



STATE OF PLAY FOR BIOECONOMY IN THE SOUTH BALTIC AREA





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Abbreviations

Approx.	Approximately
BioBIGG	Bioeconomy in the South Baltic Area: Biomass-based Innovation and Green Growth
DM	Dry matter
E.g.	Exempli gratia
EU	European Union
SBA	South Baltic Area
SME	Small and medium-sized enterprises
R&D	Research and development
R&I	Research and Innovation
Tons	Metric tonne
WW	Wet weight

Executive summary

In order to cope with increasing global population, rapid depletion of natural resources, increasing environmental pressures and climate change, Europe needs to radically change its approach to production, consumption, processing, storage, recycling and disposal of biological waste and residues. The Europe 2020 Strategy calls for a bioeconomy as a key element for smart and green growth in Europe.

Advancements in bioeconomy research and uptake of innovation will allow Europe to improve the management of its renewable biological potential and to open new and diversified markets, for example in food and bio-based products. Establishing a bioeconomy in Europe holds great potential. Specifically it can maintain and create economic growth and jobs in rural, coastal and industrial areas, reduce fossil fuel dependence and improve the economic and environmental sustainability of primary production and processing industries. The bioeconomy thus contributes significantly to the objectives of the Europe 2020 flagship initiatives “Innovation Union” and “A Resource Efficient Europe”.

Countries belonging to the South Baltic Area (SBA) are striving to be at the forefront of the European Union (EU) region to improve their wealth and prosperity and create a sustainable future for the region. That is to be achieved through a wide range of initiatives, including the implementation of bioeconomy policies and relevant actions. The BioBIGG project involves 6 partners from the South Baltic Area, as well as 25 associated partners.

The project aims to demonstrate attractive business opportunities for SMEs concerning production of innovative food, non-food products and bioenergy based on regionally available resources and at the same time to strengthen the innovation capacity of the SMEs and decrease pollution discharged in the South Baltic Area. The project will, at the same time, both strengthen the innovation capacity of the SMEs and decrease pollution discharged in the South Baltic Area, by the means of cross-border knowledge transfer, advisory activities and innovation activities for the preparation of piloting and investments.

Emerging from the biomass resources, innovation potentials and the production systems in the participating regions, concrete proposals for biomass-based products and production processes will be identified and developed in the BioBIGG project. Existing and new knowledge will also be transferred between the regions and disseminated to SMEs and other key actors through workshops and conferences and other active dissemination, an example of which will be the South Baltic Bioeconomy network, one of the outcomes of the project.

The main target groups of the project are regional SMEs, local authorities, energy and waste companies (some of them are already represented in the project partnership). In the scope of the report is a profile of four regions participating in the programme. In each case we indicate strengths and weaknesses distinguishable within the biomass-based economy, biomass potential and bioeconomy opportunities in the region. In every case, most focus have been put on the value chains for wood, cereals, sugar and food processing.

1 Preface

Countries belonging to the South Baltic Area (SBA) are striving to be at the forefront of the European Union (EU) region, to improve its wealth and prosperity and create a sustainable future for the region. That is to be achieved, amongst other things, through the implementation of bioeconomy. The regions belonging to the South Baltic Area are displayed in the Figure. 1.1. The BioBIGG project partners represent all but one (Lithuania) of the countries in the eligible region, namely:

- Roskilde Universitet (RUC), Denmark
- Research Institutes of Sweden (RISE), Sweden
- Politechnika Gdańska (GUT), Poland
- Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany
- Universität Greifswald (UG), Germany
- Swedish University of Agricultural Sciences (SLU), Sweden

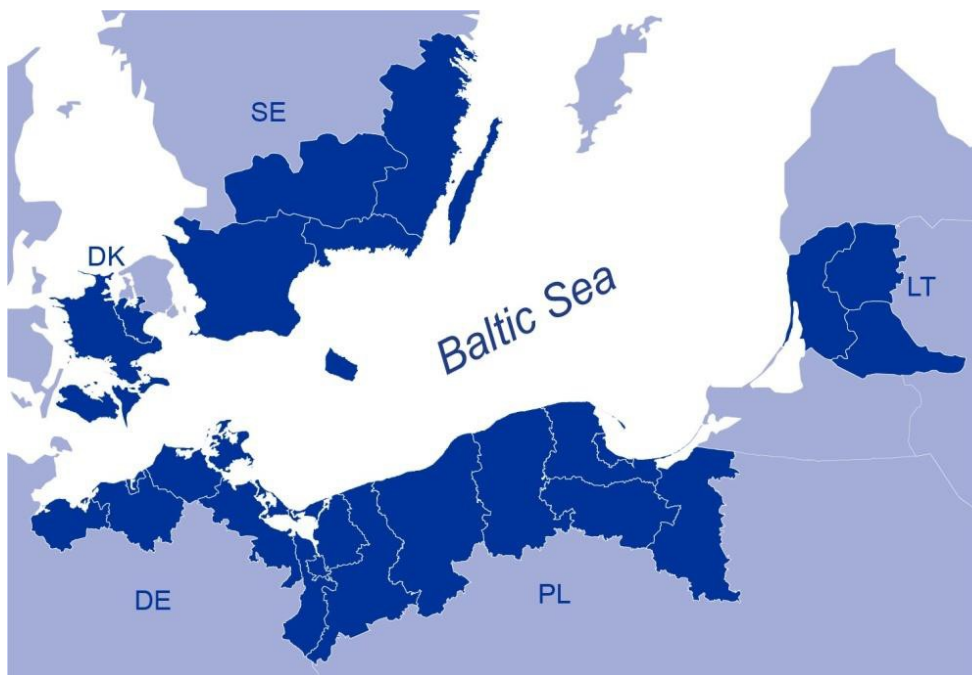


Figure. 1.1. South Baltic Area participating countries.

The EU is setting a course for a resource-efficient and sustainable economy, which is outlined below. The objective is to attain a more innovative and low-emissions economy, reconciling demands for sustainable agriculture and fisheries, food security, and the sustainable use of renewable, biological resources for industrial purposes, while ensuring biodiversity and environmental protection.

1 Introduction

In order to address the complex and interconnected challenges of climate change, food security, sustainable management of natural resources and eco-systems, as well as a reducing dependence on non-renewable resources there is a need for a transition towards a more sustainable production and consumption system¹. Unlocking the potential of the bioeconomy is central if we are going to succeed in this transition and is a key element in smart and green growth in the EU².

The definitions of bioeconomy vary between different organisations and governments, but the main focus is typically on optimising the use of biomass to support sustainable development. The bioeconomy concept has been becoming increasingly popular in recent years and is promoted by several major organisations and countries. The OECD have been one of the central organisation in the discussion of the bioeconomy. In the report *The Bioeconomy to 2030: Designing a Policy Agenda* they defined the term in the following way³:

“A bioeconomy can be thought of as a world where biotechnology contributes to a significant share of economic output. The emerging bioeconomy is likely to involve three elements: the use of advanced knowledge of genes and complex cell processes to develop new processes and products, the use of renewable biomass and efficient bioprocesses to support sustainable production, and the integration of biotechnology knowledge and applications across sectors”⁴.

The OECD definition focuses on the use of biotechnology, with emphasis on increased innovation and use of advanced knowledge to ensure its development across sectors. The OECD also stresses that the business opportunities that the bioeconomy encompasses require new business models⁵. Bioeconomy is also one of the major priorities in an EU context. In 2012 the European Commission launched its first bioeconomy strategy *Innovating for Sustainable Growth: A Bioeconomy for Europe*. In the 2012 Bioeconomy Strategy the bioeconomy was described in the following way:

“The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products¹ and bioenergy. It includes agriculture, forestry, fisheries, food and pulp, paper production, as well as parts of chemical, biotechnological and energy industries. Its sectors have a strong innovation potential due to their use of a wide range of sciences (life sciences, agronomy, ecology, food science and social sciences), enabling and industrial technologies (biotechnology, nanotechnology, information and communication technologies (ICT), and engineering), and local and tacit knowledge”⁶.

After a review of the 2012 Bioeconomy strategy in 2017 it was concluded that there was need for an updated and more focused strategy. The updated European Bioeconomy Strategy was launched in October 2018 and clearly aims at accelerating the implementation of sustainable European bioeconomy that will contribute both towards the Paris Agreement and fulfillment of 2030 Agenda and

¹ EU COMM, 2017: Bioeconomy development in EU regions

² EU COMM 2012: Innovating for Sustainable Growth: A Bioeconomy for Europe

³ Nordregio 2014: Bioeconomy in the Nordic region: Regional case studies

⁴ OECD 2009: The Bioeconomy to 2030: Designing a policy agenda –Main Findings and Policy Conclusion

⁵ Nordregio 2014: Bioeconomy in the Nordic region: Regional case studies

⁶ EU COMM 2012: Innovating for Sustainable Growth: A Bioeconomy for Europe. Accompanying the document

its Sustainable Development Goals. In the new strategy Bioeconomy is defined in the following way:

The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services. To be successful, the European bioeconomy needs to have sustainability and circularity at its heart. This will drive the renewal of our industries, the modernisation of our primary production systems, the protection of the environment and will enhance biodiversity⁷.

As the different definitions show, the concept of new bioeconomy is still under development. The objective of the BioBIGG project is to prepare specific proposals for implementation of production of biomass-based products and services in SMEs based on residues, left-overs and waste from biomass-based value chains in order to decrease pollution and climate change.

The aim is hereby to increase use of innovative technologies and processes related to use of unutilized biomass-based residues found in the South Baltic area, enabling SMEs to develop innovative products that are both cost-efficient and sustainable⁸.

The BioBIGG project is thus already well in line with aim of 2018 Bioeconomy strategy and the 5 objectives and coherent action plans and will work to support green growth and innovation in the South Baltic area in the coming years.

2 Overview of state of play for Bioeconomy in the EU

Emerging from the "Innovation Union"⁹ and "Resource-efficient Europe"¹⁰ flagship initiatives the EU 2012 Bioeconomy Strategy and its following Action plan was presented in 2012, emphasizing the importance of the bioeconomy for the European economy and in addressing several, key inter-linked challenges. The bioeconomy Strategy was build on conclusions from the work on the Knowledge-based Bioeconomy (KBBE) in 2005, 2007 and 2010 under UK, German and Belgian Presidencies, and by the launch of the specific programme under the 7th Framework Programme for Research and Technological Development (FP7) (2007-2013) with the subtitle KBBE.

The European 2012 Bioeconomy Strategy addressed the *“aim to pave the way to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes, while ensuring environmental protection.* The Strategy also emphasized that the cross-cutting nature of bioeconomy offers a unique opportunity to address the inter-connected societal challenges comprehensively, and identifies five inter-linked objectives to which the strategy and its action plan are to contribute. The five objectives being:

- Ensuring food and nutrient security,
- Managing the natural resources sustainably,
- Reducing dependence on non-renewable resources,
- Mitigating and adapting to climate change,
- Creating jobs and maintaining EU competitiveness.

The 2012 Bioeconomy was accompanied by an Action Plan for development of the bioeconomy that focused on three main actions: 1) Investments in research, innovation and skills, 2) Investments in reinforced policy interaction and stakeholder engagement, innovation and skills, 3) Enhancement of markets and competitiveness in bioeconomy.

In the 2017 a review of the 2012 Bioeconomy Strategy was carried out. It concluded that the strategy had been successful in mobilizing research and innovation funding in the bioeconomy and bring to the attention the cross-cutting objectivities of the bioeconomy to the attention of national and regional policy-makers, e.g. demonstrated by establishment of Bioeconomy Panels and the development of bioeconomy strategies at both the national, regional and local level in several members countries. Also highlighted was that many regions have included bioeconomy related topics into their Research and Innovation Strategies for Smart Specialization¹¹.

But a main finding in the review was also that *“the current policy context highlights the need for a sustainable, circular bioeconomy. The policy context in which the bioeconomy operates has changed significantly since 2012, with EU and global policy developments such as Circular Economy, Energy Union, the Paris Agreement and the Sustainable Development Goals. In consequence, the concept of a sustainable, circular bioeconomy is being proposed by various*

⁹ COM(2010)0546, <http://eurlex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52010DC0546>

¹⁰ COM/2011/0571 final, <http://eurlex.europa.eu/legalcontent/EN/TXT/?uri=CELEX%3A52011DC0571>

¹¹ EU COM 2018: A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy

stakeholders. The scope of the 2012 Strategy and Action Plan and the relevance and focus of its objectives and actions have to be looked at in light of these developments¹².

The updated bioeconomy strategy was presented in October 2018 reflecting the conclusions of review. The updated 2018 Bioeconomy Strategy emphasized the importance of development of a sustainable and circular bioeconomy aiming to maximizing its contribution to the 2030 Agenda and its Sustainable Development Goals (SDGs), as well as the Paris Agreement. The 5 objectives of the first bioeconomy strategy continued to be valid but was refocused in the updated bioeconomy.

Also, like the Action Plan for the 2012 Bioeconomy Strategy the Action Plan for the updated 2018 Bioeconomy strategy focusses on three main actions to archive its aim also including several sub-actions¹³, e.g. 1) strengthen and scale up the bio-based sectors, unlock investments and market, 2) deploy local bioeconomies rapidly across the whole of Europe and 3) understand the ecological boundaries of the bioeconomy.

Strengthen and scale up the bio-based sectors, unlock investments and market

This action is aimed at accelerating the development of a sustainable and circular biomass-based solutions in Europe, by increasing the number of public and private stakeholders engaged, involved in research, demonstration and implementation of bio-based solutions. This will among other things be achieved through the EU public-private partnership on Bio-Based Industries¹⁴ and launch of the EUR 100 million Circular Bioeconomy Thematic Investment Platform both under Horizon2020 alongside the development of new standards and labels for bio-based products¹⁵.

Action Title	Who
1 Strengthen and scale-up the bio-based sectors, unlock investments and markets	
1.1 Mobilise public and private stakeholders, in research, demonstration and deployment of sustainable, inclusive and circular bio-based solutions	Commission, Member States, Regions and stakeholders
1.2 Launch of the EUR 100 million Circular Bioeconomy Thematic Investment Platform	Commission
1.3 Study and analysis of enablers and bottlenecks and provide voluntary guidance to the deployment of bio-based innovations	Commission
1.4 Promote and/or develop standards and emerging market-based incentives, and improve labels applicable to bio-based products on the basis of reliable and comparable data on environmental and climate performance	Commission and Member States/stakeholders
1.5 Facilitate the development of new sustainable biorefineries and confirm the type and estimated potential	Commission and Member States
1.6 Research and innovation investments for the development of substitutes to fossil based materials that are bio-based, recyclable and marine-biodegradable, and of bio-remediation methods by mobilising the key actors in the relevant value chains including the plastics value chain and to contribute to plastic-free, healthy and productive European seas and oceans	Commission, stakeholders

¹² EU COM 2017: Review of the 2012 European Bioeconomy Strategy

¹³ EU COM 2018: A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment Updated Bioeconomy Strategy

¹⁴ <https://www.bbi-europe.eu/>

¹⁵ EU COM 2018: A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment Updated Bioeconomy Strategy

Deploy local bioeconomies rapidly across the whole of Europe

The aim of this action is to develop a Strategic Development Agenda that will ensure a long-term vision and path ways to deploy and scale up the bioeconomy in a sustainable and circular at the local level. This will include pilot actions showcasing the potential of the bioeconomy for rural, coastal and urban areas together with EU bioeconomy policy support for members state set up under Horizon2020.

Action Title	Who
2 Deploy local bioeconomies rapidly across Europe	
2.1 A Strategic Deployment Agenda for sustainable food and farming systems, forestry and bio-based production in a circular bioeconomy	Commission, Member States, private sector, stakeholders
2.2 Pilot actions to support local bioeconomy development (rural, coastal, urban) via Commission instruments and programmes	Commission, Member States, regions, municipalities and other stakeholders
2.3 Set up an EU Bioeconomy policy support facility and a European Bioeconomy Forum for Member States	Commission and Member States
2.4 Promote education, training and skills across the bioeconomy	Commission and Member States

Understand the ecological boundaries of the bioeconomy

The aim of this action is to become better at understanding and measuring the effects and impacts of local and regional biomass supply within safe ecological limits. Enchaining this knowledge will also provide the foundation for others actions in the strategy and will ensure that the development of the bioeconomy is systematically monitored and reported so that governance and policy-making at the national, regional and local level can become coherent and sustainable.

