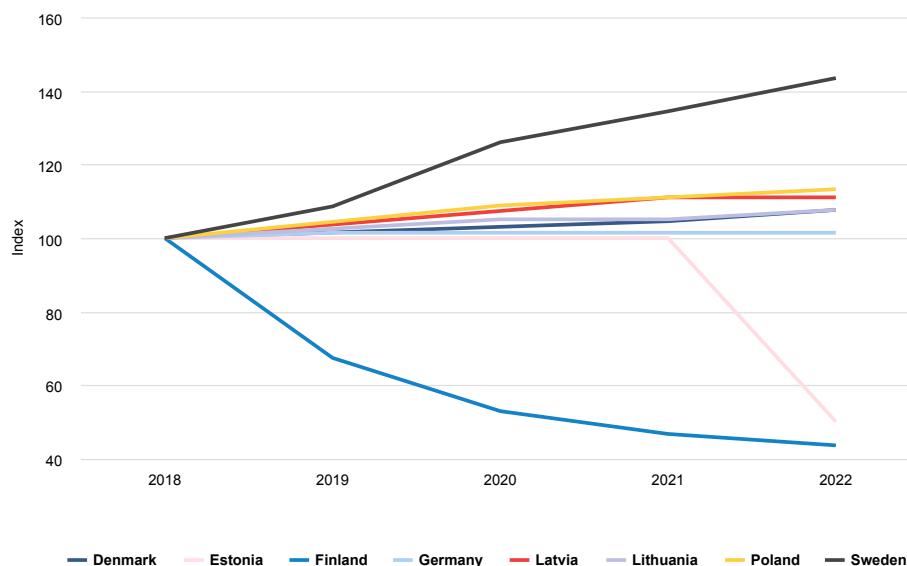
Figure 16: Change in share of biofuels in transport from 2010 to 2018



Total biofuel consumption for transport has risen more than the figure indicates due to an increase in transport use over the period.

According to a recent study, the current prognosis for the use of renewables in transport shows little or uneven progress (see Figure 17). Only Sweden seems to be poised for significant growth in renewables in this sector (including but not limited to biofuels), while Estonia and Finland are each expected to see a declining share.

Figure 17: Prognosis for share of renewables in transport (2018=index 100)



The prognosis for the share of renewables in transport shows only slow growth or decline, with the exception of Sweden. The share of renewables in Estonia and Finland is projected to decline from 0.4 to 0.2 and 19.3 to 8.4, respectively.

Data Source: P. Bórawski et al./Journal of Cleaner Production 228 (2019) 467–484

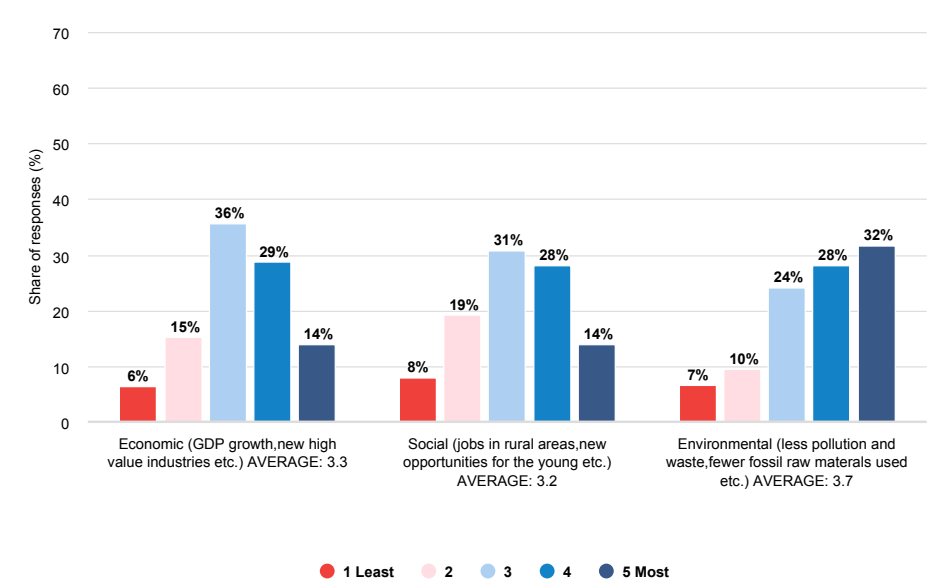
This divide on biofuels is also reflected in the interviews and survey responses. Some proponents of biofuels mention the unmet need to use more renewable energy in transport in order to reduce greenhouse gas emissions. Some highlight the potential of untapped biomass sources from bio-industry waste.

Other, more sceptical voices assert that producing and using biofuels still release greenhouse gasses – albeit less than fossil fuels – and that greater use of biomass for transport means increased competition with other, perhaps more valuable uses, such as in food production or raw materials for industry or construction. The introduction of other renewable energy sources in the transport sector, especially wind power via electric cars, has led respondents to argue that biofuels will be a temporary tool in the transition from fossil fuels to more renewable energy systems.

The next decade is crucial for determining value

Biofuel production increased dramatically between 2003 and 2017 but has stagnated in recent years. However, "increasing demand for green energy suggests that the production of ethanol and esters of vegetable oils will increase by 2030" (Bórawski et al., 2019). The survey responses closely mirror this picture. Biofuels are seen as having a moderate value-creation potential, primarily driven by the expectation that they will generate environmental value.

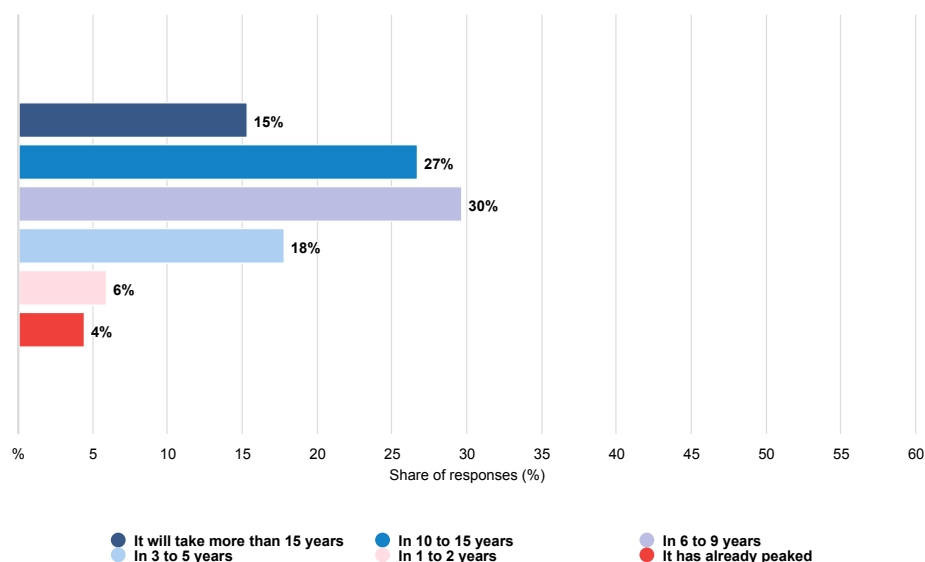
Figure 18: Value-creation potential of biofuels



Responses to the survey question: "How do you see the value-creation potential of biofuels? Please give 1 to 5 points (with 5 being most) for each of the three value categories below." N=202

Most respondents believe biofuels will reach their full potential in 6 to 15 years, with 30 per cent anticipating full impact in nine years' time. Fifteen per cent believe that biofuels may take more than 15 years to reach their full impact.

Figure 19: Value-creation potential over time for biofuels



Responses to the survey question: "When do you believe biofuels will reach their full potential?" N=202

Weighing the options: Sustainability of biofuels depends on local resources and conditions

When it comes to the value-creation potential of biofuels, the survey respondents are divided. Some doubt the long-term sustainability of biofuels due to continued, albeit lower, emissions of greenhouse gases, and see them as a tool to transition to a low-carbon future: "this interim technology is not likely to be a win-win enterprise" noted Brooks Kaiser, Environmental Economics Professor at the University of Southern Denmark.

The respondents also highlight the need for strong political leadership and legislation to guide the shift from fossils to biofuels while avoiding competition with food production. "Conflicting aims with the food supply, material use, or the social dimension as well as possible impacts on biodiversity and indirect land use effects must be minimised," concludes Christin Boldt, Policy Lead with the Secretariat of the Global Bioeconomy Summit 2020.

Looking ahead, several respondents see the potential of biofuels in specific sectors or geographies. Biofuels derived from forests are already well developed in the Nordic region, and second-generation approaches are now being explored. The slow development of biofuels in other regions, particularly the Baltics, illustrates the regional variation in this trend. Sewage sludge and manure remain largely untapped sources of biofuels, which means there is less competition for these resources than in areas such as forestry and field waste.



BIOECONOMY TREND #3

The fast track: Local branding

The trend of branding products based on their origin is seen as a short-cut to delivering growth in the bioeconomy and great social effects. This creates a market niche for bioeconomy products, particularly food, both locally and globally.

For centuries, branding products by telling a story about their production in a special locality has been a value driver for a wide range of products, from Norwegian and Icelandic salted cod to potatoes from the small Danish island of Samsø. Local branding adds value to a product or service by giving it an appealing story about sustainability, local supply chains and what makes its origin superior. This allows producers to charge a premium for the product, and consumers to enjoy the added benefits of supporting a certain region, either locally or at a distance. The respondents see this as a particularly strong trend within the food sector, with the potential to be applied in other sectors.

Many businesses have successfully carved out a production niche based on an appealing story of green and local production. This is often at odds with the classic economy-of-scale approach, which favours more uniform and centralised production. As noted in Lund University's bioeconomy review: "Instead of exporting bio-resources for upgrading elsewhere, domestic upgrading would ensure a higher value-creation locally, in addition to expected synergies in terms of research and innovation" (2018, p. 34).