Action Title	Who
3 Understand the ecological boundaries of the bioeconomy	
3.1 Enhance the knowledge on the bioeconomy, including on biodiversity and ecosystems, to deploy it within safe ecological limits and make it accessible through the Knowledge Centre for Bioeconomy	Commission, Member States, International Organisations, IPBES
3.2 Increase observation, measurement, monitoring and reporting capabilities and build EU-wide, internationally coherent monitoring system to track economic, environmental and social progress towards a sustainable bioeconomy	Commission, Member States, private sector
3.3 Provide voluntary guidance to operate the bioeconomy within safe ecological limits	Commission
3.4 Better integrate the benefits of biodiversity-rich ecosystems in primary production through a specific support to agro-ecology, the development of microbiome-based solutions, and new tools to integrate pollinators in supply value chains	Commission, Member States, private stakeholders

3 Overview of state of play for bioeconomy in the South Baltic Area

Introduction

The countries that are part of the South Baltic Area are all striving to improve their wealth and prosperity, and accelerate transition to a sustainable future. In this chapter we will give an overview of the different national and regional initiatives and policies that have been launched to ensure implementation of the bioeconomy in the South Baltic Area.

3.1 Sweden

In 2012, a *Swedish research and innovation strategy for a bio-based economy* was adopted by Formas, the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning¹⁶. This strategy suggests both short- and long-term research commitments. Short-term funding (3-5 years) includes assessments of knowledge requirements and challenges as well as programmes for research, development and demonstrations.

The document defines a bio-based economy as *a sustainable production of biomass to enable increased use within a number of different sectors of society. The objective is to reduce climate effects and the use of fossil-based raw materials. Furthermore, an increased added value for biomass materials, concomitant with a reduction in energy consumption and recovery of nutrients and energy as additional end products. The objective is to optimize the value and contribution of ecosystem services to the economy.*

This research policy identified four distinct research areas to further the implementation of a large-scale bioeconomy:

- The replacement of fossil-based raw materials with bio-based raw materials
- Smarter products and smarter use of raw materials
- Change in consumption habits and attitudes
- Prioritisation and choice of measures

From a more long-term perspective, the strategy stresses the importance of supporting innovation processes that lead to a wide implementation of products and services within the bioeconomy. More specifically, the formation of innovation initiatives dealing specifically with the challenges of the bioeconomy, was suggested. Finally, it pointed out a strong need for coordinating research and innovation measures between major research funders in Sweden. As a result, three main funding bodies for research and innovation in Sweden often coordinate research programmes in cooperation: The Swedish Energy Agency, Vinnova and Formas.

Currently, there is no national bioeconomy policy in Sweden. However, the Ministry of Enterprise and Innovation issued a policy for a sustainable development of industrial production in 2015,

¹⁶ Formas, 2012. Swedish research and innovation strategy for a bio-based economy. The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, Stockholm, Sweden.

in which the bioeconomy is represented in one out of four focus areas, *Sustainable Production*¹⁷. In 2016, as part of the governmental strategic cooperation program, a group of 25 representatives from industry and academia was appointed by the ministry to support the transition to a circular and bio-based economy, specifically the replacement of fossil-based with bio-based products. Focus areas of this group include (wood-based) housing, circularity and resource efficiency, innovative bio-based feedstocks, biofuels, new materials, upscaling and commercialisation¹⁸.

The workgroup currently has a mandate until 2018. Governmental initiatives, such as for a fossil-free society¹⁹, complement the work on a national bioeconomy strategy/policy.

In 2016, the progress of the development of the Swedish bioeconomy was followed up by the *Swedish Agency for Economic and Regional Growth* mandated by the Swedish government²⁰. This report estimated the Swedish bioeconomy to correspond to 7,1% of Sweden's total value added and 22,9% of the total goods exported, employing approx. 350.000 people in 2014. The study identified 30 industrial sectors that as a whole (10) or partly (20) contribute to the Swedish bioeconomy. The forestry sector was identified as the main contributor (approx. 2/3 of total value added within the bioeconomy), but the food industry was pointed out as the single largest contributor. Wood-based housing was identified as a sector with strong future development, while exports of pulp and paper products were seen as threatened by a trend of declining newsprint. Political guidelines and a prioritisation of the bioeconomy were identified as important tasks for the Swedish government.

The Swedish government has mandated a group a large research funders, including Vinnova, Formas and the Swedish Energy Agency to act as intermediators for the distribution of research funds according to the Swedish research and innovation strategy. Together, these funders cooperate in a common innovation platform called *BioInnovation*. With regard to the vision of Sweden having made the transition to a bioeconomy in 2050, the annual budget of 10 million € is used to increase the added value and competitiveness in the Swedish bio-based sector by creating the best possible conditions for new, bio-based materials, products and services to arise²¹. Five pilot studies, 31 hypothesis testing projects, six innovation projects and seven directed projects have been funded, with full projects starting in the second half of 2017. As an example, TREESEARCH is a cooperation project financed with approx. 7 million € towards a world-leading research platform for new materials and special chemicals with wood as a resource. Another example is the recently started competence centre for plant breeding of food crops – Grogrund – at the Swedish University of Agricultural Sciences (SLU).

The same group of funding bodies is also active in the co-funded ERA-NET programme *ForestValue*, distributing 3 million € in the 2017 joint call for development and proof of concept studies covering the whole forestry value chain²².

¹⁷ Regeringskansliet, 2015. Smart industri - en nyindustrialiseringsstrategi för Sverige. Ministry of Enterprise and Innovation, Swedish Government, Stockholm, Sweden.

¹⁸ Regeringskansliet, 2017. Lägesrapporter 1&2: Cirkulär och biobaserad ekonomi. Samverkansgrupp för cirkulär och biobaserad ekonomi, Ministry of Enterprise and Innovation Stockholm, Sweden.

¹⁹ Regeringskansliet, 2015. Målet är ett Fossilfritt Sverige. Ministry of the Environment and Energy, Stockholm, Sweden.

²⁰ Persson, T., 2016. Den svenska bioekonomins utveckling. Svar direkt (2016:23). Tillväxtverket, Östersund, Sweden.

²¹ BioInnovation, <http://www.bioinnovation.se/om-oss/>

²² ForestValue, 2017. Joint Call 2017 (JC 2017). <http://forestvalue.org/joint-calls/joint-call-2017-jc-2017/>

Vinnova, the Swedish Governmental Agency for Innovation Systems, has *circular and bio-based economy* as one of five prioritised areas²³, with three funding programmes: 1) The Strategic innovation programme for bio-innovation (bio-based materials, see above), 2) The Strategic innovation programme RE:Source (minimise and use waste streams), and 3) Challenge-driven Innovation. In addition, Vinnova has a mandate to support the cooperation program *The circular, bio-based economy*.

Formas has funded research and development projects to a value of approx. 7 million € investigating *Sustainable conditions for a circular and bio-based economy* during 2017-2019, which was the fifth call within the programme for *Bio-based macroeconomics* (biobaserade samhällsekonomi).

The Swedish Energy Agency (SEA) together with *f3, the Swedish Knowledge Centre for Renewable Transportation Fuels*, has funded the research programme on *Renewable transportation fuels and systems* with 4.4 million € during 2014-2017. This programme aims to *provide a broad, scientifically based source of knowledge*, to carry out *system oriented research* and to act *as a platform stimulating interaction between large research and innovation programmes*²⁴. In October 2017, SEA agreed to fund a follow-up programme running 2018-2021.

The Swedish Forest Industry Federation has defined four important current and future research areas with regard to the development of a bio-based economy²⁵, covering the whole value chain from sustainable forestry management to bio-based products: 1) Fundamental research, 2) Forests and forest raw materials, 3) Pulp, paper and biorefinery, and 4) Timber processes and products.

The Swedish government has appointed four working groups preparing a national forestry program with the vision of the forest's contribution to the job market, sustainable growth in the whole country and development of a growing bioeconomy²⁶. Two of the working groups have a direct link to the development of a bio-based economy, based on added value from forestry resources and support for bio-based products and energy sources. One of the goals is the direct integration of the forestry program in a bioeconomy framework.

In the Swedish agricultural sector, the Federation of Swedish Farmers has issued its own road map²⁷ for the implementation of a stronger bio-based economy, where general measures are suggested:

- 1) Creation of policies integrated across economic, environmental and rural development issues,
- 2) Long-term subsidies and taxes,
- 3) Identification and removal of legal barriers for innovative and climate-smart measures,
- 4) Support for innovation programs and initiatives,
- 5) Reclassification of certain waste categories into bio-based feedstocks,
- 6) Climate-smart transportation fuels and a fossil-free vehicle fleet, and
- 7) More renewable and locally produced energy.

²³ Vinnova, 2017. Tomorrow's sustainable economy. Vinnova, Stockholm, Sweden. <https://www.vinnova.se/en/m/circular-and-bio-based-economy/>

²⁴ The Swedish Knowledge Centre for Renewable Transportation fuels, f3. <http://www.f3centre.se/about>

²⁵ Skogsindustrierna, 2016. Swedish Forest Sector Research Agenda. Skogsindustrierna, Stockholm, Sweden.

²⁶ Regeringskansliet, 2017. Ett nationellt skogsprogram för Sverige. Ministry of Enterprise and Innovation, Stockholm, Sweden. <http://www.regeringen.se/regeringens-politik/ett-nationellt-skogsprogram-for-sverige/>

²⁷ LRF, 2015. Så når vi en biobaserad ekonomi - Ett inspel från Lantbrukarnas Riksförbund. Federation of Swedish Farmers, Stockholm, Sweden.

²⁸ EU COM 2012: Innovating for Sustainable Growth: A Bioeconomy for Europe

3.2 Denmark

The Danish Government in 2013 appointed a National Bioeconomy Panel, as recommend in the EU-bioeconomy strategy²⁸. The purpose of the panel was to support the transition of Denmark into a growth hub for bioeconomy in the fields of knowledge, technology and production, and also to support the development of a sustainable Danish bioeconomy effectively²⁹.

The National Bioeconomy Panel initially consisted of 27 members from leading Danish firms, research institutions, NGOs and authorities from different governmental agencies and governmental levels. The main task of the panel was to provide recommendations on concrete actions to advance the Danish bioeconomy including all bio-based value chains and to focus both on recommendations for the short and long term^{30,31}.

The bioeconomy panel between 2014 to 2015 came up with several recommendations for optimizing the Denmark bioeconomy. These recommendations were divided into four categories: blue biomass (aquatic biomass), brown biomass (organic waste), green biomass (green crops biomass) and yellow biomass (straw)³². In August 2017 with a newly elected government in the Danish Folketing, the Danish National Bioeconomy Panel was relaunched and the number of members in the panel reduced to 15 excluding members from several environmental production NGOs. Also the purpose of the panel was altered, so that it should focus more on identifying business potential within the new bioeconomy value chains.

The present panel should still give recommendations for realising this potential, but it was emphasized, with the relaunch, that it should be in ways that would advance growth and job creation as well as having a beneficial effect on the environment and climate. Finally, it was decided with the relaunch that the National Bioeconomy Panel should focus on one thematic area at a time. The first thematic area being new value chains for proteins – an area with strategic importance for Danish feedstock production. This specific work could e.g. include recommendations on innovative use of seaweed, mussels, grass and insects to substitute the proteins that are used for food production^{33,34}.

Denmark at the moment has no policies dedicated especially to bioeconomy besides the national bioeconomy panel³⁵. The development of the Danish bioeconomy has instead been integrated into a broader framework of policies. We have tried to give an overview of main objectives and actions targeting bioeconomy topics in the strategies and plans in figure 2.

<p>Denmark without waste 2013-2018 (2022)³⁶</p> <p>Aim</p>	<p>Households:</p> <ul style="list-style-type: none"> • 50% recycling of household waste (organic waste, cardboard, glass, wood, plastic and metal waste in 2022) • 75% collection of electronic waste from households(WEEE) in 2018 <p>Service Sector:</p>
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²⁹ Det nationale bioøkonomi-panel, 2013, Ministeriet for Fødevarer, Landbrug og Fiskeri

³⁰ Det nationale bioøkonomi-panel, 2013, Ministeriet for Fødevarer, Landbrug og Fiskeri

³¹ Development of Nordic Bioeconomy, 2015, Norden

³² <https://mst.dk/erhverv/groen-virksomhed/biooekonomi/>

³³ Kommissorium for Det Nationale Bioøkonomipanel, 2017, Miljø-og Fødevareministeriet

³⁴ <http://mst.dk/service/nyheder/nyhedsarkiv/2017/aug/biooekonomisk-panel-relanceres/>

³⁵ State of Play Bioeconomy strategies and policies in the Baltic Sea Region countries, 2016, Innogate

³⁶ Denmark without waste: Recycle more- incinerate less, 2013, Regeringen

	<ul style="list-style-type: none"> • 75% recycling paper, cardboard, glass, metal and plastic packaging from the service sector in 2018 • 60% recycling of organic waste from the service sector in 2018 <p>All sector:</p> <ul style="list-style-type: none"> • 60% energy recovery from garden waste • 65% collection of waste electronic equipment • 55% collection of batteries • 70% recovery of shredder waste • 80% recycling of phosphorus in sewage sludge
<p>Growth Plan for Food³⁷ Five main objectives:</p>	<ul style="list-style-type: none"> • Sustainable and resource efficient agri-food production • Solution oriented regulation and control • Talent, dynamism and exports in the agri-food sector • Business oriented agri-food research and development • Improved access to financing and focused, strategic export efforts
<p>The Danish programme for the ERDF – innovative and sustainable growth in SMEs 2014-2020³⁸ Four main priorities at the national level.</p> <p><i>The Danish Ministry of Business and Growth have made agreements with all Regions about the smart specialization priorities for regional development.</i></p>	<ul style="list-style-type: none"> • Increase the number of innovative SMEs • Increase the number of growth SMEs • Enhance energy and resource efficiency in SMEs • Reduce energy consumption in cities with more than 30.000 inhabitants
<p>The growth plan for Water, Bio and Environmental solutions 40 initiatives/themes, 3 of them targeting bioeconomy</p>	<p>Theme 5: Promotion of a European market for biomass-based, renewable products</p> <ol style="list-style-type: none"> 1. Stimulation of demand for biomass-based, renewable products by means of common renewability requirements within the EU and via the international standardisation programme <p>Theme 6: Opportunities for research, testing and market maturation of new bioproducts</p> <ol style="list-style-type: none"> 2. Excellent opportunities for research, testing, development and market

³⁷ Vækstplan for fødevarer, 2013, Regeringen

³⁸ Nationalt program for EU's Regionalfond 2014-2020 Danmark, 2014, Erhvervsstyrelsen

	<p>maturity of new biomass-based high-value products such as bioplastics and other advanced biotech products</p> <ol style="list-style-type: none"> 3. Promote market maturity of renewable materials within product design 4. Secure EU funding for Danish innovation and development of biobased products on the basis of long-term public/private partnerships between research and industry <p>Theme 7: Preparing supply chains for market pull in the biomass-based economy</p> <ol style="list-style-type: none"> 5. Increased accessibility of renewable biomass from agriculture, fisheries, food production and waste by, for instance, developing and testing plants and production methods 6. Promotion of technologies to bring down the cost of biomass where the focus is on harvesting, transportation, pre-processing and refining produce into cellulosic sugar and proteins.
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Besides the national strategies and plans there are several national research and innovation programmes funding bioeconomy projects, but no dedicated programmes.

The Danish Agency for Environment and Agriculture has a programme called the Green Development and Demonstration Programme (GUDP)³⁹ that is currently supporting several national projects located primarily in Jutland, focusing on green bio-refining and new processes for the extraction of protein from grass⁴⁰. The purpose with the GUDP-programme is to support realization of ambitious business-oriented innovation in the agri-food industry through green transition. The project should furthermore aim at solving main challenges within the Danish agri-food industry and key food, business and environmental policy objectives⁴¹.

The Danish Energy Agency has the programme Energy Technology Development and Demonstration Programme (EUDP)⁴² and Danish Eco-Innovation Programme (MUDP)⁴³. Finally, there is the Programme for Rural Development in Denmark 2014-2020, that has as its objective to support the competitiveness and green transition of the Danish Agricultural Sector and the DK Innovation fund,

³⁹ <http://mst.dk/erhverv/groen-virksomhed/groent-udviklings-og-demonstrationsprogram-gudp/>

⁴⁰ Biorefinery in the circular economy, presentation by Miljøstyrelsen 2018

⁴¹ ambitious business-oriented innovation in the Danish food industry through green change

⁴² <https://ens.dk/ansvarsomraader/forskning-udvikling/eudp>

⁴³ <http://ecoinnovation.dk/>

DK's Green Investment fund and the Green Climate Fund⁴⁴. Also, the Danish Ministry of Education and Research is supporting efforts to take part in EU research programmes e.g. Horizon 2020⁴⁵.

The Danish government has also assigned both an Advisory Board for Circular Economy and a Taskforce for Enhanced Resource Efficiency. The Advisory Board on Circular Economy was assigned to identify the best framework conditions for Danish enterprises, consumers and public institutions within the circular economy. The Advisory Board on Circular Economy in June 2017 came up with its first recommendations for future regulation and policies to the Danish government. The statement includes 27 recommendations, 3 of them specifically targeting bioeconomy topics.

The Taskforce for Enhanced Resource Efficiency was appointed in 2015 with the purpose of enhancing the competitiveness of Danish enterprises by identifying restrictive and contradictory regulations that halt enhanced resource efficiency. The taskforce identified several barriers relating to bioeconomy topics. See figure 3.

Advisory Board for Circular Economy	<ul style="list-style-type: none"> <input type="checkbox"/> Better framework conditions for biorefining <input type="checkbox"/> Establishment of new value chains for new agricultural crops, that better utilise photosynthesis <input type="checkbox"/> Optimise use of animal by-products⁴⁶
Taskforce for Enhanced Resource Efficiency	<ul style="list-style-type: none"> <input type="checkbox"/> The different waste management and collection systems in the Danish municipalities – especially for organic waste, and another issue <input type="checkbox"/> Different problems related to the classification of waste, end-of-waste and defining where in the EU waste hierarchy a given action should be categorized⁴⁷

Denmark is taking part in several intergovernmental and cross-border collaboration activities linked to development of the bioeconomy. One of the main forum for this is the interparliamentary co-operation in the official body Nordic Co-operation where Denmark is taking part together with Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland. Among other activities a Nordic Bioeconomy Panel has been established as well as several reports on development of a sustainable bioeconomy⁴⁸. Also, Denmark is taking part in Baltic Sea cooperation including the Council of the Baltic Sea States (CBSS) and the EU Strategy for the Baltic Sea Region (EUSBSR). The EUSBSR was launched in 2009 as the very first macro-regional strategy in the EU with bioeconomy being one policy area under the objective Save the Sea^{49,50}.

⁴⁴ <http://lbst.dk/tvaergaaende/eu-reformer/landbrugsreformen-2014-2020/landdistriktsprogrammet-2014-2020/>

⁴⁵ <https://ufm.dk/en/research-and-innovation/funding-programmes-for-research-and-innovation/eu-and-international-funding-programmes/horizon-2020>

⁴⁶ Anbefalinger til regeringen. Rapport fra Advisory Board for cirkulær økonomi, 2017, Advisory Board for Cirkulær økonomi

⁴⁷ Reguleringsmæssige barrierer for danske virksomheders ressourceeffektivitet, 2015, NIRAS

⁴⁸ <https://www.norden.org/da/bioekonomi>

3.3 Poland

Poland also does not have a dedicated, national resource efficiency strategy or action plan. However, there are several documents (either ready or well advanced) that touch upon the question of resource efficiency.

Due to the need to adjust the National Development Strategy 2007-2015, adopted on 29 November 2006, to the new socio-economic conditions and to the internal and external challenges, as well as the requirements of the newly introduced development policy management system, it was decided to update it and to extend its time horizon until 2020. At the moment, it is a major document defining the country's development direction. The efforts to update the strategy were correlated with the work on other strategic documents under development, such as the Long-term National Development Strategy and the Integrated Strategies. These are outlined in Fig. 4.1.

In Poland, there is no single, wide-ranging and strategic document dedicated to bioeconomy. Issues related to the development of bioeconomy are incorporated in three integrated strategies, which are included in the implementation of the Strategy for the Development of the Country.

The main strategic documents of the new system, on the basis of which the development policy is implemented, include:⁵¹

1. Long-Term National Development Strategy - LTNDS (Poland 2030 – the Third Wave of Innovation) which defines major trends and challenges as well as the concept of development of the country in the long-term,
2. Medium-Term National Development Strategy - MTNDS (National Development Strategy 2020) which is the most important document in the medium term, setting out strategic objectives for the development of the country until 2020, and which is key in determining the development activities, including those that can potentially be funded under the EU financial perspective 2014-2020,
3. 9 Integrated Strategies, whose aim is to assist in achieving the long-term and medium-term development objectives:
 - a. Strategy for Innovation and Efficiency of the Economy,
 - b. Human Capital Development Strategy,
 - c. Transport Development Strategy,
 - d. Energy Security and the Environment Strategy,
 - e. Efficient State Strategy,
 - f. Social Capital Development Strategy,
 - g. National Strategy for Regional Development 2010-2020. Regions, cities, rural areas,
 - h. Strategy for Development of the National Security System,
 - i. Strategy for Sustainable Development of Rural Areas, Agriculture and Fisheries.

⁴⁹ <https://www.balticsea-region-strategy.eu/>

⁵⁰ <http://www.cbss.org/>

⁵¹ National Development Strategy 2020 Active Society, Competitive Economy, Efficient State, Warsaw, September 2012

The schematic view of National Spatial Development Concept 2030 can be seen in Fig. 4.1.



Figure 4.1 The system of Country National Spatial Development strategic documents ⁵²

There are also other plans, programs and strategies that are connected with the bioeconomy. To mention a few:

1. **National Forest Programme** (in preparation); the prospective strategy for the development of the forest sector for 2030–2080; European environment agency: This country profile is based on information provided by: Ministry of Economy, Ministry of Environment, Chief Inspectorate for Environmental Protection, Ministry of Agriculture and Rural Development, Ministry of Infrastructure and Development, and Central Statistical Office. Coordination: Małgorzata Bednarek, EEA/EIONET National Focal Point, CIEP (May 2016).
2. **National Waste Management Plan 2014**; This 2014 National Waste Management Plan is an updated version of the 2010 National Waste Management Plan (hereinafter "the 2010 National Plan"), which was approved by Regulation No. 233 of the Council of Ministers (i.e. Polish Cabinet) of 29 December 2006 (Governmental Gazette No. 90, Item 946). The National Waste Management Plan should be the origin of all strategic documents approved at both the national and the Community levels.
3. **National Waste Prevention Programme (NWPP)** by the General Directorate for Environmental Protection, Warsaw 2014; According to the Waste Framework Directive (Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives), which is a key act of Community law in the field of

⁵² National Development Strategy 2020 Active Society, Competitive Economy, Efficient State, Warsaw, September 2012

waste management, the EU strives to create a "recycling society", "seeking to avoid waste generation and to use waste as a resource".

On the one hand, national documents transfer the European challenges and recommendations into the national area, and on the other, they enable active participation in the formulation of strategic objectives of the EU through the identification of national potentials and barriers. The development of objectives and priorities indicated in the national documents are, to a significant extent, a part of the European objectives, and are consistent with them.

In the Strategy for Innovation and Efficiency of the Economy (SIEE), the Energy Security and Environment Strategy (ESES) as well as in the National Development Strategy 2020 (NDS) the resources have been divided into natural, i.e. those extracted for example by mining and used for the first time, and secondary resources, those acquired by recycling.

The SIEE is not focused on specific resources but it emphasizes interdependencies between resources and economic progress and it also describes action in the areas of sustainable agriculture and sustainable building as the most important in the context of resource efficiency. Generally, implementation of SIEE in the Polish SBA is based on the individual, regional strategies. All three Baltic neighbouring regions have developed their regional strategies and fortunately they focus on similar issues such as ^{53,54,55}:

- higher energy efficiency, especially in electricity production (preferably by virtue of cogeneration) and energy transmission and rationalization of its use (mainly residential and public sectors);
- high level of use of renewable energy sources, mainly in the distributed generation system;
- lower costs of using energy;
- better air quality;
- innovative solutions implemented in power engineering, including smart grids;
- high public awareness of the need to rationalize energy consumption and the impact of energy on the quality of the environment and living conditions, as well as common consumer attitudes.

The primary focus of the ESES and NDS is on energy resources and water, whereas in the case of ESES it is also on timber. All strategies focus on the increase in three areas: competitive and innovative economy, effective and robust state, and demonstration of the differences in the development of the provinces.

The main objective of medium-term strategy is to strengthen and make use of the economic, social and institutional capabilities, in order to ensure rapid and sustainable development of the country, and to improve the quality of life.⁵⁶

Some actions have already been initiated. Among them the following already exist : ⁵⁷

⁵³ Strategia rozwoju Województwa Pomorskiego do roku 2020 (Strategy for development of Pomeranian Region by 2020)

⁵⁴ Strategia rozwoju Województwa Zachodniopomorskiego do roku 2020 (Strategy for development of West-Pomeranian Region by 2020)

⁵⁵ Strategia rozwoju społeczno-gospodarczego Województwa Warmińsko-Mazurskiego do roku 2025 (Strategy for development of Warmia and Mazury Region by 2025)

⁵⁶ Strategia Rozwoju Kraju do roku 2020 Aktywne społeczeństwo, konkurencyjna gospodarka, sprawne państwo (National Development Strategy 2020 Active society, competitive economy, efficient state, Warsaw, September 2012)

⁵⁷ Bioeconomy development in EU regions. Mapping of EU Member States' / regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy. February 2017

1. Value chain approaches to supply and waste, processing and conversion and bio-based products are being combined into the strategies.
2. The first bioregion in Poland, which is the establishment of a plan to transform Łódzkie into one of the most innovative regions in Poland with sustainable bioeconomy as a strategic and integrated cornerstone. The recognition of Łódzkie as a bioregion has given the region the role of coordinator of all Polish Bioregions”.
3. R&I (Research and Innovations) support and service providers for the bioeconomy such as Łódzkie in Poland, use events to gather together stakeholders and to raise visibility of their own R&I activities. Events are also an important tool to bring together all stakeholders in the bioeconomy innovation ecosystems.
4. The Marshall’s office of the Łódzkie region organises annually a bioeconomy congress in the city of Łódź. The purpose of the Congress is to create a friendly atmosphere around the innovative, effective and competitive approach to activities, intended to support the development of bioeconomy.

The implementation of the bioeconomy issues is supported by the numerous national and regional funds. Under this development theme, several bioeconomy projects have been funded. To mention a few:

- ERA NET Bioenergy; ERA-NET Bioenergy is a network of R&D&I financing entities in the field of bioenergy, operating since 2004. The aim of the initiative is to increase the production of bioenergy in Europe and the development of technologies in this field. The Program runs annual competitions in which international scientific consortia can participate. Participating agencies are: Austrian Ministry for Transport, Innovation and Technology (BMVIT), Netherlands Enterprise Agency, Sustainable Energy Authority of Ireland, Fachagentur Nachwachsende Rohstoffe, National Centre for Research and Development, Bundesamt für Energie (Switzerland), Swedish Energy Agency and Innovate UK,
- "Natural environment, agriculture and forestry" - BIOSTRATEG is a strategic program of scientific research and development prepared by the Council of the National Center for Research and Development and approved by the Minister of Science and Higher Education. The program includes five strategic problem areas, resulting directly from the National Research Program, consistent with the priority directions of research currently conducted in the European Union and across the world. These areas are:
 - Food security and food safety;
 - Rational management of natural resources, with particular emphasis on water management;
 - Counteracting and adapting to climate change, with particular emphasis on agriculture;
 - Biodiversity protection and sustainable development of agricultural production space;
 - Forestry and the wood industry.

The main objective of the Program is the development of knowledge in the areas of the Program, leading to the growth of Poland's international position in scientific research and development work in this field, and to transfer to the socio-economic environment innovative solutions developed under the Program. The Program aims to stimulate the growth of innovation and competitiveness in the Polish economy.

The results of the projects implemented under the program will be the development and preparation of implementation of new products, techniques and technologies as well as a whole range of other solutions applicable to the fields covered by the thematic scope of the program. The assumed total budget of the Program, under which projects covering scientific research, development works and activities related to preparation for implementation (which will be implemented in 2014-2019), will amount to ca. PLN 500 million.

3.4 Germany

In 2013 the Ministry for Food and Agriculture (BMEL) published the “National Policy Strategy on Bioeconomy”. The strategy lists 4 major challenges:

- Food security for a growing world population
- Limited fossil resources
- Protection of the environment and climate
- Preservation of biodiversity

A year after, a progress report was published (2014). It reformulates priorities as follows:

- Unified political framework for sustainable bioeconomy
- Societal dialogue
- Development of innovative technologies and products
- International context
- Research

The national bioeconomy strategy from BMEL can be seen as a political paper. In addition to this strategy, there is another strategy, which is written from a research point of view. The “National Research Strategy BioEconomy 2030”⁵⁸ was formulated by the Ministry for Education and Research (BMBF). There are also sector specific-strategies, including the “Energy Concept for an Environmentally Sound, Reliable and Affordable Energy Supply”, the “Action Plan for the Industrial Use of Renewable Resources”, the “German Resource Efficiency Programme” and the “Biorefineries Roadmap”⁵⁹.

The overall “National Policy Strategy on Bioeconomy” defines three cross-sectoral areas of action and five thematic areas of action. The cross sectoral areas are:

- a coherent policy framework for a sustainable bioeconomy,
- information and dialogue within society,
- vocational training,
- apprenticeship.

Thematically, the focus is on sustainable production and provision of renewable resources, growth markets, innovative technologies and products, processes and value-adding networks, competition among uses of land and the international context.

⁵⁸ https://www.bmbf.de/pub/Nationale_Forschungsstrategie_Bioeconomie_Kurz_dt._eng.pdf (Last access: 03.01.2018)

⁵⁹ State of Play. Bioeconomy strategies and policies in the Baltic Sea Region countries. Working Paper no. 1 The Baltic Sea Regional Bioeconomy Council (2016).

4 Regional bioeconomy potential

Introduction

The South Baltic regions participating in the project have different potentials and experience levels within the new bioeconomy. In this part of the report we will analyse their strengths and weaknesses as well as biomass potentials from woody biomass, sugar production, grain production and food processing residues and food waste. Furthermore we will try to identify the most promising value chains and bioeconomy opportunities within the participating regions.

4.1 Region Skåne

At a regional level, Skåne (Scania), the southernmost county of Sweden and part of the South Baltic Area, has developed its own initiatives for the development of the circular bioeconomy. *Region Skåne*, the highest directly elected political organization in Skåne, has – in cooperation with other partners – developed an action plan for the Skåne bioeconomy in 2030⁶⁰.

As a support group, the Skåne bioeconomy panel, consisting of 20 members from industry and academia, was established to give guidance in the development of the action plan. In contrast to contributions at the national level, the forestry sector only contributes 18% to the bioeconomy in Skåne, while the food industry and agriculture contribute 61%. In total, bioeconomy in Skåne contributes 11,5% of the economic turnover. The action plan integrates with the regional development strategy⁶¹, promoting Skåne as a strong, sustainable growth engine and identified six focus areas for action: 1) Communication, 2) Education, 3) Cooperation and industrial symbiosis, 4) International cooperation, 5) Funding and business models and 6) Research and innovation.

Skåne is also part of the STRING network, a political cross-border partnership⁶² including Skåne, Sjaelland, Copenhagen and the capital region (all part of the SBA) as well as Schleswig Holstein and Hamburg. The strategy developed within this cluster is aimed at developing business models within five themes: 1) Green mobility, 2) Sustainable cities, 3) Energy efficiency in buildings, 4) Renewable energy and 5) Resource efficiency and waste management. Several of these themes are tightly interlinked with the promotion of the bio-based economy, especially biofuel production.

5.1.1 Regional strengths and weaknesses

The economy in Skåne is already to a great extent based on bio-based raw materials. Skåne has good conditions both as a commodity producer, through processing and production of goods, and as a service provider. At present, 11.5% of net sales in the region's business sector are included in the bioeconomy⁶³. However, the proportion of bio-based products could increase significantly and include much of the production currently using fossil raw materials. There are plenty of examples of successful collaboration in Skåne, but also of the opposite. This is a challenge that it is important to face in the future.

⁶⁰ Region Skåne, 2016. Handlingsplan för en Skånsk bioekonomi 2030. Region Skåne, Malmö, Sweden.

⁶¹ Region Skåne, 2014. The open Skåne 2030 - Skåne's Regional Development Strategy. Region Skåne, Malmö, Sweden.

⁶² STRING, 2014. Green growth in STRING - Ambition, strategy and profile projects. STRING secretariat, Sorø, Denmark.

⁶³ Region Skåne & JTI. 2016. Handlingsplan för en Skånsk bioekonomi 2030. Region Skåne, Kristianstad, Sweden.

The population in Skåne is around 1,3 million inhabitants and the land area is around 11.302 km²⁶⁴. The number of farms was around 8.800 in Skåne in 2013⁶⁵. The farms are slightly larger in Skåne than the average for the country. With it's around 450.000 ha of arable land, Skåne has the highest proportion of arable land in Sweden (46% of the total land area)⁶⁶. There are also regions in Sweden with a proportion of arable land as low as 0,5% of the total land. The proportion of forest also shows major regional differences in Sweden with the proportion of forest of the total land area at 37% in the Skåne Region, and almost 90% in other regions. There are about 23 million hectares of productive forest land in total in Sweden, equivalent to 57% of the land area. The productive forest land in Skåne is around 393.000 hectares⁶⁷.