The trend of local branding includes both locally produced and consumed products, as well as products that are marketed using local attributes but also sold outside of the region

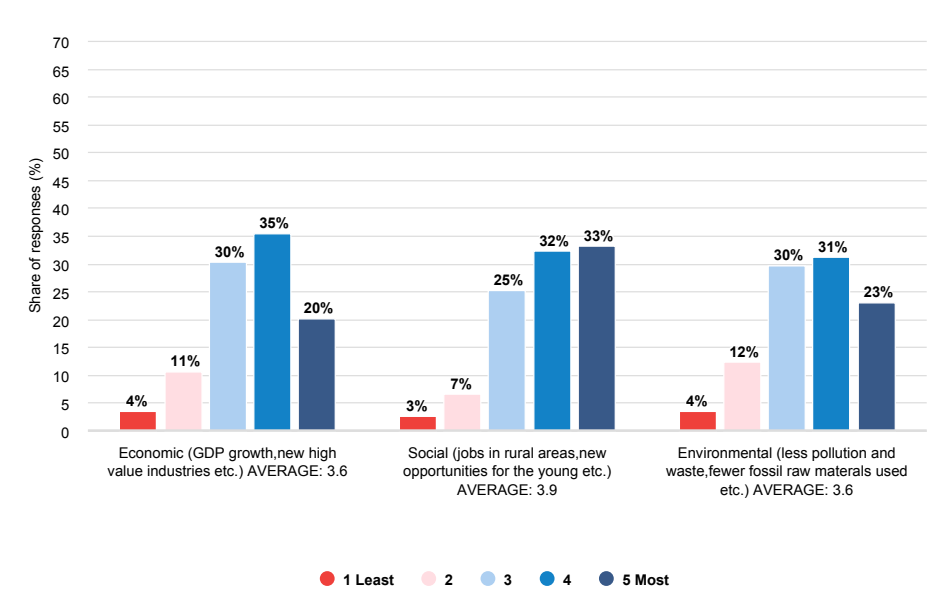
where they are produced. According to several sources in the literature review, these two aspects of the trend are reflected in customer preferences – consumers in the EU demonstrate a stronger preference for products marketed as local, particularly in the food sector (European Commission, 2018b; Meyerding et al., 2019; Scalvedi & Saba, 2018).

The preference for locally branded products has increased over time, especially in conjunction with organic goods (Wägeli & Hamm, 2016). While the bulk of existing research applies to food products, there are also opportunities in other bioeconomy-based products, especially as consumers become more aware of the environmental and social impact of their consumption (European Commission & LE Europe, 2018).

Local branding grows the bioeconomy, including in the short term

The respondents mirror the research and express relatively high expectations for local branding as a value generator in the bioeconomy. This is especially true for social value-creation, which is in line with the local focus and opportunities for job creation in rural areas, but the trend is also strong in the other categories of value-creation.

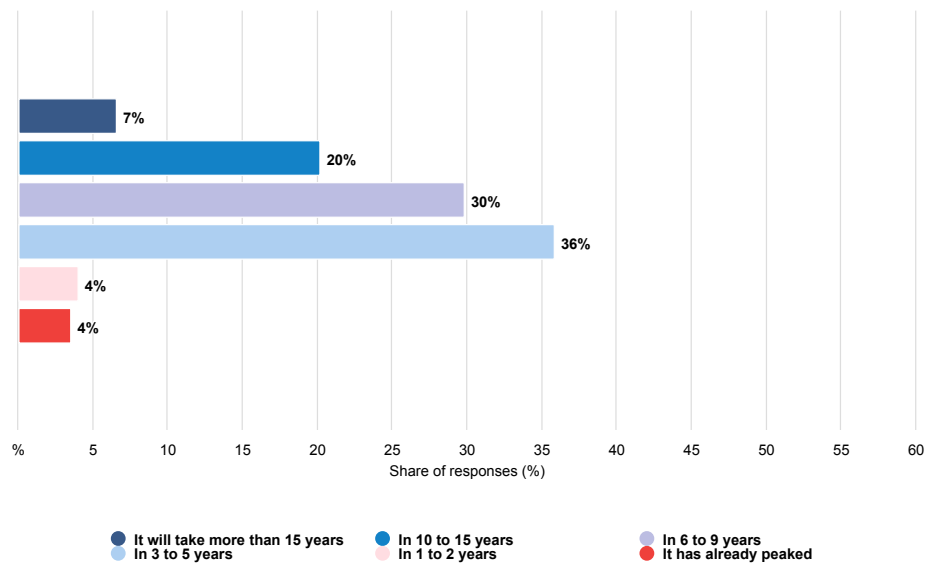
Figure 20: Value creation potential of local branding



Responses to the survey question: "How do you see the value-creation potential of local branding of bioeconomy products? Please give 1 to 5 points (with 5 being most value added) for each of the three value categories below". N=198

The most remarkable aspect is the timescale, as respondents see local branding as the fastest way to grow the bioeconomy. Almost half of the respondents see it reaching full value-creation potential in the next five years, while almost three out of four see it happening within the decade.

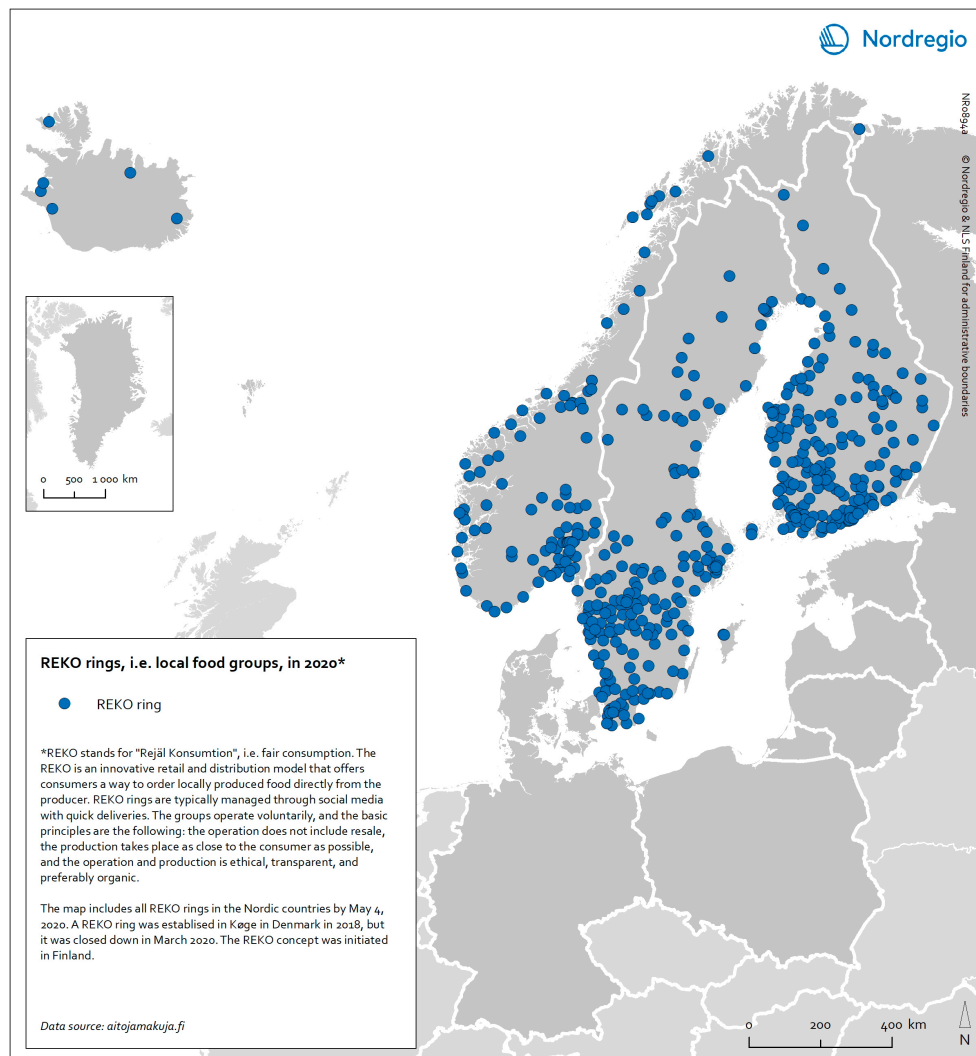
Figure 21: Value-creation potential over time for local branding



Responses to the survey question: "When do you believe local branding of bioeconomy products will reach full potential?" N=198

One example of an innovative business model that is already generating value is REKO's approach to retail and distribution. REKO is an acronym for *Rejäl Konsumtion* ("fair consumption" in Swedish) and is mainly restricted to food products. The concept is spreading from its origin in Finland across the Nordic countries (see Figure 22). The REKO rings offer customers a way to order products directly from the producer without the need for intermediaries. They operate via closed groups on social media, run by volunteers.

Figure 22: REKO rings (local food groups) in 2020



REKO rings in the Nordic countries as of May 2020. The REKO distribution model is widely used in Finland, Sweden, Norway and Iceland.

Strong support for local branding as a driver of growth in local communities

The survey respondents see this trend as a lever for developing business and industries in more remote areas across the region. "Sweden, Denmark, and Germany are very strong in branding and product design. Other countries have huge potential, but less tangible and competitive products," says Kyösti Lempa, Senior Adviser with NordForsk, describing local branding as a way for products to become more competitive by adding environmental or social benefits.

Respondents also point out that it is important to grasp the differences between individual countries' economies in order to understand the future of local branding and its success. "I think in general that smaller countries can be more successful at a national scale to promote local branding. The populations on islands like Iceland and Åland Islands have a culture of local entrepreneurship," says Hans-Olof Stålgren, Coordinator with the Swedish Board of Agriculture.



BIOECONOMY TREND #4

The slow starter: Seaweed and algae

The production of algae for food and industrial uses has significant potential, particularly in terms of environmental impact, but it is still at an early stage. If this trend is to reach its full potential, further policy support is needed.