Skåne can be divided into three agricultural areas; the southern plains, the central districts and the woodlands. The crop distribution varies between the three different areas. The southern plains have more cereals, oil seed crops and sugar beets than the other areas. The central district also has large areas of cereals, but more area of pasture, potatoes and maize compared with the other areas. The woodlands have much smaller areas of cereals and sugar beet, but large areas of pasture.

The two crops that dominate cultivation in Skåne in terms of area are pasture (105.330 ha) and cereals (214.260 ha)⁶⁸. Winter rapeseed (47.590 ha) and sugar beet (28.680 ha) are relatively large crops. Examples of crops with slightly less hectares are green peas (6.950 ha), coppice (2.290 ha) and maize (6.200 ha). The crops that dominate in terms of hectares are also the crops that produce the greatest quantity of biomass in total; cereals (around 1.370.560 tons WW/year) and sugar beets (around 1.658.340 tons WW/year). Coniferous forest in the form of pine or fir forests dominate in all regions in Sweden except for Skåne and one other region. In Skåne there is also a large area of deciduous forest in addition to the coniferous forest.

A large quantity of residues and waste is produced every year in Skåne, around 7,7 million tons WW/year or 1,5 million tons DM/year⁶⁹. The cultivation of crops result in crop residues which, in many cases, are left in the field, around 2.640.000 tons WW are produced per year. The livestock in Skåne produce around 2.350.000 tons WW manure every year. In addition, waste from households, industries and water treatment plants (sewage sludge) are produced in large amounts every year.

The bioeconomy in Skåne is estimated at around 3.200 companies with combined net sales of about EUR 10,7 billion and about 33.000 employees⁷⁰. It is estimated to be about 11,5 percent of the region's total business turnover and 5,8 percent of the total number of employees.

The food business sector constitutes the largest segment of the bioeconomy in Skåne, in terms of both turnover and number of employees, Figure 1. Roughly half of the Swedish food industry and food production is in Skåne. A large part of Swedish food research and development is located in Skåne. The food industry is one of the most distinctive corporate clusters in Skåne, with several highly specialized industries in primary production, processing and packaging.

⁶⁴ Länsstyrelsen. 2017. www.lansstyrelsen.se

⁶⁵ Swedish Board of Agriculture. 2017. www.jordbruksverket.se

⁶⁶ Swedish Board of Agriculture. 2017. www.jordbruksverket.se

⁶⁷ Swedish Forest Agency and Official Statistics of Sweden. 2014. Skogsstatistisk årsbok 2014. Swedish Statistical Yearbook of Forestry. Skogsstyrelsen, Jönköping, Sweden.

⁶⁸ Swedish Board of Agriculture. 2017. www.jordbruksverket.se

⁶⁹ Willquist, K., Olsson, J., Ekman, A. & Lantz, M. 2014. Bioraffinaderi i Skåne, en pusselbit för hållbar regional utveckling. SP Rapport 2014:60. SP, Borås, Sweden.

⁷⁰ Region Skåne & JTI. 2016. Handlingsplan för en Skånsk bioekonomi 2030. Region Skåne, Kristianstad, Sweden.

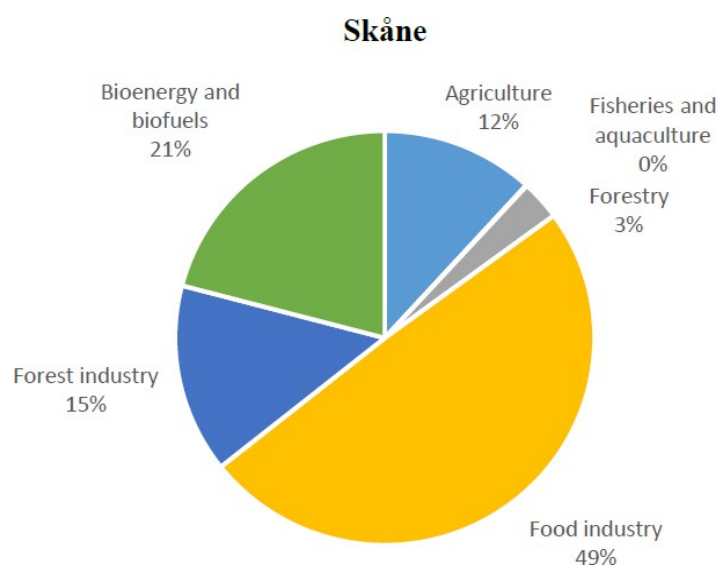


Figure 5.1. The composition of the bioeconomy in Skåne⁷¹

The greatest number of companies in the bioeconomy in Skåne is found in the agricultural industry with a turnover of between 10.000 and 20 million, or about 30 percent of all the enterprises in Skåne defined within the bioeconomy. Most of the bioeconomy businesses in Skåne have fewer than 10 employees, (2.668 companies, or about 83 percent). The companies that account for most net sales in the bioeconomy, however, are companies with 10-49, and 50-249 employees, accounting for about 34 percent and 30 percent of net sales respectively.

A mapping of enterprises in the bioeconomy has been done within the Vanguard initiative⁷². Here is a selection of businesses that are listed under a number of sectors, (it is not a complete inventory):

- **Agriculture** (Flour, specialty products, functional foods, starches): Finax, Oatly, Nordic Sugar, Lyckeby Stärkelsen, Kungsörnen, Lantmännen
- **Forestry**: Stora Enso, Södra Skogsägarna
- **Fats and Oils** (Animal feed, Stearates): Gelita, Ellco Food, AAK
- **Waste processing** (Biogas production, waste to energy): NSR, SYSAV, Norab, Kristianstad Renhållning
- **Biotechnology** (Enzymes, yeast, microorganisms): C5LT, Protista
- **Chemicals and Materials** (Plastic films, Starch derivatives, bioplastics): GAIA, Trioplast, Lyckeby Stärkelsen, Perstorp AB
- **Paper, pulp, packaging industry** (Pulp, paper, packaging): Stora Enso, TetraPak, Å&R Carton, Flextrus
- **Biofuels** (Biogas, Bio diesel, Methanol): NSR, C4Energi, Perstorp AB, Kristianstad renhållning, NSVA, Öresundskraft, E.ON. Purac, Malmbergs, Norup

⁷¹ Region Skåne & JTI. 2016. Handlingsplan för en Skånsk bioekonomi 2030. Region Skåne, Kristianstad, Sweden.

⁷² Vanguard Initiative. 2017. www.s3vanguardinitiative.eu/

5.1.2 Biomass potential in Region Skåne

Skåne is one of the regions in Sweden with a net surplus of straw⁷³. The net surplus of straw is estimated to be 308.100 tons in the report *Straw as fuel - Part 1: Available resources and harvest times* when the harvest index has been included and the utilization of straw for animal production as feed and litter has been removed, (Table 5.1.) No distinction was made in the study between the utilization of the different straw types.

The two dominating straw types in Skåne are winter wheat straw and spring barley straw, (Table 5.2). Large amounts of straw are also produced from winter rape. For most farmers, it is important to maintain the humus content in the soil. Removing large amounts of straw over a long period of time can have a negative impact on the soil organic content (SOC). The SOC is influenced by a range of factors; such as crop rotation, fertilizer intensity, the type of fertilizer that is used etc. In interviews with farmers in Skåne in 2006, the farmers raised the risk of reducing SOC when removing straw from the field. Given this risk, most of them only wanted to deliver straw from a quarter of the area⁷⁴.

Table 5.1. Estimated straw resources in Skåne (tons of straw with 18% water content (wet base))

Region	Area cereals and oilseed crops, hectares	Physical straw resources, tons	Straw resources according to the harvest index, tons	Utilization of straw for animal production, tons	Net surplus of straw, tons
Skåne	245.100	772.600	540.400	232.300	308.100

Table 5.2. Area of different cereal and oil seed crops in Skåne in hectares, average 2011-2015 (own calculations based on data from Jordbruksverket⁷⁵)

Region	Winter wheat	Spring wheat	Rye	Winter barley	Spring barley	Oat	Rye wheat	Winter rape
	hectares							
Skåne	96.061	7.565	12.598	4.594	77.797	9.087	5.056	42.75

The food industry in Skåne generates in total around 753.900 tons of waste or by-products per year according to the report *Bioraffinaderi Öresund potentialstudie för produktion av kemikalier och bränsle*⁷⁶, (Table 5.3).

The amount of food waste in Skåne derives from supermarkets, restaurants, large kitchens and households, (Table 5.4). The amount of food waste increases the further up in the processing chain we come; a large amount originates from the households.

⁷³ Bernesson, S. & Nilsson, D. 2009. *Straw as fuel - Part 1: Available resources and harvest times*. Report 001, Department of Energy and Technology, SLU, Uppsala, Sweden.

⁷⁴ Kjell, O. 2006. *Kartläggning av tillgängliga mängder stråbränslen runt Örtofta*. Examensarbete inom Lantmästarprogrammet, SLU, Alnarp, Sweden.

⁷⁵ Jordbruksverket. 2017. www.jordbruksverket.se

⁷⁶ Engdahl, K., Tufvesson, L. & Tufvesson, P. 2011. *Bioraffinaderi Öresund potentialstudie för produktion av kemikalier och bränsle*. Institutionen för teknik och samhälle, avdelningen för miljö- och energisystemanalys, Lunds Tekniska Högskola, Lund, Sweden.

Table 5.3. Waste from the food industry in Skåne⁷⁷

Type of food industry	Amount of waste, tons WW	Type of waste	Companies
Bakery/mills	11.000	Discarded bread, returned bread, discarded yeast, cereal husks, flour, feed residues, chaff	Pågen, Lantmännen, Farina
Fruit and vegetable preparations	43.000	Shell, starch, potato residues, vegetable and fruit residues, biosludge, grease separator sludge, cooking oil, yeast residues, dregs, oil, sugar	Solanum Odlarna i Kävlinge, 3N Produkter, Magnihill, Musteriet i Kivik, Procordia Food, Mariannes Farm
Dairies	74.000	Whey, waste milk, grease separator sludge, fatty acids	Skånemejerier, Unilever Produktion, Belico Food, Lunnarps mejeri
Slaughterhouses	45.000	Sludge, residual blood, gastric and intestinal content, intestinal package, discarded products and raw material, fat from fat separator	Team Ugglarp, Ellco Food, HKScan, KLS Ugglarps,
Fishing industry	5.900	Fish offal, fatty sludge	Skillinge-Fisk Impex, Simrishamns Fryshus
Consumption liquor	345.000	Draft	Absolut
Starch industry	230.000	Juice, feed protein, pulp, waste from processing	Lyckeby, Stadex
Total	753.900		

There are two sawmills in Skåne in Hästveda and Widtsköfle. Together they produce around 175.000-225.000 m³ sawn products, the same amount of residues are produced in each. The residues are now largely utilized⁷⁸. The residues consist of sawdust, shavings, dry chips and bark (grated and non-grated).

⁷⁷ Engdahl, K., Tufvesson, L. & Tufvesson, P. 2011. Bioraffinaderi Öresund potentialstudie för produktion av kemikalier och bränsle. Institutionen för teknik och samhälle, avdelningen för miljö- och energisystemanalys, Lunds Tekniska Högskola, Lund, Sweden.

⁷⁸ Skogsindustrierna. 2017. www.skogsindustrierna.se

The harvested area with tops and branches was 4.949 hectares and 47 hectares with stumps in Skåne in 2013⁷⁹. The amount of tops and branches was 675.000 m³ (external volume of material, including air) in final felling and 311.000 m³ in thinning in an average for the three years 2011-2013.

There are two paper mills in Skåne in Nymölla and Klippan. Nymölla has a production capacity of 400.000-499.000 tons of paper and 300.000-399.000 tons of pulp⁸⁰. Klippan has a production capacity of 100.000 tons of soft paper. The residual streams will be investigated further.

Table 5.4. Food waste in Skåne from different sources⁸¹

Waste source	Food waste per person in Sweden, kg/person	Total food waste in Skåne, tons
Supermarket	7	9.380
Restaurants	15	20.100
Large kitchens	6	8.040
Households	81	160.000
Total	109	146.060

In Skåne there is one sugar refinery that is running all year round in Arlööv, owned by Nordic Sugar, and one sugar factory in Örtofta, also owned by Nordic Sugar, that only runs for part of the year, during the production season from mid-September to mid-January. The co-products produced at Nordic Sugar in Skåne are all utilized today, but it is possible to utilize the co-products in a different way and increase the value. Around 74.000 tons molassed sugar beet pellets are produced annually at Nordic Sugars in Skåne, which consists of approx. 90% dried beet fibers and about 10% molasses, (Table 5.5)⁸². It can be stored for a long time without changing its nutritional content. Molassed sugar beet pellets are used as feed material in the feed industry. It can also be used as a silage agent. Around 69.000 tons of HP Pulp are also produced every year at Nordic Sugar in Skåne and it is primarily used as feed for ruminants and is an excellent complement to home-grown silage and grain. HP Pulp must be ensiled before use.

Molasses, another co-product from Nordic Sugar in Skåne, is used as feed. It is also a good binder for pelleting and also binds dust. Molasses is also used as a silage agent and as a substrate in biotechnological production.

The residues in fields from sugar production consist of sugar beet tops. The average yield for sugar beet tops in Sweden is around 2,5 tons of dry matter per hectare⁸³. Today the majority of the sugar beet tops are left in the field and are ploughed into the soil. If all sugar beet tops in Sweden were harvested, around 80.000 tons of dry matter beet tops would theoretically be generated. Different harvesting and transport chains for sugar beets and beet tops were evaluated theoretically in a study by Kreuger et al. (2014)⁸⁴. In the most economically feasible harvest chain only 55% of the available beet tops were

⁷⁹ Swedish Forest Agency. 2014. Skogsstatistisk Årsbok 2014. Swedish Statistical Yearbook of Forestry. Skogsstyrelsen, Jönköping, Sweden.

⁸⁰ Skogsindustrierna. 2017. www.skogsindustrierna.se

⁸¹ Swedish Environmental Protection Agency. 2012. Matavfallsmängder i Sverige. Naturvårdsverket, Stockholm, Sweden.

⁸² Nordic Sugar. 2017. www.nordicsugar.se

⁸³ Swedish Board of Agriculture. 2017. www.jordbruksverket.se

⁸⁴ Kreuger E., T. Prade, L. Björnsson, M. Lantz, I. Bohn, S.E. Svensson, A. Lindkvist & T. Hörndahl, 2014. Biogas från Skånsk betblast - potential, teknik och ekonomi. Miljö- och energisystem, LTH, Lund University.

harvested to minimize machine waiting times; this would generate around 44.000 tons of dry matter beet tops.

An in-between crop is defined as a crop that grows between two main crops. The crop is grown, similar to a conventional catch crop, when the field is normally not cultivated. It captures the nitrogen that the previous crop left in the soil, thus reducing the nutrient leakage from the farm. With a crop yield of 3,5 tons of dry matter per hectare per year for in-between crops, and the assumption that intermediate crops could be integrated into the crop succession of a quarter of the arable land in Skåne, almost 400.000 tons of dry matter medium crops could potentially be produced peryear⁸⁵. In a normal year, farmers produce more silage bales than they utilize as feed for the animals in the winter. Bad conditions and deficiencies in the storage system can result in discarded silage. If 1% of the silage round bales in Skåne were left over or discarded, silage bales would result in 2.421 tons of DM/year. The corresponding number for 5% left-over or discarded silage bales is 12.106 tons DM/year and for 10% 24.213 tons DM/year (own calculations based on Jordbruksverket⁸⁶).

Table 5.5. Co-products from Arlöv and Örtofta

Products from Arlöv and Örtofta	Produced amount, tons/year
Molassed sugar beet pellets (Betfor®)	74.000
HP-Pulp (HP-Massa®)	69.000
Molasses	58.250

5.1.3 Bioeconomy opportunities in Region Skåne

Agriculture and food production are strong sectors in Skåne today. They constitute a large part of the bioeconomy today and will continue to be strong sectors in the bioeconomy in the future. There is great expertise and strong companies in plant production in Skåne which provide great opportunities in the bioeconomy.

There are always opportunities for new business in the whole food system, for example, side streams from the food industry can be used to produce new biocommodities for the chemical industry or utilized in energy production. In Skåne there is also great technical know-how in many industries that are closely linked, such as agriculture/food/packaging/energy. Within the packaging industry it is possible to develop biodegradable biomaterial with locally produced raw materials; this would be best implemented in close cooperation with other stakeholders.