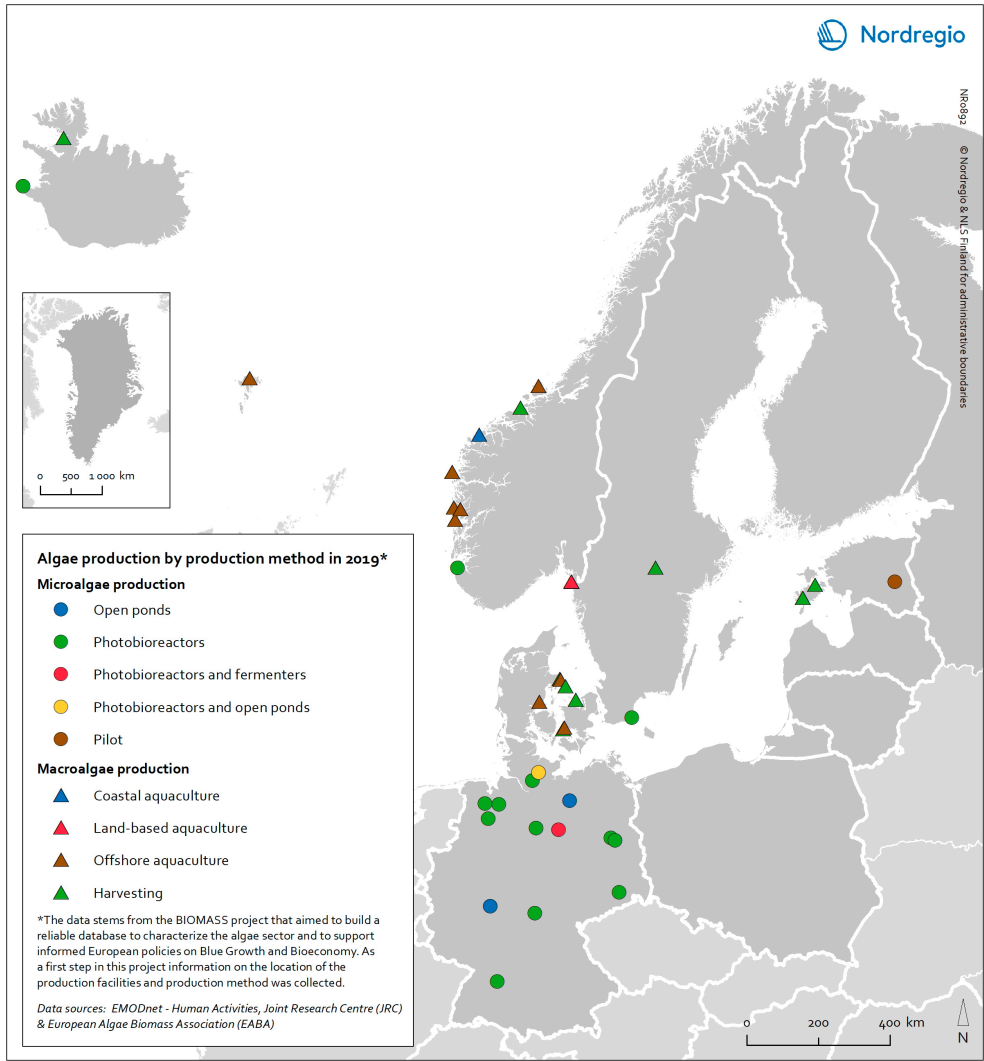
Algae and seaweeds are gaining attention as useful inputs for industries as diverse as energy and human food production. Aquatic vegetation – both in the seas and in freshwater – can grow at several times the pace of terrestrial plants, and the high natural oil content of some algae makes them ideal for producing a variety of products, from cosmetic oils to biofuels. At the same time, algae farming has added value in potential synergies with farming on land, as algae farms utilise nutrient run-off and reduce eutrophication. In addition, aquatic vegetation is a highly versatile feedstock. Algae and seaweed thrive in challenging and varied conditions and can be transformed into products ranging from fuel, feeds, fertiliser, and chemicals, to third-generation sugar and biomass.

These benefits are the basis for seaweed and algae emerging as one of the most important bioeconomy trends in the region. According to A Sustainable Bioeconomy for Europe, algae farming in the EU is still at an early phase. However, it should also be seen as a fast-moving sector that has advanced significantly in recent years, expanding by 66 per cent between 2005 and 2014 in the EU (European Commission, 2018a).

The production of algae (both micro- and macroalgae) can take numerous forms. At least nine different production methods have been identified in the region covered in this

analysis (see Figure 23). A total of 41 production sites are currently operating in Denmark, Estonia, the Faroe Islands, Iceland, Norway, Germany, and Sweden. Germany has by far the most sites for microalgae production, whereas Denmark and Norway have the most macroalgae sites.

Figure 23: Algae production 2019

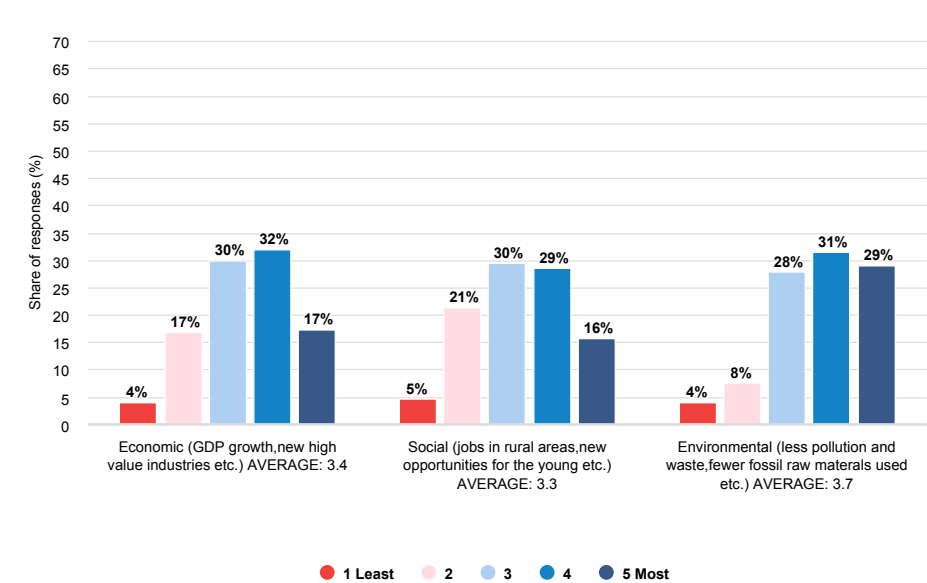


Algae production sites by production method – a total of 41 sites across nine production methods.

High environmental potential, but not in the next ten years

The respondents support the notion that there is great potential for scaling up algae production. Nearly two-thirds of respondents believe that algae have the potential to create moderate to high environmental value, and moderate economic and social value. The economic prospects weigh slightly higher than the social.

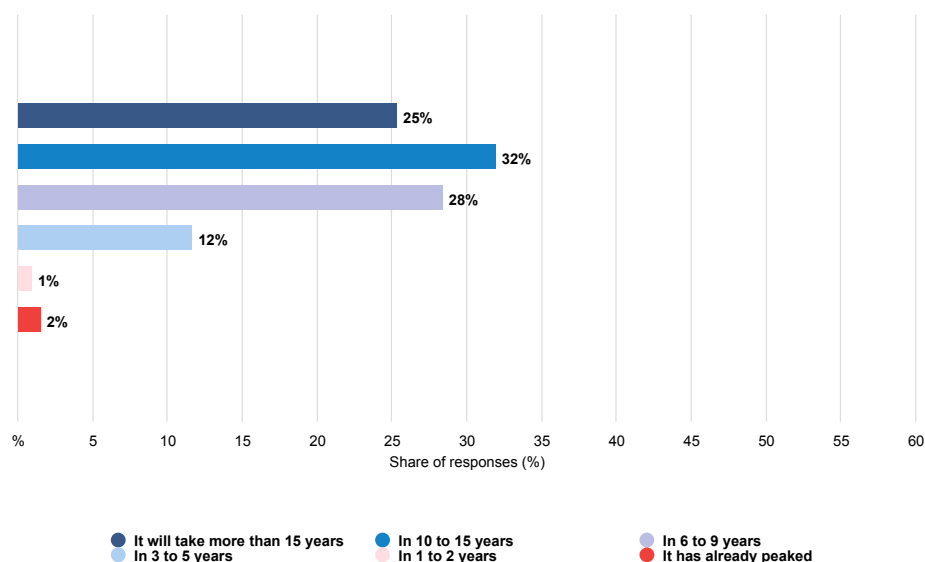
Figure 24: Value-creation potential of seaweed and algae



Responses from the survey question: "How do you see the value-creation potential of algae? Please give 1 to 5 points (with 5 being most value-added) for each of the three value categories below." N=197

Although overall expectations for this trend are optimistic, most respondents believe that it will take more time for algae and seaweed utilisation to come to fruition. Just over four out of ten respondents believe that the field will reach its full value-creation potential within the decade. One in four believes it may take more than 15 years.

Figure 25: Value-creation potential over time for seaweed and algae



Responses to the survey question: "When do you believe the utilisation of algae will reach its full potential?" N= 202

Strong natural advantages, but lacking support

Most respondents acknowledge both the usefulness of algae as a raw material and the environmental value of algae farming. However, several highlight the need for support at policy level to develop these industries and associated technologies. This corresponds closely with signals from other expert groups, such as the European Union co-funded Blue Bioeconomy R&D network, which sees aquatic vegetation as a "still largely untapped resource for bio-based processes and products" (Hurst et al., 2018).

While coastal areas offer major advantages for developing marine vegetation industries, countries with less coastline are far from excluded. Elin Bergman, a Circular Economy Expert with WWF Sweden, notes that: "there is a big potential for sustainable algae production in contained, circular environments on land and all countries have the potential of participating in this sector".

Today, however, the market for seaweed and algae products is under-developed. Harnessing its potential requires thoughtful planning, stimulation, and technological advancement. "Like the agricultural farmers, algae farmers need subsidies to cover costs and upscale production, otherwise we cannot expect much development. Also, only with licensing regulations and proper planning in place will the sectors grow," says Efthalia Arvaniti, Program Manager for the SUBMARINER Network for Blue Growth.



BIOECONOMY TREND #5

The newcomer: Alternative protein sources

New, alternative protein sources score highly on value-creation potential, despite minimal market presence. The scores are mainly driven by respondents' strong expectations of the environmental benefits of shifting to new protein sources.

Animal protein sources such as meat and dairy are a major part of the diet of people in the Baltic Sea Region and Nordic Arctic. However, these often entail high environmental costs in the form of greenhouse gas emissions, extensive land use, nutrient run-off and resulting eutrophication. A significant portion of the environmental footprint comes from animal feed, which is often imported.

With the world population expected to grow to between nine and ten billion people by 2050, there is an increasing need for protein sources with a lower environmental impact, which is driving this trend.