Another opportunity in Skåne is that there is both forestry, aquaculture and agriculture within the region. The fertile arable land in Skåne has the highest yields in Sweden and among the best in Europe, and the same applies to forestry, which is the most productive in Sweden. Much experience shows that greater interaction between actors and stakeholders is essential for developing the potential of the bioeconomy.

There are also strong chemical companies in Skåne. The chemical industry will also play a key role in many of the new value networks in the bioeconomy, as it manufactures intermediates and chemicals that are used in many different industries and with high value added. The chemical industry has the necessary knowledge and infrastructure and is already operational to some extent.

⁸⁵ KFSK. 2017. www.kfsk.se

⁸⁶ Swedish Board of Agriculture. 2017. www.jordbruksverket.se

It is expected to have great potential to grow, using more bio-based inputs. There are major innovation opportunities for new materials and chemicals and for their circulation.

An important aspect that can affect the development of the bioeconomy and its potential is changing the use of existing raw materials. Better utilization of the residues and refining of biomass can be obtained by using existing innovations and technologies. An example of how this can happen is via more decentralized bioeconomic solutions. By creating energy and material efficiency, the bioeconomy can promote regional energy and nutrition self-sufficiency. The transition to a sustainable bioeconomy is a complex and dynamic process. A future bioeconomy with growing demands on biomass may also generate severely negative impacts on the environment, as well as the socio-economic system, if it fails to ensure sustainable production. We need system-wide thinking and a broad stakeholder interest in Skåne.

5.2 Region Zealand

At the national level in Denmark, there is no dedicated bioeconomy strategy in Region Zealand, but bioeconomy is being pursued through the *Regional Growth and Development Strategy 2015-2018*, developed by Regional Council and Growth Forum Zealand. The strategy focuses on 4 themes, one of which is business development including four sectors: food production, building and construction, logistics and transport, and bioeconomy⁸⁷.

The regional strategy emphasises that cooperation between enterprises and knowledge institutions should be enhanced to support the bioeconomy sector. Also, a focus on establishing wider knowledge of market opportunities for unutilized types of biomass that can be used for sustainable production of high value products e.g. medical products, food ingredients, power and heat - where it is profitable.

The implementation of the strategy is supported by Growth Forum Zealand that is responsible for the implementation of the Danish ERDF program in Region Zealand. The Danish Ministry of Business in 2014 made an agreement with Growth Forum Zealand focusing on 5 smart specialization areas⁸⁸.

Regional Growth partnership: Agreement between Growth Forum Zealand and the Government.	<ul style="list-style-type: none">• Strengthen Denmark as a country for production• Strengthen cooperation on improvement of broadband and mobile connection.• Enhance resource efficiency and bio-based solutions in industrial production• Enhance growth potentials in the Fernern Belt area• Enhance workforce qualifications
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Growth Forum Zealand and Region Zealand have made 3 calls for projects focusing on the development of the regional bioeconomy focusing on development of the straw market, bioeconomy and innovation⁸⁹. Also, the region has supported efforts to strength collaboration and knowledge-sharing with neighboring regions in the field of bioeconomy by supporting organizations wanting to take part in Interreg programmes.

⁸⁷ Den Regional Vækst- og udviklingsstrategi 2015-2018, Vækstforum Sjælland

⁸⁸ Aftale om vækstpartnerskab mellem Vækst Forum Sjælland og Regeringen, 2014

⁸⁹ <https://www.regionsjaelland.dk/vus/Annonceringer/Sider/default.aspx>

Several municipalities have been engaged in the development of a bioeconomy, e.g. Odsherred Municipality has been engaged in several regional projects encompassing bioeconomy topics, including supporting efforts to implement a biogas plant utilizing local residues and supporting resource efficiency in SMEs. Solrød Municipality has played a key role in establishing Solrød Biogas, that utilizes biomass residues from the company CP Kelco as feedstock, together with seaweed from local beaches. Guldborgsund Municipality has also taken part in several Interreg projects and national programmes focusing on use of residues in the production of high-value products and has hosted a national conference on bioeconomy, establishing the Bioeconomy Growth Center⁹⁰.

5.2.1 Regional strengths and weaknesses

Region Zealand already has a number of leading enterprises working with bio-based production producing medicines, enzymes, food, feed and bioenergy. Region Zealand is the region in Denmark with the highest production of crop farming and has substantial potential related to unutilized biomass in and along the agri-industrial value chains⁹¹.



Figure 5.2 Region Zealand

Region Zealand is one of five Danish regions and is located in the eastern part of Denmark, consisting of 17 municipalities. The population is approximately 830.000 inhabitants and the region covers a land area of 722.400 ha⁹². The number of farms is approximately 5.671 and the area with arable land is 468.638 ha accounting for approximately 18 percent of the arable land area in Denmark.

⁹⁰ <http://www.bioguldborgsund.dk/>

⁹¹ Den Regional Vækst- og udviklingsstrategi 2015-2018, Vækstforum Sjælland

⁹² Danmark statistik bank: AREALDK1 (2017)

The crops dominating cultivation are wheat and barley with approximately 60 percent of arable land in Region Zealand. Other widely cultivated crops are rapeseed (8%), industrial seeds (8%) and sugar beet (7%)⁹³.

The number of organic farmers is 446 and they account for about 19.296 ha, increasing by approximately 7.000 ha in total over the last 10 years⁹⁴. The arable land accounts for 65,8 percent of the total land area in the region. This is a bit higher than the total arable land use in the rest of Denmark which accounts for 61,1 percent^{95, 96}. the highest arable land use of all countries in Europe⁹⁷.

Table 5.6. Cultivated area in Region Zealand

	Total cultivated area (ha)
Wheat	138.689
Rye	9.940
Barley	127.220
Oats	3.217
Triticale and other grain to maturity	2.118
Legumes seed to maturity	2.940
Potatoes	2.159
Sugar beets	33.619
Feed beets	117
Rapeseed	46.555
Seed	35.875
Grass and green feed in rotation	24.358
Vegetables and horticulture	5.916
Grass production out of rotation	26.481
Christmas tree production	2.898
Fallow area with grass	1.737
Other crops	802
Without crops	7.054
Total cultivated area	468.638

⁹³ Danmark statistik bank: AFG07 (2016)

⁹⁴ Statistik over økologiske jordbrugsbedrifter 2016 Autorisation & produktion, 2017, Miljø- og Fødevareministeriet

⁹⁵ Danmark statistik bank: AREALDK1 (2016)

⁹⁶ Danmark statistik bank: BDF11 (2016)

⁹⁷ <https://www.indexmundi.com/facts/indicators/AG.LND.ARBL.ZS/map/europe>

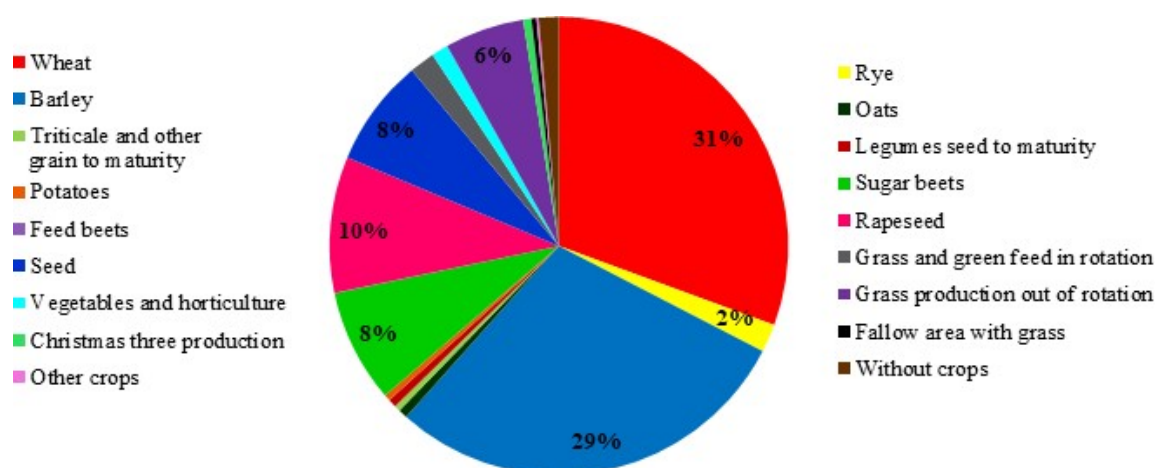


Figure 5.3 Total cultivated area in hectares in Region Zealand

The amount of forest in Region Zealand is 99.709 ha with beech, oak and spruce being the dominant tree species, accounting for approximately 50 percent of the forest area. Forest covers 13 percent of the total land area in the region coming close to the national average of 14,5 percent (624.782 ha)⁹⁸.⁹⁹ Even though this is far less than in surrounding countries like Sweden, Germany and Poland, the forest area is well distributed across the landscape with many small forests¹⁰⁰.

Table 5.7. Amount of forest area of Region Zealand

	Total area (ha)
Broad leaved trees	70.451
Beech	27.290
Oak	13.365
Ash	4.416
Honor	9.333
Birch	4.840
Hard wood other	11.208
Coniferous trees	24.388
Norway spruce	10.366
Plug Gran	1.937
Fir Species	1.018
Forty Species	1.446
Nordmann fir	5.103
Nobilis	1.155
Softwood other	3.362
Total forest area	99.709
Supporting areas	1.423
Forest vegetated	98.287
Temporally unvegetated forest area	2.588

⁹⁸ Danmark statistik bank: SKOV11 (2015)

⁹⁹ Skove og plantager 2015, KU

¹⁰⁰ Træer og buske i landskabet, 2007 Danmarks Naturfredningsforening,

Each year a large amount of organic residue and waste is produced from agri-food industries in Region Zealand, but so far there is no regional data on the total amount. The Danish Environmental Agency published a report in 2014, estimating the total of organic waste from industries in Denmark to be 5.917.090¹⁰¹ tons, with 3.514.250 tons (54%) used for raw material substitution (mostly feed), 286.842 tons WW (2%) used for biogas production, 2.010.000 tons (44%) used for soil improvement, while 27.092 tons is incinerated, 7.304 tons landfilled and 15.000 tons exported.

No regional accounts exist for the service sector, but it has been estimated that the national potential is 206.481 tons, out of which 164.686 tons is incinerated¹⁰². The leading enterprises within the bioeconomy in Region Zealand are currently found within the pharma- and agri-food sector¹⁰³.

The pharma biorefining sector today employs 3.687 people in the region. The pharma sector cluster is a highly specialised production cluster requiring highly skilled labour and is part of a bigger pharma-medico cluster centered around Copenhagen City. The agri-industrial sector in Region Zealand comprises many small and medium sized enterprises and plays an important role in the regional economy. The sector has around 10.460 employees in the agricultural sector and 6.204 employees in the food, ingredients and beverage production industry.

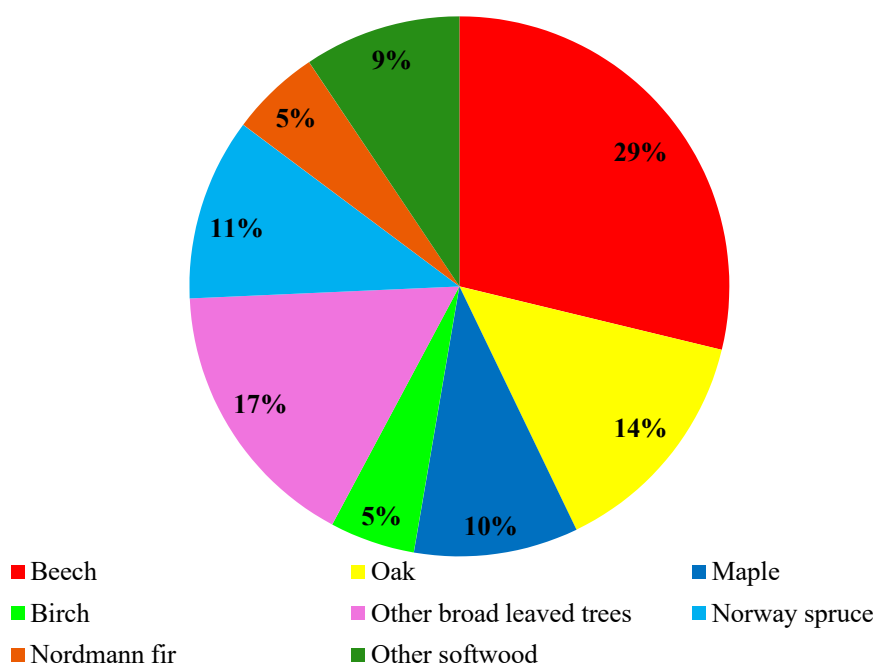


Figure 5.4 Dominant wood species in Region Zealand

¹⁰¹ wet weight (WW)

¹⁰² Organiske restprodukter - vurdering af potentiale og behandlet mængde, 2014, Miljøstyrelsen

¹⁰³ Erhverv, vækst og beskæftigelse i Region Sjælland, Vækstforum, 2014

¹⁰⁴ Bioeconomy development in EU regions, 2017, DG Research & Innovation, European Commission

¹⁰⁵ Innovating for Sustainable Growth: A Bioeconomy for Europe, 2012, COM

	EU Biobased economy ¹⁰⁴	EU Bioeconomy ¹⁰⁵
Agricultural sector		10.460
Food and beverage industry		6.204
Textile and leather industry	220	220
Paper industry	1.462	1.462
Plastic industry	2.711	2.711
Chemical industry	1.596	1.596
Pharma industry	3.687	3.687
Furniture industry	3.286	3.286
Bioenergy	280	280
Total	13.226	29.890

Table 5.8. Employment in regional bioeconomy sector

The number of employees in the regional bioeconomy varies depending on which sectors are included. In the biobased economy we estimate 13.226 employees and in the bioeconomy sector, including the agriculture and food industry, 29.890 employees¹⁰⁶. Only a few enterprises can be categorised as part of the “*advanced bioeconomy*” based on their production of sustainable uses of biomass. The overall objective of reducing climate effect and use of fossil-based materials, and the number of employees is therefore unknown.

A mapping of leading bioeconomy enterprises in the region, in different sectors, has been accomplished. The list is not complete but should give an overview of the different types of enterprise that can be found within the bioeconomy area in the region and their number of employees.

Table 5.9. Leading enterprises in the bio-based value chains in Region Zealand

Company	Sector	Production type	Employees
CP Kelco	Ingredients industry	Pectin	377
Danish Crown	Meat industry	Meat products	1.000
Arla Food A/S	Dairy industry	Dairy products	480
Haribo Lakrids	Sweet industry	Candy	475
Stryhns A/S	Meat industry	Pâté production	349
Bisca A/S	Bakery industry	Cookies	263
Harboe Bryggeri A/S	Brewery	Beer and soda	192
Royal Unibrew	Brewery	Beer and soda	876
Danish Malting industry	Malt industry	Malt for beer production	49
Nordic Sugar	Sugar Industry	Sugar and feed	99
Novo Nordisk	Pharma industry	Medicine	2.250
Lundbeck Pharma	Pharma industry	Medicine	250
DAKA	Bioenergy	Biofuel and biofertilisers	49
F. Junckers Industries	Wood manufacturing	Flooring	308

¹⁰⁶ Danmark statistik bank: RAS301 (2015)

5.2.2 Biomass potentials in Region Zealand

A large quantity of unutilised biological resources is located in Region Zealand. Mapping the availability of selected local resources is the first step in supporting the development of the regional bioeconomy, and innovation efforts in SMEs.

The amount of straw produced each year varies from year to year, depending on the weather and other variables. In 2014, 1,426 million tons was produced while only 1,174 million tons was produced in 2011.