Over the past decade, self-sufficiency in feed protein in the European Union has slowly declined (European Commission, 2019c). This has spurred a search for more sustainable and local

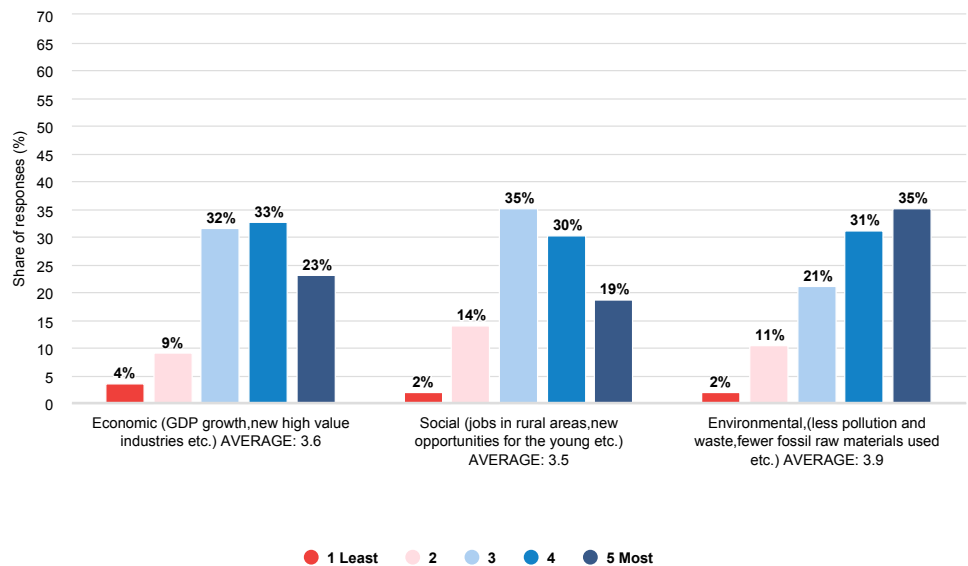
protein sources, which further drives this trend.

Research is still being conducted into a range of new protein sources, and several of them look promising. The Nordic Alternative Protein Potentials report (Lindberg et al., 2016), mentions grasses, legumes, and grain- and oil seed co-products, but also highlights the high potential of fungi, bacteria, insects, and micro-algae for both human and animal consumption.

Environmental benefits expected when the trend matures

New protein sources perform well in the survey, with respondents rating the value-creation potential in the middle of the field. This is driven mainly by strong expectations for the environmental benefits of shifting to new sources of proteins.

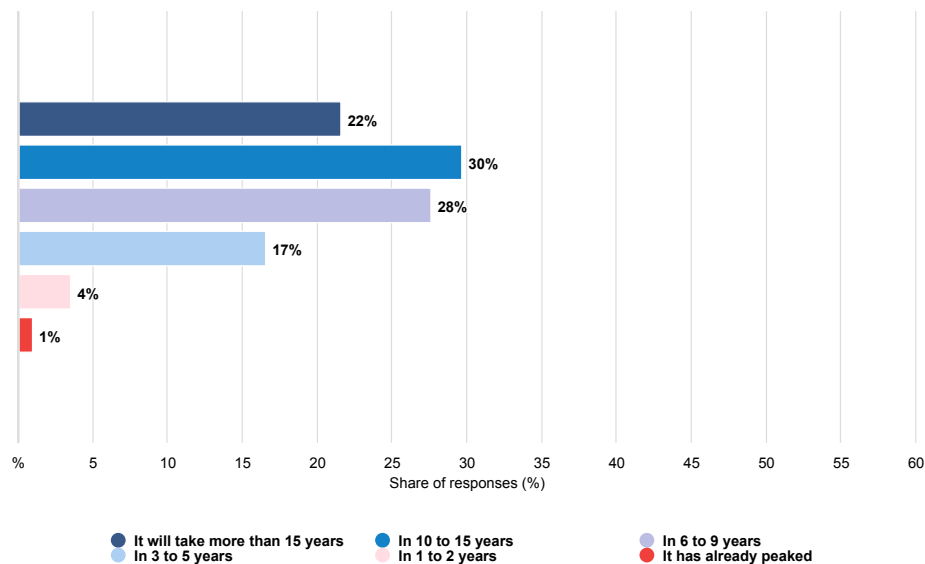
Figure 26: Value-creation potential of alternative proteins



Responses to the survey question: "How do you see the value-creation potential of new protein sources? Please give 1 to 5 points (with 5 being most value added) for each of the three value categories below." N=199

However, as the newcomer in the field, this trend is also expected to be relatively slow to mature. Fewer than half of the survey respondents – 48 per cent – expect it to reach full value-creation potential within the decade. There are two reasons for this. Firstly, many new protein sources are still under development or in early market stage and will take time to upscale. Secondly, there is an expectation that, at least for human consumption, it will take some time for consumers to incorporate new protein sources as staples in their diet. As one respondent puts it: “The key question is how to change protein-consumption habits.”

Figure 27: Value-creation potential over time for alternative proteins



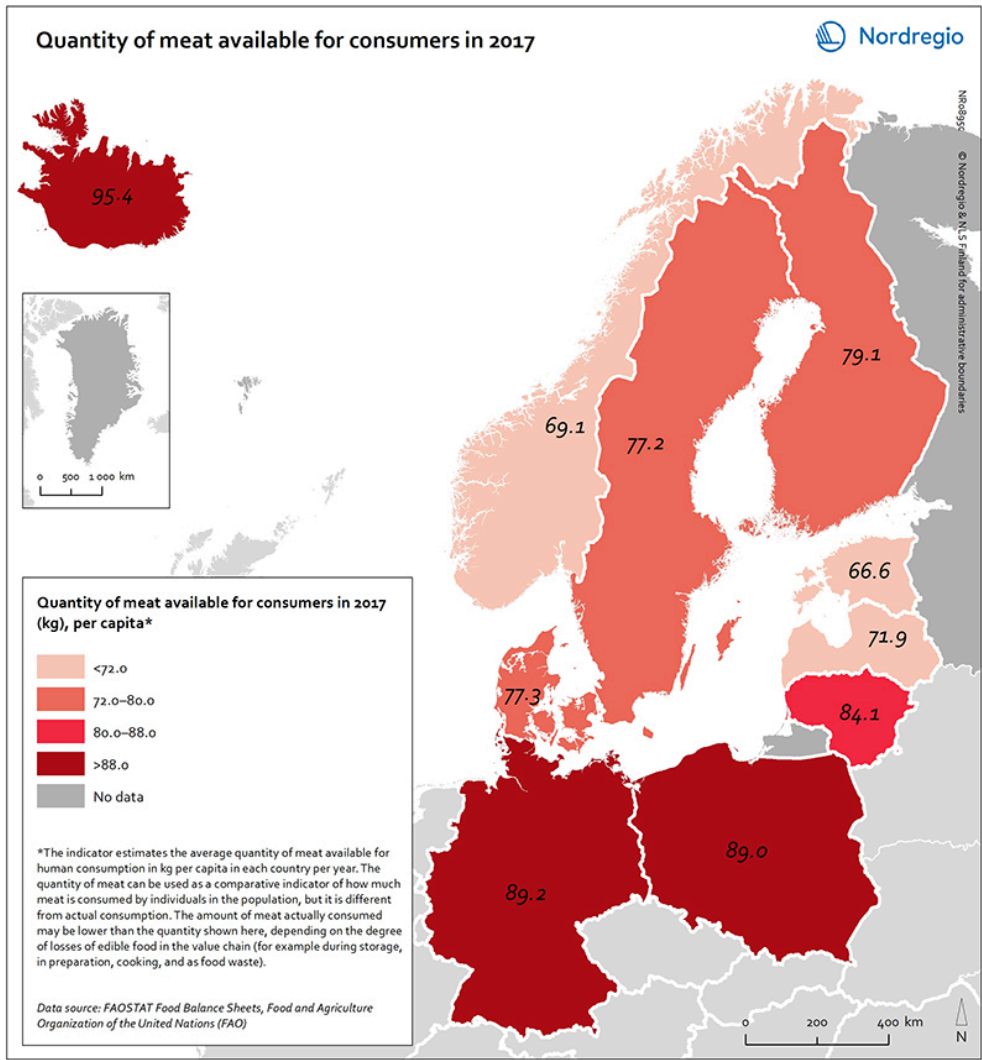
Responses to survey question: “When do you believe new protein sources will reach their full value-creation potential?” N=199

Meat consumption is the driver behind the trend

The respondents point to how the development of alternative and new protein sources is intrinsically linked to levels of meat consumption, which remain high throughout the region compared to most of the world. Average meat consumption ranges from 67 to 95 kg per person annually (see Figure 28), and all of the countries except Sweden and Germany are at the higher end of this range (see Figure 29).

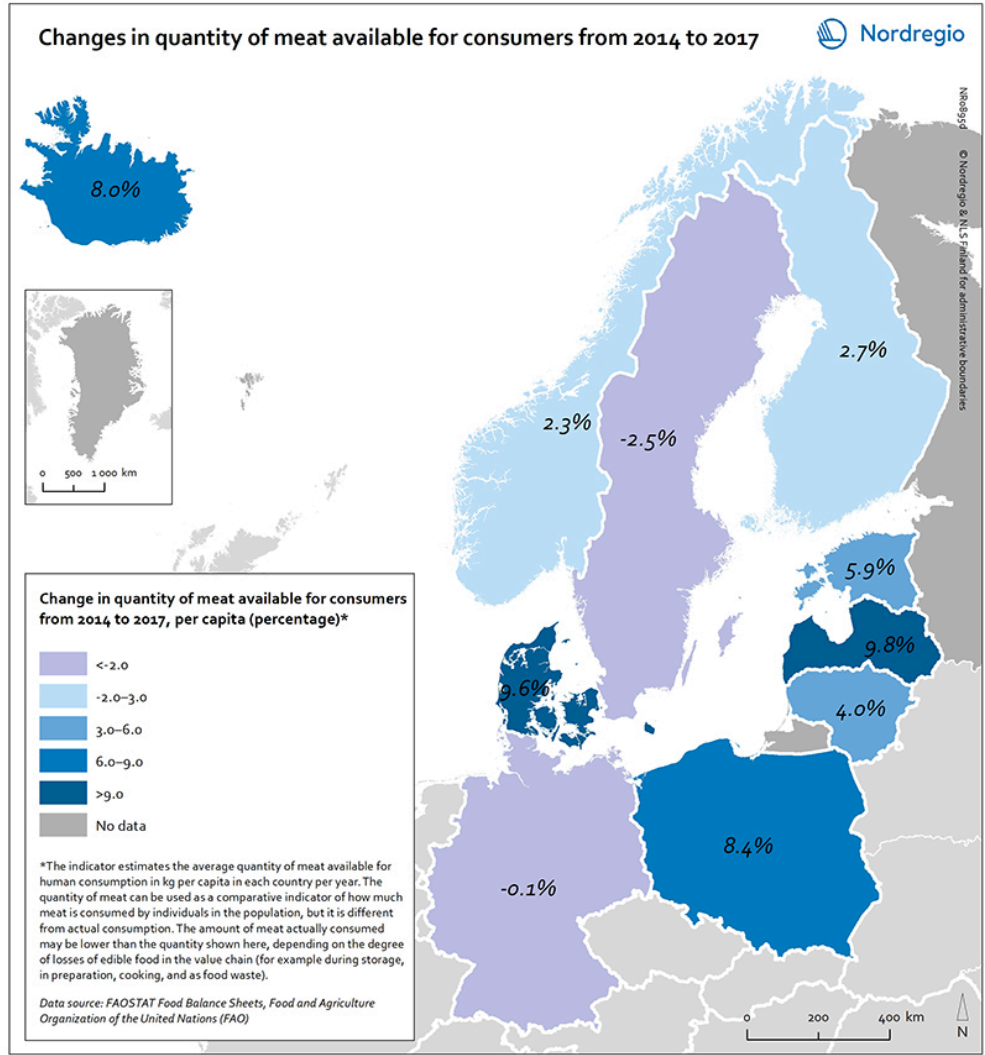
However, the respondents also see changing consumer attitudes towards new, more plant-based diets. As one notes, in Poland where meat supply is among the highest in the region (89 kg per person per year), three million people are vegetarians or vegans. This also corresponds well with a recent analysis for the European Commission, which reports a rise in the number of flexitarian, vegetarian, and vegan diets, a change that is expected to support this trend (European Commission, 2019b). The analysis also describes a growing demand for more organic and genetically modified (GM)-free protein-rich plants for feed grown in Europe.

Figure 28: Quantity of meat available for consumers in 2017



The numbers represent the amount of meat available for consumption per capita, rather than what is actually consumed. This is due to losses in the value chain that are not taken into account, such as food waste.

Figure 29: Changes in quantity of meat available for consumers from 2014 to 2017 to 2017



The numbers represent changes in the quantity of meat available for consumers per capita from 2014 to 2017, but do not take into account losses in the value chain.

In the survey comments, Denmark is referred to as a future frontrunner in this trend, due to its initial work of refining protein-rich grasses. "The highest potential right now is in Denmark, but other countries also have their own unique possibilities to learn from their approach," says Katrin Kepp, Head of the Centre of Bioeconomy, Estonian University of Life Sciences.

Looking ahead, some respondents point out that this trend is still reliant on policy support, especially if it is to spread across much of the region. "We need robust investment in, e.g. plant breeding for high-latitude areas, as well as for seaweed production and fermentation processes," concludes Tróndur G. Leivsson, Managing Director and CEO of the Agricultural Agency in the Faroe Islands.



Five macrotrends influencing the bioeconomy

The bioeconomy is not developing in a vacuum. The potential of an economy based on the sustainable utilisation of biological resources is highly dependent on societal and technological trends, which are not themselves part of the bioeconomy.

For the survey, five macrotrends were identified – based on the literature review and expert interviews – as being relevant for the development of the bioeconomy. The five macrotrends were surveyed in order to understand respondents' expectations of how they will influence the growth of the bioeconomy – positively or negatively.

THE FIVE MACROTRENDS ARE:

Digitalisation: Defined as the use of digital technologies to change business models, generate new revenue, and create value-producing opportunities (Gartner, 2020). Digitalisation can influence the bioeconomy in several ways: resources can be more efficiently grown, transported, utilised, and cascaded and investments can be planned for their optimal use.

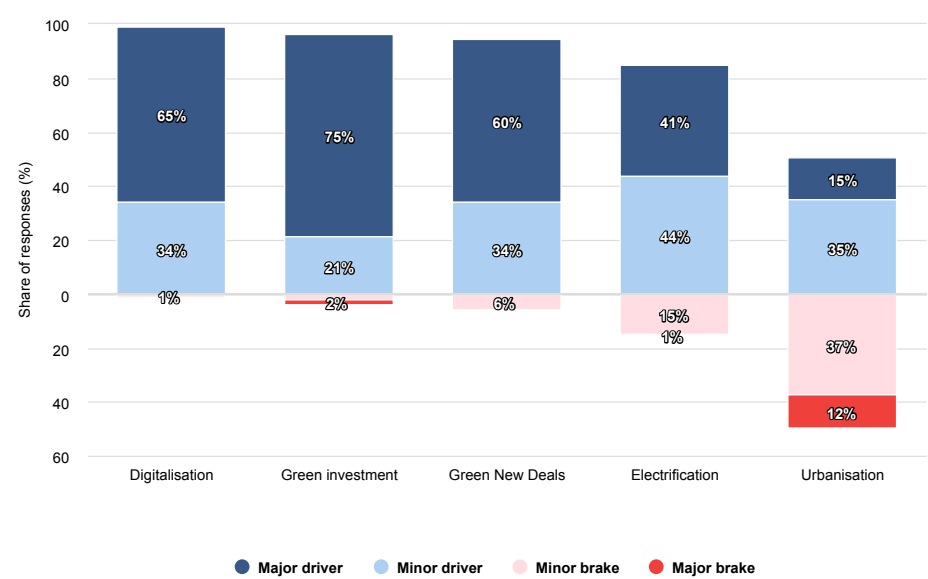
Green investments: Pension funds and other large institutional investors are shifting their focus towards long-term investment in sustainability. This provides new funding opportunities for the bioeconomy, especially large-scale projects, as large investors tend to favour fewer and larger investments over many small ones.

Urbanisation: Many rural and less populated areas in the Nordic region and around the Baltic Sea are expected to see further falls in their population towards 2030. Urbanisation, especially the relocation of younger people to the cities, can be an obstacle to bioeconomic growth in rural areas.

Green New Deals: The idea of a new political "contract" between politicians and voters that favours sustainability – a Green New Deal – has recently emerged in many places around the world. This proposal has been amplified by many of the European policy initiatives aimed at restarting the economy after the COVID-19 pandemic.

Electrification: Electricity is replacing combustion in many areas of the energy system, from district heating to transport. This affects the bioeconomy by reducing the need for biomass in heating, electricity generation, and for biofuels, while potentially supplying cheap, renewable energy that can reduce the cost of refining biomass into high-value products like CO₂-neutral jet fuels, plastics, etc.

Figure 30: Influence of macrotrends on the bioeconomy



Responses to survey question: "How do you believe [macrotrend] will influence the development of the bioeconomy?" N=189-192

Macrotrend #1: Digitalisation

More than 90 per cent of respondents see digitalisation as a driver (major or minor) for the bioeconomy. However, in terms of how strong a driver it will be, responses are mixed – a third of respondents believe it will only be a minor one.

While some respondents highlight that digitalisation is already widespread in the bioeconomy, others point to the opportunities provided by newer technologies like remote control, 5G, automation, and artificial intelligence in relation to monitoring, planning, harvesting, and distributing bio-based resources. Agriculture, wood production, bio-refining, fisheries, and aquaculture seem especially promising. Digitalisation may even aid local bioeconomy growth by giving local producers access to much wider markets via webshopping and social media.

"Digitalisation is a must in the value-creation at every step of the process," explains Kyösti Lempa, Senior Adviser for NordForsk, Norway. Lempa and other respondents highlight how digitalisation can increase efficiency by bridging information gaps, supporting small-stream supply chains, reducing labour costs, and discovering unused potential.

"Digitalisation can make value chains more transparent, help to account for externalities and ultimately lead to competitive advantage of circular resource loops," adds Kaj Granholm, Project Manager, Baltic Sea Action Group.

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Digitalisation is a must in the value-creation at every step of the process.

– Kyösti Lempa, Senior Adviser, NordForsk

Macrotrend #2: Green investments

Many of the respondents focus on the need to increase investment in bioeconomic enterprises. As Jonathan Turner, the Director of NLA International, notes: "the enabling impact of investment cannot be underestimated. It is vital if a meaningful level of sustainable industry is to be established." It is not surprising, therefore, that green investment is seen as a strong supporter for bioeconomic growth – 75 per cent of respondents consider it a major driver.

Some respondents see potential in divestment from the fossil fuels, which will free up funds that can be reinvested in the bioeconomy. The current uncertainty about the future of the fossil-fuel industry in the wake of the COVID-19 pandemic will likely add weight to that argument.

However, some respondents voice concern over the magnitude of the change necessary to reset global economic pathways. Some also express concern that some of these so-called "green investments" are more a matter of greenwashing than actual sustainability. Other respondents point out that modest growth in green investments is likely to be dwarfed by the rest of the financial sector. This is compounded by a concern that green investments tend to have a longer timeline and can be less lucrative than traditional investments.

"Most investors are still following the market that is rather conservative," notes Holger Wallbaum, Professor of Sustainable building at Chalmers University of Technology, Sweden.

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Most investors are still following the market that is rather conservative.

– Holger Wallbaum, Professor of Sustainable building, Chalmers University of Technology, Sweden

Macrotrend #3: Urbanisation

Urbanisation is expected to be a potential threat. There is almost a 50/50 split among respondents as to whether urbanisation will be a driver or a brake for the growth of the bioeconomy. Some point out that decreased rural land values could present new opportunities to scale up new bio-industries more rapidly. Others focus on the negative effects of urbanisation, such as potentially problematic shifts in ownership of biological resources and what amounts to a “brain drain” of skilled labour. The responses suggest, however, that this macrotrend is likely to have a less significant impact on the bioeconomy – 72.2 per cent rate this trend as a minor influence in either direction.

Most of the respondents’ comments address strategies to actively resist urbanisation by utilising various policy interventions to incentivise people to move back to rural communities. Respondents propose enhancing education in rural areas and strengthening incentives for rural entrepreneurship.

Other respondents promote an approach in which best practice and new ideas from urban testing grounds are implemented in rural areas: “Urbanisation is a powerful trend that needs a lot of attention. How do we build attractive environments in rural areas to make it possible for young people and others to stay and live their lives?” says Per Hansson, General Secretary of the Nordic Joint Committee for Agriculture and Food Research.

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Urbanisation is a powerful trend that needs a lot of attention. How do we build attractive environments in rural areas to make it possible for young people and others to stay and live their lives?