The main utilization of straw produced in Region Zealand is for bioenergy in central straw-fired CHP plants, within the region itself and in the neighbouring Capital Region. The utilization of straw for energy production has been quite stable over the last eight years but has been declining since Amagerværket, one of the two-straw fired CHP plants, changed to wood pellets due to better economy and more stable distribution

Table 5.10. Straw utilization in Region Zealand

Straw utilization in 1.000 tons WW ¹⁰⁷							
	2010	2011	2012	2013	2014	2015	2016
Total amount of straw	1.210	1.174	1.346	1.355	1.426	1.319	1.157
For energy production	476	414	364	423	348	346	367
Feed	106	93	116	92	87	97	61
Bedding	60	77	76	83	63	49	68
Not utilised	568	590	790	757	914	827	649

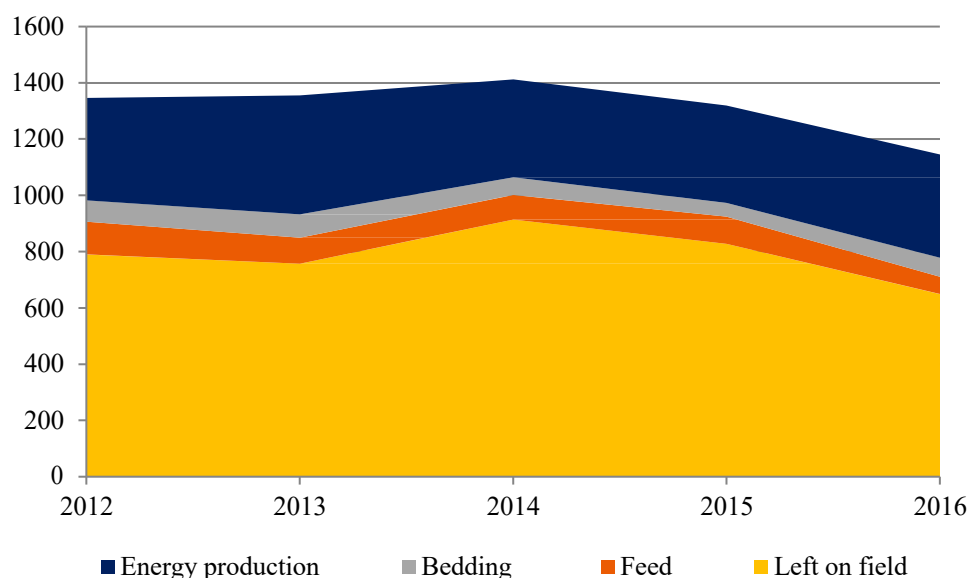


Figure 5.5 Straw utilization in Region Zealand

¹⁰⁷ Grønne regnskaber 2009-2015, Miljøstyrelsen

Nordic Sugar has two sugar factories in Region Zealand, one in Nakskov and the other in Nykøbing. The two factories combined produce around utilise 2.637.369 tons WW of sugar beet to produce 450.000 tons of sugar annually. One tone of beet (DM) amounts to 380 kg of sugar, 100 kg of molasses, 70 kg of animal feed and 80 kg of beet pulp¹⁰⁸.

Around 99.709 ha in the region is covered with forests, with a larger proportion in the southern part of the region. The yearly gross increment is around 1.792.000 m³ and the net increment 1.066.000 m³ of non-harvest wood, accounting for around 35% of the total Danish net increment. The harvested wood is utilized for energy, either energy production or timber in the wood manufacturing industry.

F. Junckers Industries is the only company with a substantial amount of the wood residuals. The company produces 10.626 tons of wood flooring, resulting in 55.519 tons of sawdust and wood cutting that is today utilized for energy production at Køge Kraftvarmeværk.

Table 5.11. Residues from sugar production process

	Nakskov, tons WW	tons DM	Nykøbing, tons WW	tons DM
Sugar beets	1.466.705		1.352.361	
Soil	89.749		91.948	
Net sugar beets	1.376.956	316.700	1.260.413	289.895
Sugar	239.727	119.864	214.024	107.012
Molasses free			30.408	22.806
Molasses	43.013	32.260		
Feed pellets	64.138	21.807		
Pulp	106.308	26.577		
Feed products (18% melasse)			128.847	43.808
Other products *	42.754	28.503	53.912	26.956
Other				
Biogas (metan, 1.000 Nm ³)	1.383	692	Biogas (metan, tons)	1.561
Other products, losses waste, sewage (kg)	923.078	86.998		87.752

¹⁰⁸ Energiproducenttælling 2009-2015, Energistyrelsen

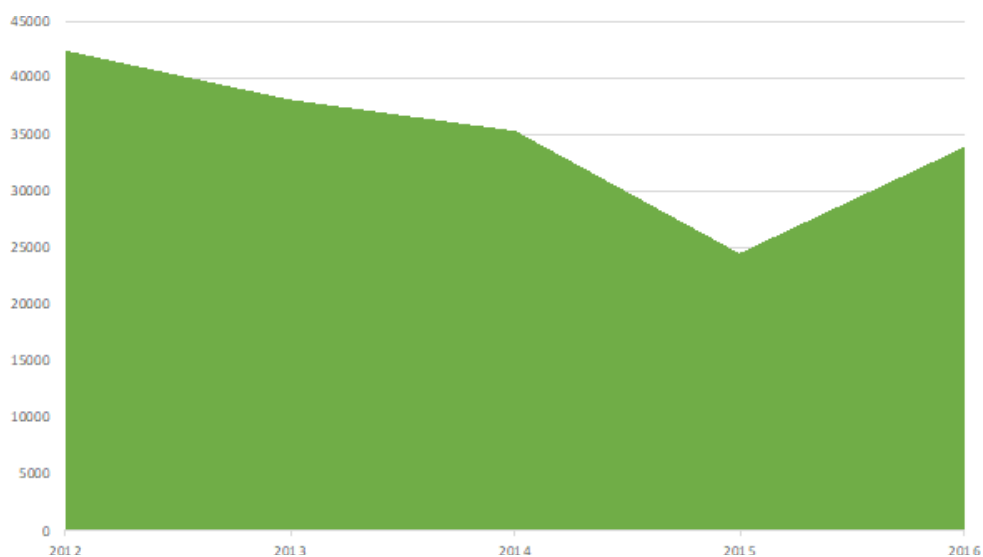


Figure 5.6 Cultivation of sugar beets in Region Zealand (ha)

There is no complete set of data about side streams from the food processing industry in Region Zealand. Therefore the list below is incomplete and should be seen as a minimum. Also, besides the biomass potential found here, there is also a substantial amount of organic waste from the service sector and households¹⁰⁹.

Table 5.12. Residues from forestry and wood¹¹⁰

	Denmark	Region Zealand
1.000 m³	Annual increment and removals m³/year and m³/ha/year	
Net increment	3.057	1.066
	2,5	4,5
Total removals	4.274	726
	7,3	8,3
Harvested wood	4.274	566
	5,4	6,4

¹⁰⁹ Estimated to around 78.339 tons, Based on Affaldplus data.

¹¹⁰ Skove og plantager 2015, KU

Use of harvested wood ¹¹¹		
Timber	1.637	305,9
Firewood	380	88,0
Wood chips	1.576,6	133,5
Wood logs for energy use	321,6	44,8
Windthrow	76	7
	0,1	0,1
Dead	443	85
	0,8	1,0
Missing	585	68
	1,0	0,8
Gross increment	7.331	1.793
	9,7	12,2

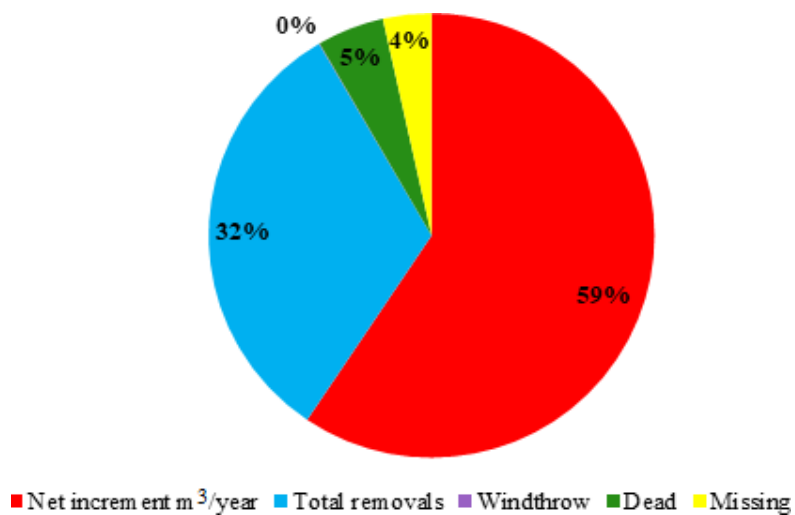


Figure 5.7 Forest utilization in Region Zealand

¹¹¹ Danmark statistik bank: Skov55 (2015)

Table 5.13. Food processing waste

Food processing residues^{112, 113}			
Type of food industry	Amounts of side streams, tons WW	Type	Firm/plant
Dairies	12.000	Whey, waste milk, grease separator sludge, fatty acids	Arla foods, Slagelse Kommune
Slaughterhouses and meat product preparation	40.000	Sludge, residual blood, gastric and intestinal content, intestinal package, discarded products and raw material, fat from fat separator	Danish Crown A, Ringsted Kommune Stryhns A/S, Roskilde Kommune (Unknown)
Brewery and malting industry	58.000	Corn and malt residues, green malt sprouts, mach and yeast	Harboes, Slagelse Kommune Royal Unibrew, Faxe Kommune Danish Malting Group, Vordingborg Kommune Køge Bryggeri ApS, Køge Kommune (Unknown) Stevns Bryghus, Stevns Kommune (Unknown)
Ingredients production	116.000	Pectin	CP Kelco, Køge Kommune
Fruit and vegetable preparations	1.200	Shell, starch, potato residues, vegetable and fruit residues, biosludge, grease separator sludge, cooking oil, yeast residues, dregs, oil, sugar	Ardo, Guldborgsund Kommune Oscar A/S (Unknown)
Bakery/mills	Unknown	Discarded bread, sent back bread, discarded yeast, cereal husks, flour, feed residues, chaff	Bisca, Vordingborg Kommune Crispy food int., Kalundborg Kommune Nakskov Mill Foods, Lolland Kommune Valsemøllen, Køge Kommune Coronet Cake Company, Ringsted Kommune
Sweet production	Unknown	Food waste	Harribo Lakrids, Faxe Kommune L.M. Frellsen K/S, Roskilde Kommune Orkla foods, Holbæk Kommune
Sugar production	439.000	HP-Pulp, sugar beat pellets, molasses, green and beat tops	Nordic Sugar; Guldborgsund Kommune Nordic Sugar; Lolland Kommune
Total in tons	665.000		

There are three main utilities handling the treatment of organic household waste from municipalities in Region Zealand. Based on one study on the average amount collected from apartment buildings and houses combined with studies of the amount of waste, it has been estimated that there is a collection potential of approximately 51.820 tons in the region.

¹¹² Grønne regnskaber, 2013, Miljøstyrelsen

¹¹³ Bioraffinaderi Öresund - potentialstudie för produktion av kemikalier och bränsle, Lunds tekniska Högskola og DTU

Table 5.14. Collection potential of organic household waste

Organic household waste ¹¹⁴	Population	Households	Total potential in tons WW	Collection potential in tons WW
ARGO municipalities				
Greve	49.518	20.660	4.382	2.893
Holbæk	69.972	30.710	6.491	4.276
Kalundborg	48.660	21.886	4.814	3.251
Køge	59.868	25.555	5.339	3.490
Lejre	27.317	10.277	2.376	1.653
Odsherred	32.816	14.263	3.194	2.180
Roskilde	86.207	38.503	7.733	4.922
Solrød	21.788	8.915	1.911	1.270
Stevns	22.260	9.263	2.115	1.460
Total for ARGO	418.406	180.032	38.355	25.395
Affaldplus municipalities				
Faxe	35.614	15.758	3.504	2.382
Næstved	82.342	37.953	8.037	5.301
Ringsted	34.031	14.964	3.059	1.970
Slagelse	78.140	36.727	7.456	4.781
Sorø	29.543	13.103	2.893	1.959
Vordingborg	45.806	21.875	4.694	3.122
Total for A+	305.476	140.380	29.643	19.515
REFA municipalities				
Guldborgsund	60.979	29.739	6.416	4.282
Lolland	42.638	18.094	3.925	2.628
Total for REFA	103.617	47.833	10.341	6.910
Total Region Zealand	827.499	368.245	78.339	51.820

The 2016 the pig production in Region Zealand consisted of around 1.265.279 livestock accounting for approximately 10 percent of the total Danish pig production while the dairy production consisted of around 81.614 livestock amounting to approximately 5 percent of total Danish dairy production¹¹⁵.

¹¹⁴ Kildesorteret husholdningsaffald på biogasanlæg, 2017, RUC based on data from Danish Environmental Agency

¹¹⁵ Danmark statistik bank: KOMB07 (2016)

Even though livestock production in Region Zealand is relatively small compared to other regions Denmark, there is still a substantial amount of manure that could be utilized in the production of biogas. The total amount of manure in Region Zealand is 3.318.827 WW tons. If selecting only farmers with over 3.000 tons per year the amount is 2.195.850 tons WW – the typical minimum size for farmers taking part in central biogas plants.

Table 5.16. Manure from livestock production^{116, 117}.

	Cattle manure in tons WW	Pig manure in tons WW	Total amount in tons WW
Faxe	25.646	75.360	101.006
Greve	899	3.906	4.805
Guldborgsund	126.950	413.595	540.545
Holbæk	114.726	413.595	407.046
Kalundborg	112.289	310.833	423.122
Køge	10.013	40.054	53.621
Lejre	15.564	30.078	70.756
Lolland	37.245	292.500	329.745
Næstved	105.951	187.489	294.440
Odsherred	66.346	50.509	116.854
Ringsted	43.496	97.656	141.152
Roskilde	8.412	33.719	42.131
Slagelse	68.504	135.889	204.393
Solrød	1.352	3.720	5.072
Sorø	50.454	98.453	148.907
Stevns	29.547	92.290	121.837
Vordingborg	150.384	132.933	283.317
Total Region Zealand	986.845	2.331.981	3.318.827

5.2.3 Bioeconomy opportunities in Region Zealand

The pharma and agri-food industry are the leading sectors within the bioeconomy in Region Zealand today, but many SMEs are not lacking innovation capacity to seize new business opportunities. The primary opportunity for development of a sustainable bioeconomy and new business opportunities in Region Zealand is found in relation to valorization of side streams from the forest and agri-food value-chains, while replacing fossil-based energy or materials.

For example sawdust, straw or other residues as a filling material in the production of biocomposites. The region has approximately 70 SMEs in the plastics industry with 2.700 employees. The plastics industry today mainly bases its production on fossil-based (petrochemical) materials. The substitution of these fossil-based materials is a big challenge, but they encompass a unique opportunity

for the production of bio-based products and building knowledge of innovative production systems for a new market.

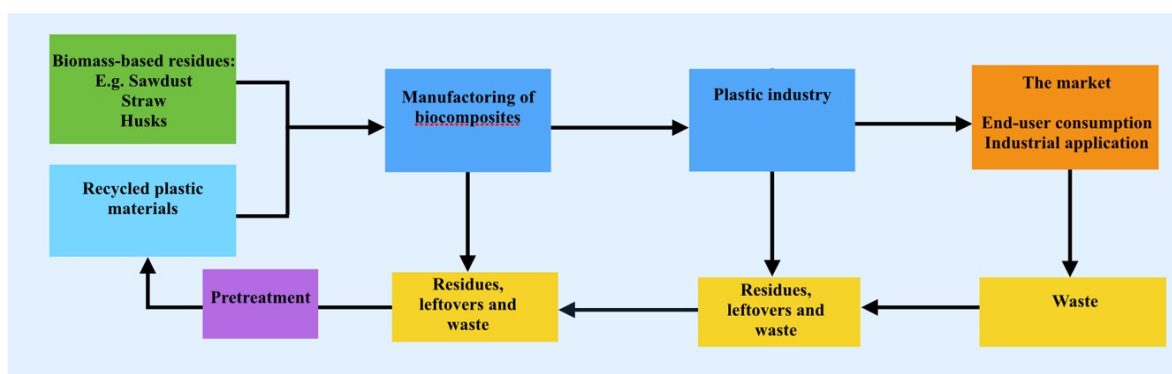


Figure 5.8 Production of bio-based products

The market for biocomposites has been increasing in recent years in the EU and worldwide, and could offer interesting possibilities both when it comes to the compounding of biocomposite pellets that could e.g. be used in the production of bio-based products such as drains, gutters, pipes, decking, cladding, floors, and auto-components in the regional plastic production enterprises. They could also be exported to other regions.

Another promising business opportunity within the bioeconomy in Region Zealand could be the production of bioplastics from sugar production residues. In recent year there has been an increasing demand for bioplastic from the food and beverages industry. This increase is expected to continue in the coming years and production of bioplastics could therefore maybe be an interesting possibility for SMEs in the region.

Finally, a large amount of utilized manure and unutilized crop residues (e.g. straw, beet tops, spent grain, green biomass) and also other types of agri-food waste that could be utilized for the production of biogas. Pre-treatment technologies for organic agri-food waste and crop residue are already being demonstrated on a small scale, but there is a need for large scale implementation. Also, biogas plants provide a unique opportunity for the production of designer fertiliser products, which would be especially interesting for organic farmers who are currently lacking nutrients.