– Per Hansson, General Secretary of the Nordic Joint Committee for Agriculture and Food Research

Macrotrend #4: Green New Deals

In 2019, Europe saw a number of elections in which sustainability and climate were high on the political agenda. The idea of a “Green New Deal” that steers societies toward sustainability has taken root in many parts of Europe, including the region covered in this report. It is expected that governmental response to the COVID-19 pandemic will amplify this concept. Survey respondents overwhelmingly rate the recent “greening” of politics as beneficial for the bioeconomy, with 96 per cent of respondents describing this trend as a positive driver. However, a third of respondents think it may only be a minor positive driver, while a few respondents believe it may even slow bioeconomic development.

“Political direction will make an impact and change the current situation,” predicts one respondent. Respondents generally predict a shift toward sustainability in the larger ecosystem of industry, consumers, and civil society. They say that policy-makers will have to anchor these positive developments, integrate the bioeconomy, and strive for even higher levels of ambition, in order to push other sectors. Green New Deals are “an absolute necessity for creating new markets within the bioeconomy. I would like to see even more regulation of industries that are harmful to the environment,” says one respondent from the financial industry.

Others point out that while Green New Deals across Europe are off to a good start, they have yet to deliver real results. They caution that while large-scale policies and ambitions are an important first step, the success of actual legislation depends on effective operationalisation. Systems-based scientific research and an ongoing focus on the bioeconomy are seen as important prerequisites for creating the type of detailed sustainability policies that respondents deem necessary, both now and in the future. As such, some respondents expressed concerns about the lack of focus on the bioeconomy in the EU Green New Deal presented in late 2019.

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I would like to see even more regulation of industries that are harmful to the environment.

– One respondent from the financial industry

Macrotrend #5: Electrification

The increased production of electricity from renewable energy is starting to replace combustion in many aspects of the energy system. This can have an enormous effect on the bioeconomy. First, it can reduce the need for biomass in heating, electricity generation, and biofuels. Second, the abundance – at least during certain periods – of cheap, renewable energy can reduce the cost of refining biomass into high-value products like CO₂-neutral jet fuels, gas, plastics, and more. The development of these products is closely tied to the concept of "Power-to-X" that is gaining attention in countries such as Denmark and Germany, in which fluctuating, renewable energy generation exceeds demand. Electrification can also provide opportunities for more advanced, partly bio-based energy carriers, e.g. synthfuels that combine carbon from biomass with hydrogen made from renewable electricity.

The optimism around this trend is reflected in the survey – 84.8 per cent of respondents consider it a driver of the bioeconomy. Those who are less optimistic worry about its short-term effects: "Electrification of the energy sector will perhaps in the short term increase the demand for biomass power production, but in the longer term it will reduce the demand for solid biomass for heat and power production," asserts Niclas Scott Bentsen.

Electrification is also mentioned as a tool for developing greater resource efficiency, especially in sectors like transportation and forestry. While respondents generally assert that this trend has already begun, some feel that its influence on the bioeconomy has yet to be felt. Electrification goes hand in hand with digitalisation, as new digital tools will increase efficiency in energy supply. "Digitalisation of the energy system will facilitate wider collaboration across the bioeconomy, such as between the water, food, and health sectors," believes Alan Whiteside, Innovation Consultant with NHS Highland, Scotland.

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Digitalisation of the energy system will facilitate wider collaboration across the bioeconomy, such as between the water, food, and health sectors.

– Alan Whiteside, Innovation Consultant, NHS Highland, Scotland



COVID-19 has made the bioeconomy more important than ever

The COVID-19 pandemic has brought about a sudden shift in society and has left many unanswered questions about the nature of future economic growth and the role of the transition to more sustainable production and consumption. The urgent need to reboot economies comes with both risks, in the form of setbacks to environmental progress, as well as opportunities to speed up the sustainable transition. We already know that the pandemic has had serious consequences for the fossil-fuel sector. In particular, the significant fall in oil prices may result in investments shifting away from fossil fuels.

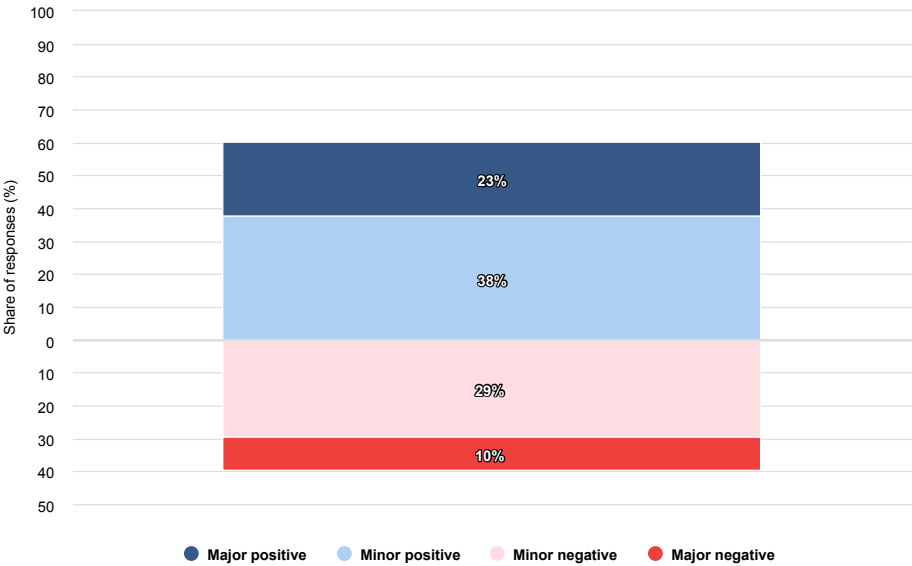
To understand the impact of the COVID-19 pandemic on the bioeconomy and its potential role in a green economic recovery, a survey was conducted between April and May 2020. Respondents with substantial professional experience in the bioeconomy were asked to reflect on the future of sustainable bioeconomic developments in the light of the pandemic, and to assess its potential impact on the identified trends in the bioeconomy.

Overall, respondents expect the pandemic to galvanise stakeholders' support for the bioeconomy, and that the growth of the sustainable bioeconomy will be an ever-greater priority. In particular, they expect that the focus will be on the social and environmental benefits. Respondents see local branding as the trend that has the greatest potential for attracting support in the wake of the pandemic.

Bioeconomy expected to fare slightly better as a result of the pandemic

Approximately 60 per cent of respondents believe that the COVID-19 pandemic will increase the momentum for the growth of the bioeconomy. The survey also indicates that the respondents are split, as the remaining 40 per cent anticipate a minor or major negative impact on the growth of the bioeconomy. However, the general expectation – shared by two-thirds of respondents – is that the pandemic’s effects will be minor, regardless of whether they are positive or negative.

Figure 31: Anticipated impact of COVID-19 on bioeconomy growth

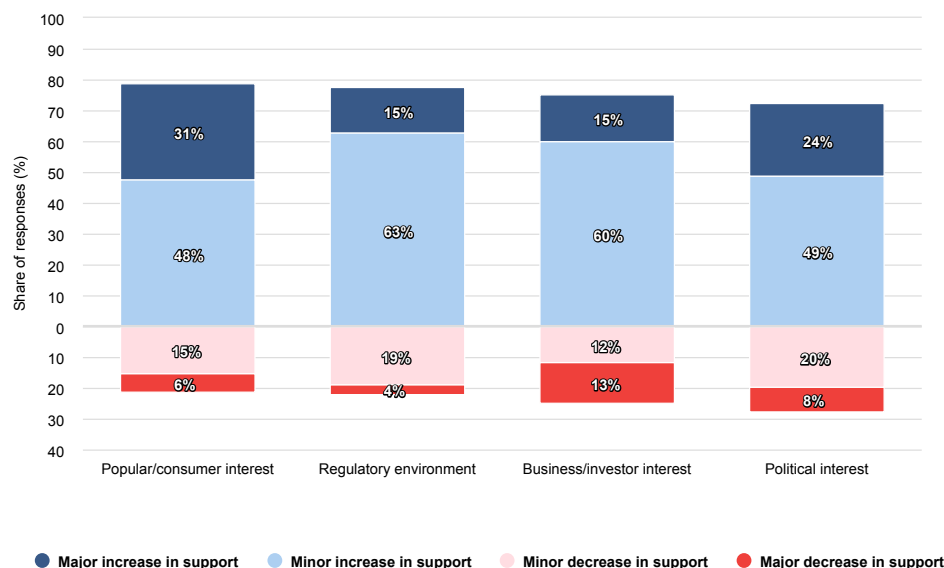


Response to survey question: "How do you believe the COVID-19 pandemic and resulting effects on the economy will impact the growth of the bioeconomy in the country where you live?" 6.1 percent respondents indicated that they did not know the answer to the question.

Growing stakeholder support for the bioeconomy

A similar picture emerged when respondents were asked to evaluate how the pandemic will affect support for the bioeconomy amongst stakeholders. Approximately three out of four expect more support for the bioeconomy across all stakeholder categories. Again, however, the general expectation is that the effect will be mostly minor. Around one in four believe that the pandemic will have a negative effect on stakeholder support.

Figure 32: Expected changes in support for bioeconomy growth

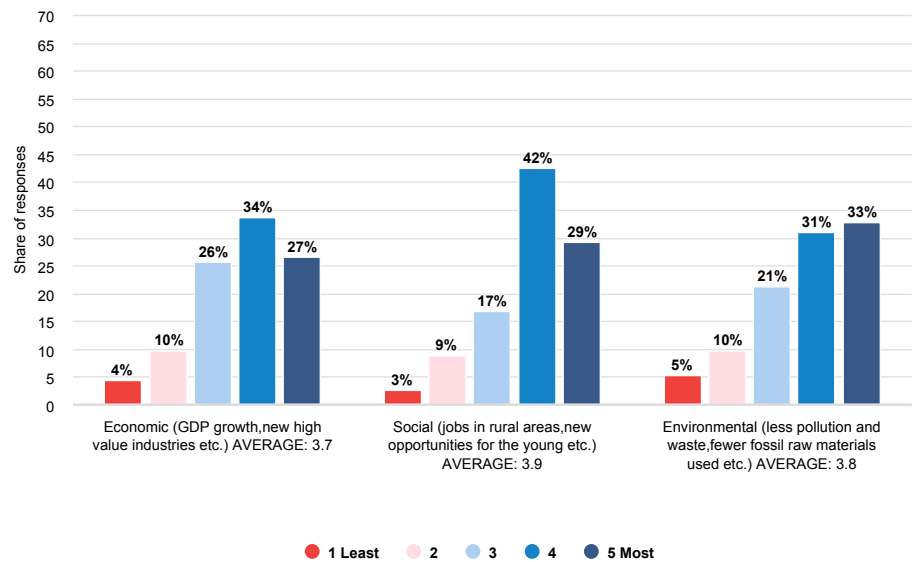


Responses to the survey question: "How do you expect the support for the bioeconomy to change, as compared to before the COVID-19 pandemic? Please rate each of the aspects below." N=113

In their comments, respondents focus in particular on how they expect the political ambition of strengthening the bioeconomy will continue to be relevant after the COVID-19 outbreak. This is the case across all political and administrative levels: EU, national, regional, local government, etc. "I believe that after the coronavirus, it will be necessary to invest to get the societal wheels rolling. The bioeconomy will benefit from these investments, which will likely be combined with the ambition to develop the bioeconomy further through the European Green Deal," says Jerker Johnson, Coordinator of International Affairs for the Regional Council of Ostrobothnia in Finland.

This corresponds well with the results from another survey question, about whether the pandemic has made it more important to develop the bioeconomy. The responses – which consider the issue in relation to the same three value areas: economic, social, and environmental – send a generally positive signal that the bioeconomy is becoming more important.

Figure 33: Importance of economic, social and environmental value to the bioeconomy in the wake of COVID-19

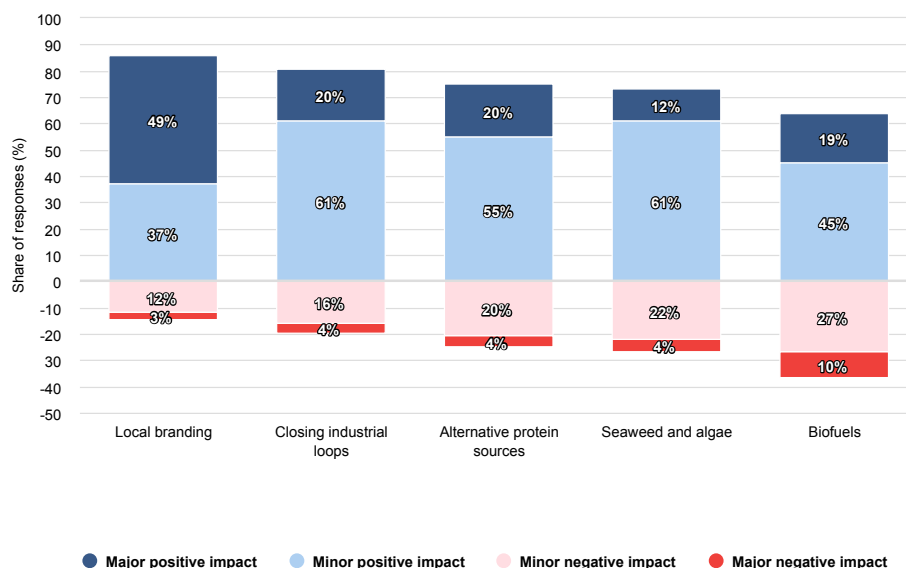


Responses to survey question: "To what extent do you believe the COVID-19 pandemic has made it more important to develop a sustainable bioeconomy? Please rate the importance for economic, social, and environmental benefits (5 = greatest importance)" N=113

Local branding will become even more important

The respondents are most confident about the effect of local branding, with almost half (48.7 per cent) anticipating a major positive impact as a consequence of the COVID-19 pandemic. Several respondents pointed out that global supply chains have exposed their vulnerabilities throughout this crisis, which further supports the value of local branding.

Figure 34: Anticipated COVID-19 impacts on bioeconomy trends



Responses to the survey question: "How impactful do you believe the COVID-19 pandemic will be on the bioeconomy trends defined in the original survey? Please rate the impact of the COVID-19 pandemic in terms of facilitating a growing bioeconomy for each of the five bioeconomy trends."

The trends relating to closing material loops, new protein sources, and algae are all also expected to be impacted positively – 73 per cent and upwards of respondents predict a minor or major positive impact on these trends as a result of the crisis. Despite most respondents anticipating that the pandemic will positively impact all of the trends, the biofuels trend has the lowest level of support, and 36.2 per cent of respondents even see the trend as being negatively impacted.

Despite a positive outlook, the future is uncertain

This survey generally illustrates that the COVID-19 pandemic is expected to have a positive impact on the sustainable bioeconomy in the region. However, there are also clear signs of uncertainty about how growth in the bioeconomy can be implemented during a period of economic decline. Continual transformation requires funding and political attention, which could be difficult to attract if priorities shift to other areas that have been greatly impacted by the pandemic. Dr. Christian Patermann, former Director at the European Commission, highlights this point, stating that "bioeconomy technologies must to a greater extent take costs into account, with a particular focus on low-cost technologies in the areas of food, energy, and construction. This will not only be essential for emerging countries but also for many industrialised ones".

With regards to the COVID-19 pandemic's impact on oil prices, some respondents expressed concerns about the ramifications for the bioeconomy. For example, Hans-Olof Stålgren, of the Swedish Board of Agriculture, says that "with the very low prices of oil right now, there will be large amounts of activity from oil companies and oil-producing states aimed at increasing demand". Another key reflection from respondents is that the changes brought about by the pandemic may not last when the world returns to a more normal situation. They find it hard to assess which changes will become permanent: "Most likely, after the end of the crisis, efforts may be too focused on getting back on track after the pause, no matter the cost. This may not be an ideal situation for the development of a sustainable bioeconomy," said Santa Vītola, Project Manager, Vidzeme Planning Region, Latvia.



Next steps for bioeconomy policy: insights from cross-border dialogue

Following the publication of this report, a series of online events were organised to discuss the policy implications of the ten trends. This included three interactive roundtables that brought together policymakers, practitioners and experts from the regions featured in the report.

This chapter, which has been added to the report four months after its initial completion, summarises the insights generated by these discussions.

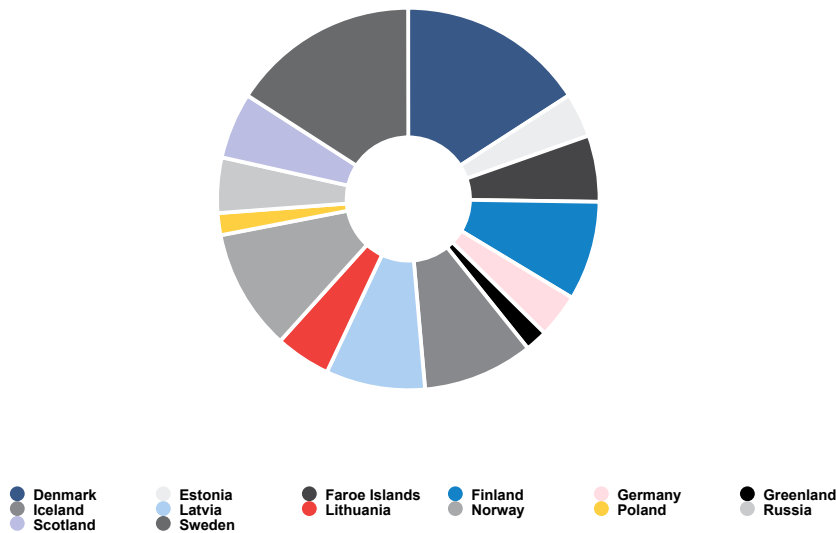
Five themes emerged from the roundtable discussions, along with three visions for the future of the bioeconomy, presented by the keynote speakers. The themes represent the most urgent actions needed to grow the sustainable bioeconomy and set the direction for policymakers.

This report was initially launched at a workshop at the EU Strategy for the Baltic Sea Region Annual Forum 2020. It was subsequently presented at a workshop at the Global Bioeconomy Summit.

The purpose of the interactive digital roundtables was to create a dialogue about policies for the sustainable bioeconomy across the Baltic Sea Region and Nordic Arctic. The roundtables were divided into three regionally-focused events:

- 1. **Eastern Baltic:** Estonia, Finland, Latvia, Lithuania, Poland, and NW Russia
- 2. **Western Baltic:** Denmark, Germany, and Sweden
- 3. **North Atlantic:** Faroe Islands, Greenland, Iceland, and Norway. The scope of the project was also expanded to include Scotland.

Figure 35: Participants according to country of residence



Each roundtable included a keynote speaker and between three and five panellists, as well as a group of up to 35 selected participants. The panellists reflected on how the trends in the report can be translated into policy action, and identified opportunities for and obstacles to growing the bioeconomy in their region.

Through an analysis of these discussions, five themes emerged that need support at policy level in order to grow the sustainable bioeconomy:

The bioeconomy brand: Establish a compelling vision across diverse stakeholder groups and steer bioeconomy growth towards circularity

Collaboration and innovation: Improve value generation by supporting research and development, and collaboration across sectors and borders

Protection of natural resources: Ensure sustainable bioeconomy development by maximising the efficient use of resources while prioritising the conservation of natural areas

Capacity building: Establish opportunities for skilled jobs in rural areas and engage young people in order to develop the workforce of the future

Innovative business models: Support the development of new markets and reduce regulatory barriers for new bioeconomy products

The keynote speakers set the tone for the roundtables by presenting their visions of opportunities for the bioeconomy:

Create a societal ecosystem to support the transition to a more bio-based economy: Esko Aho, former Prime Minister of Finland

Harness the innovation potential at the intersection of biology and IT - The digital bioeconomy: Beate El-Chichakli, Director of Programme Management at the German High-Tech Forum

Grow the blue bioeconomy to feed the world sustainably: Árni M. Mathiesen, former Minister of Fisheries of Iceland

Five themes for bioeconomy policy

THE BIOECONOMY BRAND

The bioeconomy is not a trend. Many of the roundtable participants voiced concern regarding the lack of a shared understanding of the bioeconomy. Realising the full potential of the bioeconomy demands a strong narrative based on building awareness of opportunities and galvanising collaboration across diverse sectors. This may include, for example, empowering architects to swap steel and concrete for wood, or opening young people's eyes to the skilled jobs available in the bioeconomy. Digital tools can provide an opportunity to share inspiring stories widely, but strategic policy support could help bring this narrative to the mainstream.