¹¹⁶ Behov for energiafgrøder I regionen, 2013, RUC

¹¹⁷ Udviklingen i den primære svineproduktion og i slagteriindustrien, 2012, Fødevarøkonomisk Institut

5.3 West Pomeranian, Pomeranian and Warmia and Mazury regions

As mentioned earlier, implementation of Strategy for Innovation and Efficiency of the Economy (SIEE) in the Polish South Baltic Area is based on individual, regional strategies. All three Baltic neighbouring regions have developed their own regional strategies and fortunately they focus on similar issues such as^{118 119 120}:

- higher energy efficiency, especially in electricity production and energy transmission, together with rationalization of its use;
- high level of use of renewable energy resources, mainly in the distributed generation system;
- lower costs of using energy;
- better air quality;
- innovative solutions implemented in power engineering, including smart grids;
- high public awareness of the need to rationalize energy consumption and the impact of energy on the quality of the environment and living conditions, as well as common consumer attitude.

The primary focus of the ESES and NDS is on energy resources and water, and for ESES there is also a focus on timber. All strategies focus on the increase in three areas: competitive and innovative economy, effective and robust state, and demonstration of the differences in development of the provinces.

The main objective of the medium-term strategy is to strengthen and make use of the economic, social and institutional capabilities in order to ensure rapid and sustainable development of the country, and to improve quality of life¹²¹.

5.3.1 Regional strengths and weaknesses

Poland is divided into 16 regions, called voivodeships (provinces). Three of them are in the South Baltic Area, i.e. West Pomerania, Pomerania and Warmia and Mazury Regions.

According to the data provided by EUROSTAT, bioeconomy is already one of the largest and most important components of the Polish economy. Gross value added in bioeconomy sectors in the years 2009-2013 had an annual average of about € 63,5 billion, representing more than 19% of gross value added produced in the national economy. The bioeconomy sector in Poland employs more than 4,7 million people, representing more than 30% of employees in the whole economy.

Biomass production sectors (agriculture, forestry and fisheries) and the sectors entirely based on raw materials of biological origin (food industry, production of beverage, tobacco industry, wood and paper industry) are also very important segments of the Polish economy. Their share in the gross value added of the Polish economy in the years 2009-2013 was about 7,5%, while in terms

¹¹⁸ Strategia rozwoju Województwa Pomorskiego do roku 2020 (Strategy for development of Pomeranian Region by 2020)

¹¹⁹ Strategia rozwoju Województwa Zachodniopomorskiego do roku 2020 (Strategy for development of West-Pomeranian Region by 2020)

¹²⁰ Strategia rozwoju społeczno-gospodarczego Województwa Warmińsko-Mazurskiego do roku 2025 (Strategy for development of Warmia and Mazury Region by 2025)

¹²¹ Strategia Rozwoju Kraju do roku 2020 Aktywne społeczeństwo, konkurencyjna gospodarka, sprawne państwo (National Development Strategy 2020 Active society, competitive economy, efficient state, Warsaw, September 2012)

of employment it was about 17,5%. Agriculture and agro-food industries are the most important nodes of the Polish bioeconomy¹²².

Table 5.17. Land structure in Polish South Baltic Area

Land	Pomeranian Region ¹²³		West Pomeranian Region ¹²⁴		Warmia and Mazury Region ¹²⁵	
Agriculture [k ha]	759,9	41,5%	837,1	36,6%	994,6	41,1%
Forestry [k ha]	683,4	37,4%	813,8	35,5%	753,3	31,2%
Fallow land [k ha]	4,9	0,3%	13,1	0,6%	7,1	0,3%
Urbanized [k ha]	97,2	5,3%	101,1	4,4%	93,1	3,9%
Other [k ha]	283,9	15,5%	524,1	22,9%	569,2	23,5%
Total [k ha]	1.829,3	100%	2.289,2	100%	2.417,3	100%

The Pomeranian Region is located in the middle of the Polish South Baltic Area, see Fig. 1.1. The territory of the Region is 1.829.300 ha, which makes the region the eighth largest in Poland. The region is divided into 16 powiats (counties), 123 municipalities and 8 towns with the status of municipality. The population is approximately 2.309.400 inhabitants (eighth in the country) and the region covers a land area of 1.829.300 ha (5,9% the area of Poland). The number of farms is approximately 60.900 and the area with arable land is 759.900 ha.^{126 127}

The population density in the region is 126 people per square kilometer. On the territory of the region there are practically no natural resources except for sand, gravel and clay. The region features a significant amount of forests, amounting to 36%, whereas the average forestation of the country is about 28%. Soils in the region have rather low fertility, except for the area of Żuławy Wiślane (fen soils).

The Warmia and Mazury Region is located in the east part of the Polish South Baltic Area and consists of 116 municipalities. The population is approximately 1.443.967 inhabitants and the region covers a land area of 2.417.300 ha (7,7% the area of Poland). The number of farms is approximately 41.700 and the area with arable land is 994.569 ha.^{128 129}

The West Pomeranian Region is located in the west part of the Polish South Baltic Area and consists of 114 municipalities. The population is approximately 1.715.431 inhabitants and the region covers a land area of 2.289.200 ha (7,3% the area of Poland). The number of farms is approximately 29.700 and the area with arable land is 837.100 ha.^{130 131}

¹²² Bioeconomy in Poland: Condition and potential for development of the biomass market Jarosław Gołębiowski Warsaw University of Life Sciences, Poland

¹²³ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

¹²⁴ Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

¹²⁵ Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

¹²⁶ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

¹²⁷ Plan gospodarki odpadami dla województwa pomorskiego 2022

¹²⁸ Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

¹²⁹ Plan gospodarki odpadami dla województwa warmińsko-mazurskiego na lata 2016-2022

¹³⁰ Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

¹³¹ Plan gospodarki odpadami dla województwa zachodnio-pomorskiego na lata 2016-2022

Table 5.18. Crop products (ha) in Polish South Baltic Area

	Cultivated area (ha) West Pomeranian region¹³²	Cultivated area (ha) Pomeranian region¹³³	Cultivated area (ha) Warmia and Mazury region¹³⁴
Total wheat	164.111	598.626	150.888
Rye	51.966	51.386	27.031
Total barley	46.280	32.837	32.131
Oats	21.122	24.634	19.010
Triticale	69.724	77.878	85.995
Cereal mixed	7.099	34.994	37.150
Potatoes	11.661	17.693	9.355
Sugar beets	9.448	9.211	2.060
Feed	43.073	52.021	102.816
Oilseeds	115.699	79.345	77.735
Vegetables	2.873	7.335	3.052
Tree fruit	11.044	2.857	4.346
Fruit bushes and berry fruit	6.007	2.861	4.773
Total cultivated area	560.107	991.678	556.342

In Fig. 5.5 There are the dominant types of bio-industry and agriculture in Polish SBA. As we be seen, poultry and fruits, accompanied by selected vegetables and triticale, are major types of bioindustry in the SBA regions.

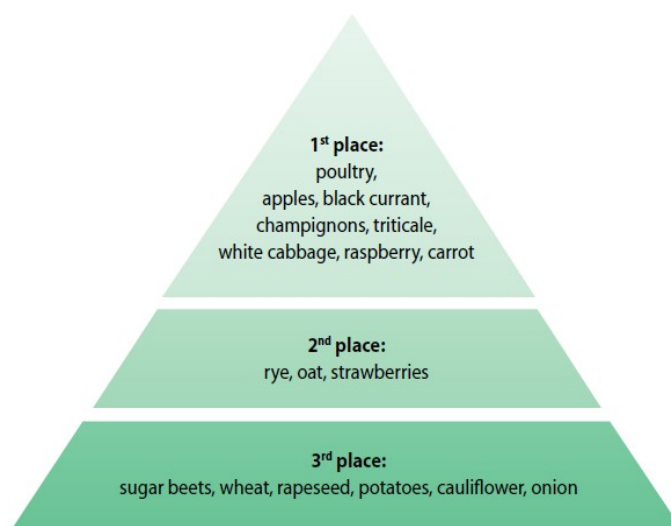


Figure 5.5. The dominating types of bio-industries and agriculture in the Polish South Baltic Area¹³⁵

The average agricultural farm size in Poland is ca. 10,5 ha. The voivodeships (provinces) that belong to the South Baltic Sea Area have much more agriculture land than the average. West Pomeranian farms

¹³² Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

¹³³ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

¹³⁴ Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

¹³⁵ EUROSTAT data

are ca. 30,3 ha, Warmia and Mazury farms are 22,9 ha and these are respectively the first and second biggest farm sizes in Poland. The Pomeranian farms are ca 19 ha, which puts them into 4th place. Fig. 5.6 shows the mean sizes of agriculture lands in every voivodeship.

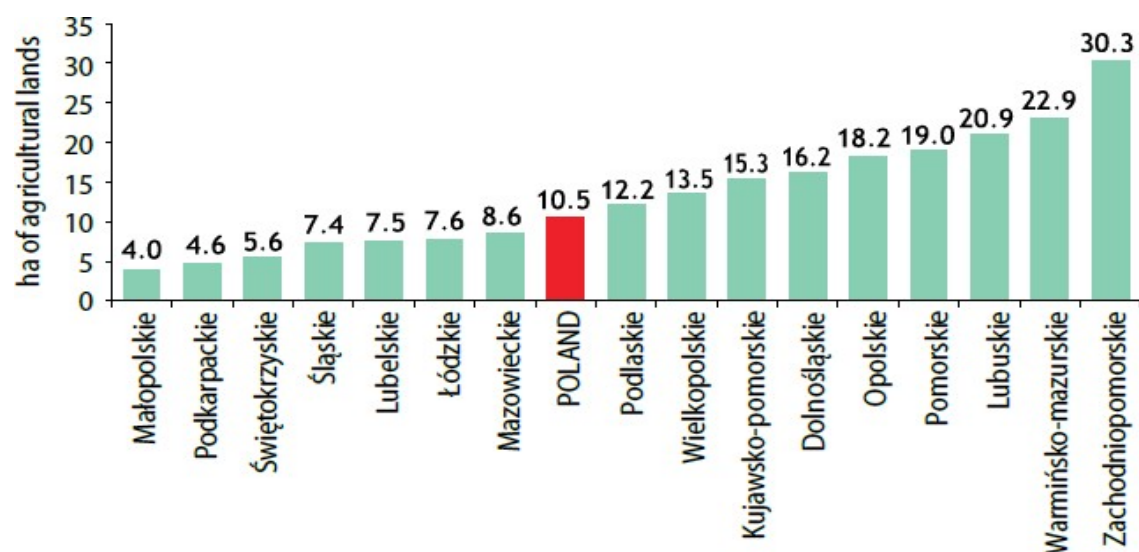


Figure 5.6. Mean size of agriculture lands in Poland¹³⁶

As can be seen in Table 5.19, the total production of meat in three Polish SBA regions are very different. Most of the meat produced is pig and poultry. The proportion of every kind of meat is strongly diverse in every region.

Table 5.19. Production of animals for slaughter

Kind	Pomerania ¹³⁷	West Pomerania ¹³⁸	Warmia and Mazury ¹³⁹
Total, tons	378.600	226.800	403.700
Cattle (excluding calves), tons	29.000	10.200	46.200
Calves, tons	200	300	800
Pigs, tons	215.600	50.400	118.800
Sheep, tons	200	100	100
Horses, tons	0	100	200
Poultry, tons	133.600	165.700	237.600
Goats and Rabbits, tons	0	0	0

The proportion of the forest area in the Pomeranian Region is 665.810 ha with coniferous trees being the dominant species, accounting for approximately 78,6% of the forest area. Forests cover 36,4%

¹³⁶ Study of the IERiGŻ-PIB, data from ARiRM

¹³⁷ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

¹³⁸ Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

¹³⁹ Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

of the total land area in the region, which is higher than the national average of 29,4% (9.197.900 ha).¹⁴⁰

The proportion of forest area in the Warmia and Mazury Region is 773.692 ha with coniferous trees being the dominant species, accounting for approximately 60,7% of the forest area. Forests covers 31% of the total land area in the region, which is close to the national average of 29,4% (9.197.900 ha).¹⁴⁰

The proportion of forest area in the West Pomeranian Region is 837.561 ha with coniferous trees being the dominant species, accounting for approximately 66,7% of the forest area. Forests covers 35,5% of the total land area in the region, which is higher than the national average of 29,4% (9.197.900 ha).¹⁴⁰

Poland is among the countries with the largest proportion of forest area in the region, following France, Germany and Ukraine.

Table 5.20. Removals in forest industry

	West Pomeranian ¹⁴⁰ dam ³	Pomeranian ¹⁴⁰ dam ³	Warmia and Mazury ¹⁴⁰ dam ³
Coniferous timber	3.197,4	2.549	2.642
Non-coniferous timber	1.178	643	1.077,8
Slash for industrial uses	65,5	25	2,5
Slash for fuel	212,6	159	135
Total	4.653,5	3.376	3.857,3
Total Poland 2015	40.247		

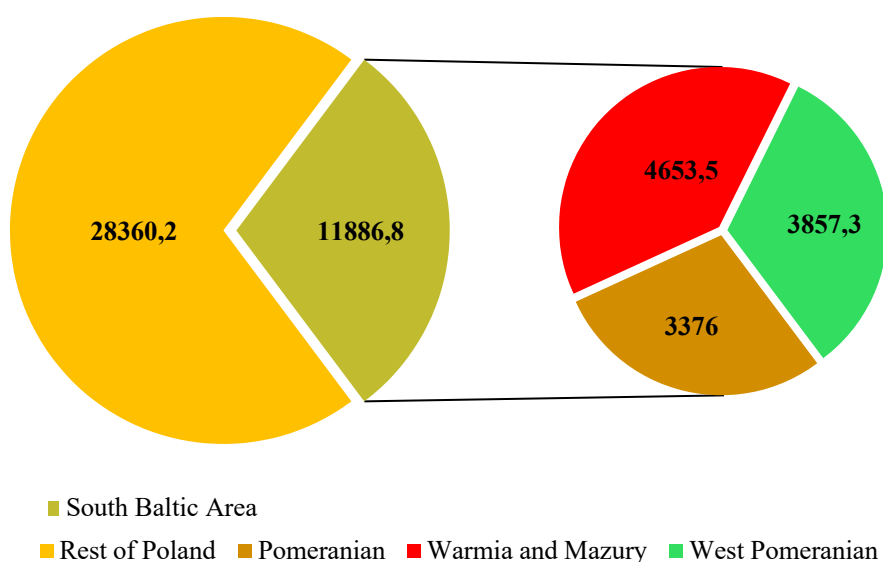


Figure 5.7. Total wood removals in Poland (dm³)

The statistical data from 2015 shows that employment in the Pomeranian region was encompassed 798.217 people. Agriculture, forestry and fishing industries employed 66.982 people which is about 8,4% of the total employment in the Pomeranian region. After 2015 there were still 12 vacancies

¹⁴⁰ Forests in Poland 2015

in these industries while 545 jobs had been newly created. The average monthly salary in the Pomeranian region in agriculture, forestry and fishing industries was 4.369,51 PLN while the average monthly salary in Poland was 3.900 PLN.¹⁴¹

The same statistical data for the Warmia and Mazury region indicates that 433.237 people were employed in 2015. Agriculture, forestry and fishing industries employed 70,442 people which is about 16,3% of the total employment in the Warmia and Mazury region. After 2015 there were still 11 vacancies in these industries while 370 jobs had been newly created. The average monthly salary in the Warmia and Mazury region in agriculture, forestry and fishing industries was 4.396,52 PLN.¹⁴²

The statistical data for the last Polish region in the South Baltic Area, namely the West Pomeranian voivodeship shows that 525.662 people were employed in 2015. Agriculture, forestry and fishing industries employed 50.507 people which is about 9,6% of total employment in the West Pomeranian region. After 2015 there were still 15 vacancies in these industries while 831 jobs had been newly created. The average monthly salary in West Pomeranian region in agriculture, forestry and fishing industries was 4.258,06 PLN¹⁴³.

At the moment, it is not possible to indicate the shares of sustainable bioeconomy in the local economies as there are no reports available on that topic. The weakness linked to above are, among others:

1. The functioning of agriculture depends on soil conditions. Good and very good soils constitute 28,6% of all arable land, average soils – 39,1%, and poor and very poor soils – 32,3%. About 80% of soils on cultivated land in Poland are characterised by a certain degree of acidity, whereas the remaining 20% of soils have a neutral or alkaline PH. Since the majority of arable crops require mildly acidic to neutral soils in order to grow properly, the experts advise the introduction of the so-called liming procedure.
2. The value of Poland's resource productivity (measured in purchasing power standards [PPS] per kg) is one of the lowest in the EU. Improving resource productivity and ensuring sustainable resource and materials management, building on the principle of the 3Rs (reduce, reuse, recycle), is a central element of green growth policies.