While many traditional bioeconomy sectors have had linear value chains, participants see the future of the bioeconomy as circular, with great innovation potential in the use of side streams. According to Maija Kāle, Advisor at Nordic Council of Ministers' Office in Latvia, "Policymakers need to address the controversies that are currently associated with bioeconomy – for example, whether it is linear and whether it will destroy biodiversity." Any narrative developed for the bioeconomy must position sustainability as a core value. This will aim to guide further bioeconomy development in order to ensure both the effective use of resources – ideally, circular – and the protection of natural areas.



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– Maija Kāle, Advisor at Nordic Council of Ministers' Office in Latvia

COLLABORATION AND INNOVATION

Innovation is key to the future of the sustainable bioeconomy. Many participants emphasised the great potential in shifting focus from the primary production of biomass to value-added products and circular processes. In order to realise this, there is a need for further investment in research and development, technology and modernisation. Participants noted digital technologies' potential to map and visualise value chains in order to identify areas that would benefit from new synergies and connections.

Collaboration and knowledge sharing across geographical areas and industries are essential for realising opportunities in the bioeconomy, e.g. to develop new products, engage in interdisciplinary research or develop industrial symbiosis. Argo Peepson, Bioeconomy Adviser at the Estonian Ministry of Rural Affairs, explained, "Problems need to be solved through regions and actors working together. I think it's very important to understand that an intersectoral perspective is key to seeing the synergistic possibilities in the bioeconomy and what the different sectors have to offer each other."

The participants emphasised the importance of action at the regional level, supported by national strategies. Kristaps Ročāns, Managing Director of the Latvian Food Bioeconomy Cluster and Project Manager in the Vidzeme Planning Region stated, "I believe that we need to work with more regional strategies and more cluster development, and bring together companies and researchers, not only within our regions, but also across borders." Where coherent government support is not yet sufficient, bioeconomy practitioners can create opportunities for collaboration via partnerships and networks.



Problems need to be solved through regions and actors working together. I think it's very important to understand that an intersectoral perspective is key to seeing the synergistic possibilities in the bioeconomy and what the different sectors have to offer each other.

– Argo Peepson, Bioeconomy Adviser at the Estonian Ministry of Rural Affairs

PROTECTION OF NATURAL RESOURCES

Sustaining a strong bioeconomy for years to come requires innovative ways of ensuring effective and sustainable resource use. Niels Gøtke, Head of Division, Danish Agency for Science, Technology and Innovation stated, "In the early years of the bioeconomy, we thought we could use biomass for everything. I think it's very much recognised today that we do not have enough biomass, and we really need to optimise its use." Rather than focusing on increasing harvesting of biomass, developing a sustainable bioeconomy requires a greater focus on developing circular value chains and utilising side streams.

It is important to remember that the protection of natural resources is the foundation for the future growth of the bioeconomy. Katherine Leys, Head of Biodiversity and Geodiversity at NatureScot, explained, "There's the climate crisis, but there's also a biodiversity crisis. And trying to tie all these things together, while supporting the green economy, is going to be quite challenging."

Participants from Iceland, Scotland and Norway expressed a shared concern regarding the erosion of soils due to overgrazing and the need for conservation of threatened peatlands. They also emphasised the importance of protecting natural resources in order to ensure that the potential of the bioeconomy can not only be realised but also sustained indefinitely.

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– Katherine Leys, Head of Biodiversity and Geodiversity at NatureScot

CAPACITY BUILDING

Many of the roundtable participants voiced concerns regarding urbanisation and its potential negative impacts on the bioeconomy. The rural-urban divide is growing as rising inequality attracts a talented workforce to urban areas, away from centres of bioeconomic activity.

Participants suggested that strengthening connections between urban and rural areas would spur growth in the bioeconomy. Opportunities include developing collaborations between farmers and researchers, establishing universities in rural areas and connecting rural entrepreneurs with sources of funding. As knowledge resources and start-up companies are often clustered in urban areas, connecting farmers to innovation hubs generates growth potential. In addition, creating skilled bioeconomy opportunities in rural areas can help to improve prospects for gender equality and make these areas more attractive to families and young people.

The bioeconomy demands a diverse range of skilled and specialised work, from land management and operating machinery to knowledge-based work in technology, research and design. Attracting a workforce that can fulfil these roles requires not only training opportunities but also effective communication that enables young people to see the potential. Camilla Widmark, Coordinator of Forest Bioeconomy Network and Associate Professor at the Swedish University of Agricultural Sciences explained, "We know that young people care about climate change and other the big issues, but they're also interested in getting a good job. So, we have to prove to them that the bioeconomy can provide a good job and a bright future, so that we can attract more young people to bioeconomy-related businesses."

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– Camilla Widmark, Coordinator of Forest Bioeconomy Network

INNOVATIVE BUSINESS MODELS

Bioeconomy entrepreneurs at the roundtables emphasised the need for policy support to enable product development and marketing, and to bring sustainable bioeconomy products to consumers. This includes greater investment opportunities for SMEs, improved market access and the removal of regulatory obstacles for innovative products. Examples of such barriers include restrictions on the kinds of marine resources permitted in the creation of feed or food, as well as restrictions on the development of insect proteins.

Discussing his company's work with growing seaweed in the Faroe Islands, Ólavur Gregersen, Managing Director of Ocean Rainforest, explained, "We have entrepreneurs ready to utilise the business opportunities, we have investors that are ready to invest in the entrepreneurs, and we have researchers developing methods to use the biomass. Yet, in many cases, we have regulatory authorities that are hindering this process because of either licences or market access."

"No matter how great a product is, if there are no buyers, it will fall apart", stated one participant working on developing new bioeconomy products in Greenland. Participants reflected that, if innovative bioeconomy products are to succeed, there is a need for political support aimed at creating and facilitating access to markets in Europe.



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– Ólavur Gregersen, Managing Director of Ocean Rainforest

Keynote speakers present their visions for the bioeconomy

At the start of each of the roundtables, keynote speakers were invited to present their reflections on the policy actions needed to enable the development of a sustainable bioeconomy.

The speakers presented three diverse visions of society: one that creates a foundation that facilitates a transition to the bioeconomy; one that takes advantage of the opportunities of interdisciplinary innovation; and one that realises the enormous potential of aquatic resources to feed its population sustainably.

CREATE A SOCIETAL ECOSYSTEM TO SUPPORT THE TRANSITION TO A MORE BIO-BASED ECONOMY

How can we create the right societal and structural conditions to make the bioeconomy a success story? A bioeconomy can be seen as an ecosystem comprising a network of elements that require interdisciplinary collaboration at regional, national and local level. Esko Aho, former Prime Minister of Finland and keynote speaker of the Eastern Baltic Roundtable, suggested that such an ecosystem would include five key elements.

First, Mr Aho stressed the importance of laying the groundwork by creating the infrastructure needed for the future. Digitalisation is a global macrotrend, and investing recovery funds in digital infrastructure, such as 5G networks in rural areas, is key. Second, supporting the development of skills and talents across disciplines, from technology, management to humanities. Third, enabling innovation by increasing access to venture capital for emerging bioeconomy innovations. Fourth, knowledge of the bioeconomy and its opportunities must be taken into account when drawing up environmental policies. Finally, it is vital that the public sector, the private sector and the people work more closely together.

These elements should be tied together with strategic leadership that supports systemic changes in society, promotes a positive narrative that drives action, and possesses the patience required to take concerted action over the long term. According to Mr Aho, there is no time like the present. "I think the timing is perfect. If you look at Europe's challenges today, we need growth. We need new innovation opportunities and new jobs. The bioeconomy can provide all of this."



I think the timing is perfect. If you look at Europe's challenges today, we need growth. We need new innovation opportunities and new jobs. The bioeconomy can provide all of this.

– Esko Aho, former Prime Minister of Finland

HARNESS THE INNOVATION POTENTIAL AT THE INTERSECTION OF BIOLOGY AND IT: THE DIGITAL BIOECONOMY

In Germany, innovation strategy and national bioeconomy strategy go hand in hand. The keynote speaker at the Western Baltic Policymaker roundtable, Dr Beate El-Chichakli, has advised the German government on bioeconomy policy issues and is currently advising on the federal government's innovation strategy, as Director of Programme Management at the German High-Tech Forum.

The German High-Tech Forum has been looking at the impact of merging key enabling technologies, with a focus on the convergence of biosciences and IT. "We are not talking about the digitalisation of the bioeconomy, which is already ongoing. We are talking about the research areas, technologies and materials in which bio and IT are becoming truly interlinked and merged." This fusion of fields is already being realised in, for example, the ability to write digital data into DNA, the development of computer/brain interfaces for direct communication with machines, or bio-foundries that can potentially automate biological production processes based on digital twins.

[A recently published paper](#) by the German High-Tech Forum investigated these merging fields and outlined the implications for the innovation strategy with regard to ethical and security considerations, as well as R&D support and policy measures. There are several promising potential uses for bio-IT innovations, including developing intelligent, personalised medicine and cancer treatments, supporting the circular sustainable economy, climate protection and restoring biodiversity. The paper also makes policy recommendations to help realise these opportunities.



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– Beate El-Chichakli, Director of Programme Management at the German High-Tech Forum

GROW THE BLUE BIOECONOMY TO FEED THE WORLD SUSTAINABLY

Árni M. Mathiesen sees blue growth – the sustainable use of renewable living resources in oceans, freshwaters and coasts – as a vital component in feeding a rapidly growing global population. Mr Mathiesen is a former Minister of Fisheries of Iceland and Deputy-Director at FAO and is currently a Senior Adviser at the Iceland Ocean Cluster.

At the North Atlantic roundtable, Mr Mathiesen described the great potential he sees in ocean biomass: “10,000 years ago, we had an agricultural revolution. Since then, we’ve been improving our productivity through animal production and genetics. But when it comes to the oceans, which make up over two-thirds of the surface of the globe, we’re only just scratching the surface. There is huge potential there.”

He highlighted four problems that must be solved in order to advance the blue bioeconomy. In the North Atlantic, both international management and allocation of fish stocks must be improved. In addition, controversies in coastal and marine planning with regard to aquaculture need to be addressed, which will require shifts in both mindset and technical innovation. Internationally, a global financing mechanism is needed to bridge the historical inequalities between the north and south and to improve the management capacity for fisheries in southern waters. Finally, as the COVID-19 crisis stems from human encroachment on nature, action must be taken to prevent further crises from occurring in the future.

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– Árni M. Mathiesen, former Minister of Fisheries of Iceland



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