The strengths linked to above are among others:

1. Poland's biodiversity is among the richest in Europe. Its transitional climate which is influenced by oceanic and continental air masses, favourable geographical position at the centre of the continent with no natural barriers to the east or the west, varied geological structure, and land and hydrographic make-up and soil types make it a good habitat for many plant and animal species. The richness of biological diversity in the country is due to many variables resulting from location and topography, soil conditions, climate impact, the level of social and economic development and historical conditions.
2. Maintaining extensive agriculture in Poland has resulted in the preservation of many local breeds of farm animals and old varieties of cultivated plants.
3. Despite the unfavourable agrarian structure and a worse, compared to other EU member states, quality of agricultural production space, Poland is a major global and European agricultural, horticultural and animal producer, with a significant workforce.

¹⁴¹ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk

¹⁴² Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn

¹⁴³ Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin

Challenges:

Despite the fact that Polish SBA regions have weaker average soil than other regions in the South Baltic Area, better resource productivity can be obtained thanks to increasing agricultural efficiency.

Opportunities:

Poland's genetic resources are one of the highest in the EU. It could be used to keep biodiversity in the South Baltic Area. A mapping of bioeconomy leading enterprises in the region in different sector has been accomplished. Data is presented in Table 5.21. The list is not complete but gives an overview of the different types of enterprise that can be found within the bioeconomy sector in the region.

Table 5.21. Employment in bioeconomy sector in Polish SBA

Company	Location	Sector	Production type	Employees
Zakłady Farmaceutyczne Polpharma S A	Koteże (Pomerania)	Pharma industry	Medicine	2.146
Grupa Azoty Zakłady Chemiczne Police S A	Police (West Pomerania)	Ingredients industry	production of fertilizers + plastic products	2.343
Warmińskie Zakłady Przetwórstwa Owocowo-Warzywnego Sp. z o.o.	Kwidzyn (Pomerania)	Food industry	Fruits / vegetables	300
Przetwórstwo Warzyw S.C. (products with name „Lutkiewicz”)	Gdańsk (Pomerania)	Food industry	Fruits / vegetables	46
Goodvalley Polska	Przechlewo (Pomerania)	Food industry	Meat products	600
Animex Foods Sp z o.o. Spółka Komandytowa	Morliny (Warmia & Mazury)	Food industry	Meat products	1.100
Indykpol S.A	Olsztyn (Warmia & Mazury)	Food industry	Meat from poultry	
Destylarnia Sobieski S A	Starogard Gdański (Pomerania)	Distillery	rectification of alcohols	310
Destylarnie Warmińskie Sp. z o.o. (company registered in Warsaw)	Nidzica (Warmia & Mazury)	Distillery	rectification of alcohols	50
Browar Kormoran Sp. z o.o.	Olsztyn (Warmia & Mazury)	Brewery	beer production	20
Browar Amber Sp z o.o. Spółka Komandytowa	Bielkówek (Pomerania)	Brewery	beer production	62
Browar Gościszewo S C Stanisław Czarnecki Chrystian Czarnecki	Gościszewo (Pomerania)	Brewery	beer production	13
Bytów Browar Kaszubski Sp z o.o.	Bytów (Pomerania)	Brewery	beer production	10
Bioen Sp z o.o. (in bankruptcy)	Szczyrkowice (Pomerania)	Pellet industry	straw products	1
SYLVA Sp. z o.o.	Wiele (Pomerania)	Wood manufacturing	pellets based on wood waste	245

Ekopal Sp z o.o.	Jagodne (<i>Warmia & Mazury</i>)	Pellet industry	pellets based on wood waste	35
Eko Pelet Danuta Kaczkan	Klonowy Dwór (<i>Warmia & Mazury</i>)	Pellet industry	pellets based on wood waste	1
Poltarex Polskie Drewno sp. z o.o. (<i>company registered in Warsaw</i>)	Szczytno (<i>Warmia & Mazury</i>)	Pellet industry	pellets based on wood waste	8
Krajowa Spółka Cukrowa S A Oddział Malbork	Malbork (<i>Pomerania</i>)	Sugar industry	sugar	140 +100 (seasonal work)
Krajowa Spółka Cukrowa S A Oddział Kluczewo	Stargard (<i>West Pomerania</i>)	Sugar industry	sugar	
Przedsiębiorstwo Przemysłu Ziemniaczanego Nowamyl S A	Łobez (<i>West Pomerania</i>)	Potato industry	starches and starch products	120

5.3.2 Biomass potentials in Polish regions of South Baltic Area

The amount of straw produced annually varies from year to year, depending on the weather and other factors. In 2015 in the Pomeranian Region 1.515.040,89 tons of straw was produced while only 1.350 161,9 tons was produced in 2010. The opposite situation can be observed in the Warmia and Mazury Region, where 1.293.685,76 tons of straw was produced in 2015 while 1.466.061,88 tons in 2010. In the West Pomeranian Region the production of straw over the years 2010-2015 was very similar, i.e. ranging from 1.798.374,37 tons in 2010 to 1.758.208,99 tons in 2015. The total straw potential in the Polish South Baltic Area is similar over the years 2010-2015, i.e. over 450.000 tons.

The production of straw from basic cereals in Poland 2016 was at the level of 20.463.000 tons. This is a huge amount that is used in a measure. The manufacture of products of wood, cork, straw and wicker in Poland gives 38.491.000.000 PLN.¹⁴⁴

¹⁴⁴Concise statistical yearbook of Poland

Table 5.22. Straw potential in Polish South Baltic Area^{145 146 147 148}

	West Pomerania		Pomerania		Warmia and Mazury	
	Grain [tons]	Straw [tons]	Grain [tons]	Straw [tons]	Grain [tons]	Straw [tons]
2010						
Wheat	908.210	826.471,1	645.667	587.556,97	703 792.4	640.451,08
Rye	233.487	336.221,28	162.320	233.740,8	137 744.4	198.351,93
Barley	257.661	221.588,46	158.609	136.403,74	200 571.8	172.491,74
Oats	133.714	144.411,12	103.687	111.981,96	78 323.1	84.588,94
Triticale	238.657	269.682,41	248.211	280.478,43	327 591.3	370.178,16
Total	1.771.729	1.798.374,37	1.318.494	1.350.161,9	1.448.023	1.466.061,88
2014						
Wheat	899.702	818.728,82	868.115	789.984,65	699.982,2	636.983,80
Rye	248.749	358.198,56	173.132	249.310,08	91.337,2	131.525,56
Barley	232.623	200.055,78	139.967	120.371,62	120.541,2	103.665,43
Oats	74.527	80.489,16	88.746	95.845,68	72.396,2	78.187,89
Triticale	264.500	298.885	260.233	294.063,29	340.655,8	384.941,05
Total	1.720.101	1.756.357,32	1.530.193	1.549.575,32	1.324.912,6	1.335.303,75
2015						
Wheat	943.030	858.157,3	850.744	774.177,04	741.110,7	674.410,73
Rye	211.275	304.236	158.452	228.170,88	79.201,9	114.050,73
Barley	210.713	181.213,18	120.702	103.803,72	100.919,5	86.790,77
Oats	71.012	76.692,96	74.718	80.695,44	52.241	56.420,28
Triticale	299.035	337.909,55	290.437	328.193,81	320.365,7	362.013,24
Total	1.735.065	1.758.208,99	1.495.053	1.515.040,89	1.293.838,8	1.293.685,76

¹⁴⁵ Statistical Yearbook Pomorskie Voivodship 2016, Statistical office in Gdańsk¹⁴⁶ Statistical Yearbook Warmińsko-Mazurskie Voivodship 2016, Statistical office in Olsztyn¹⁴⁷ Statistical Yearbook Zachodniopomorskie Voivodship 2016, Statistical office in Szczecin¹⁴⁸ Straw balance in Poland in the years 2010-2014 and forecast to the year 2030, A. Madej, Stowarzyszenie Ekonomistów Rolnictwa i Agrobiznesu

Table 5.23. Straw applications in Polish SBA in 2015 (tons)^{149 150 151}

	Pomerania	West Pomerania	Warmia and Mazury
Total amount of straw	1.515.040,89	1.758.208,99	1.293.685,76
Feed	174.835,72	291.862,69	287.974,5
Bedding	342.247,74	407.904,49	341.145
Potential	997.957,43	1.076.023,9	664.566,4

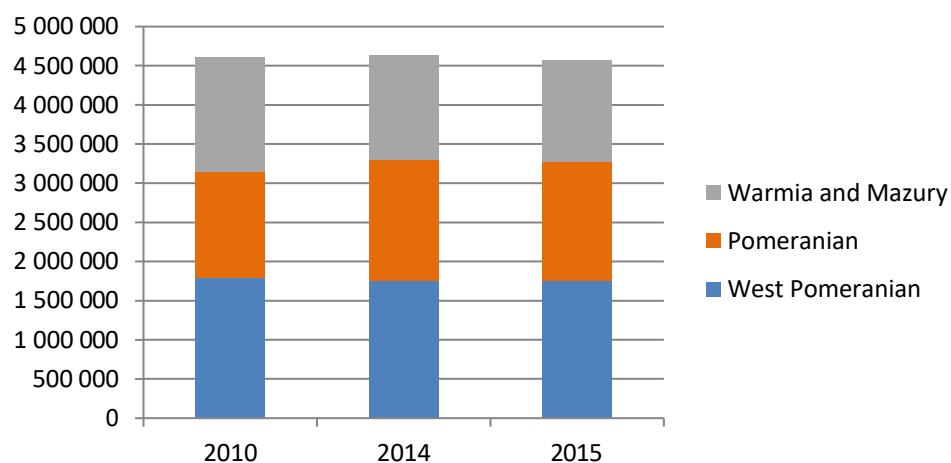


Figure 5.8. Total straw potential in Polish SBA

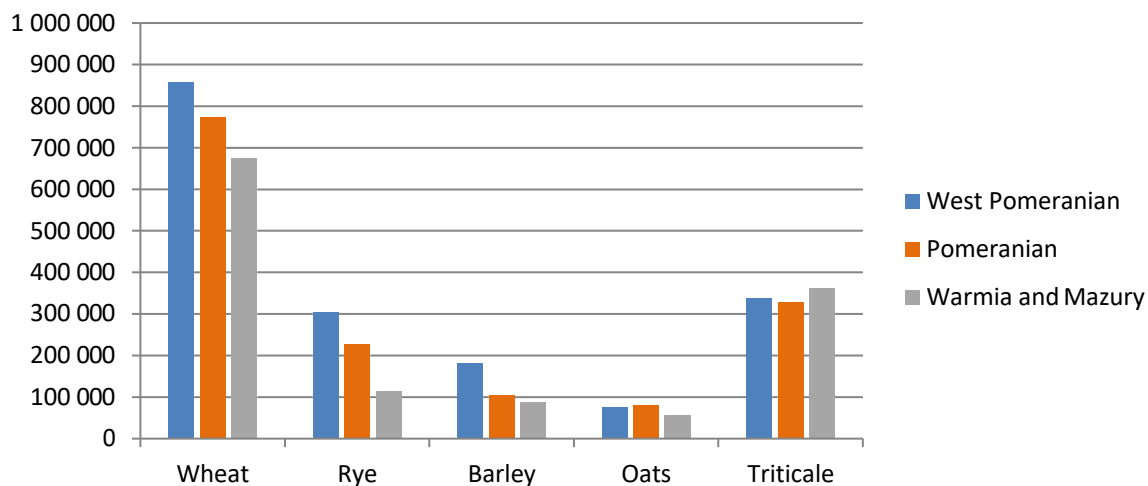


Figure 5.9. Kinds of straw in Polish SBA in 2015

¹⁴⁹ Ability to use straw as local fuel, W. Gostomczyk, Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, 2017

¹⁵⁰ Development of straw and the possibilities of its use for the production of formable fuels on the example of the Warmian-Masurian Voivodeship, R. Bal, Inżynieria Rolnicza 1(99)/2008

¹⁵¹ Possibilities of using straw for energy purposes in the Pomeranian Voivodeship, K. Gafka, D. Janiszewska, Zeszyty Naukowe Wydziału Nauk Ekonomicznych, 07.02.2017

The main utilization for the straw produced in the Polish South Baltic Area is agriculture applications (a huge amount of straw is left in the fields). There are only a few companies which use straw as a source of energy (e.g. Bioen close to Lębork).

Table 5.24. Sugar production in 2017 in Malbork sugar factory

	Amount [tons]	Present use	Location
Sugar beets input	729.933		Malbork
Soil	131.388		Malbork
Cossettes	569.347		Malbork
Product			
Sugar	81.035		Malbork
By-products			
Molasse	19.622	Feed	Malbork
Beet Pulp (fresh pulp, pressed pulp, dried pulp)	483.944	Pulp	Malbork
Carbonation Lime (CaCO ₃ , Nutrins)	49.106	Unknown	Malbork
Total by-products	552.672		

The National Sugar Company (Krajowa Spółka Cukrowa) has two sugar factories in the Polish South Baltic Area, one in the Pomeranian Region (Malbork) and one in the West Pomerania Region (Kluczewo). The sugar factory in Malbork utilised 481.000 tons of sugar beets in 2015 to produce around 53.400 tons of sugar.

The sugar factory in Kluczewo utilised 548.000 tons of sugar beets in 2015 to produce around 60.800 tons of sugar. This amount can vary over the years. For example, the sugar factory in Malbork produced around 81.000 tons of sugar from around 730.000 tons of sugar beets in 2017. Hence one ton of beets amount to 111 kg of sugar, 26 kg of molasses, and 663 kg of beet pulp. There are individual waste management plans for every region in the Polish SBA. Based on these documents analyses were done.^{152 153 154}

¹⁵² Plan gospodarki odpadami dla Województwa Pomorskiego 2022

¹⁵³ Plan gospodarki odpadami dla Województwa Warmińsko-Mazurskiego 2016-2022

¹⁵⁴ Plan gospodarki odpadami dla Województwa Zachodniopomorskiego 2016-2022 z uwzględnieniem perspektyw na lata 2023-2028

The Pomeranian Region

Table 5.25. The morphological composition of municipal waste divided into big cities, small towns and rural areas.

N.	Kind of waste	Large city (>50 k. People)	Small city (<50 k. people)	Villages
1	Paper and texture	19,1	9,7	5,00
2	Glass	10,00	10,20	10,00
3	Metals	2,6	1,5	2,4
4	Plastics	15,1	11,00	10,30
5	Multi-material waste	2,50	4,00	4,10
6	Organic waste	34,20	42,00	35,60
7	Other wastes	13,90	19,00	31,30
7.1	Mineral wastes	3,20	2,80	6,00
7.2	Fraction <10 mm	4,20	6,80	16,90
7.3	Fabrics	2,30	4,00	2,10
7.4	Wood	0,20	0,30	0,70
7.5	Dangerous	0,80	0,60	0,80
7.6	Others	3,20	4,50	4,80
8	Bulky waste	2,60	2,60	1,30

Table 5.26. The morphological of organic wastes in Pomerania Region

No.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	13.501,1
2	Biomass wastes	72.554,4
3	Clothing and textiles from natural fibers	349,3
4	Wood	36,2

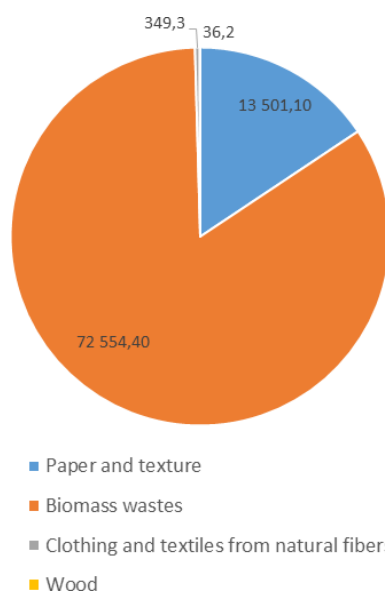


Figure 5.10. Organic wastes in Pomerania Region [tons]

The Warmia and Mazury Region

Table 5.27. The morphological composition of municipal waste

N.	Kind of waste	Percentage
1	Paper and texture	14,6
2	Glass	8,6
3	Metals	2,0
4	Plastics	14,1
5	Bulky waste	3,6
6	Fraction <10 mm	9,6
7	Fraction 10-20 mm	8,1
8	Textiles	3,9
9	Wood	0,6
10	Dangerous	0,02
11	Inert waste	3,3
12	Electric and electronic	0,27
13	Batteries	0,01
14	Other wastes	5,9
15	Organic wastes	25,4

Table 5.28 The morphological of organic wastes in Warmia and Mazury Region

N.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	3.466,21
2	Biomass wastes	14.064,12
3	Clothing and textiles from natural fibers	7,7
4	Wood	0,5

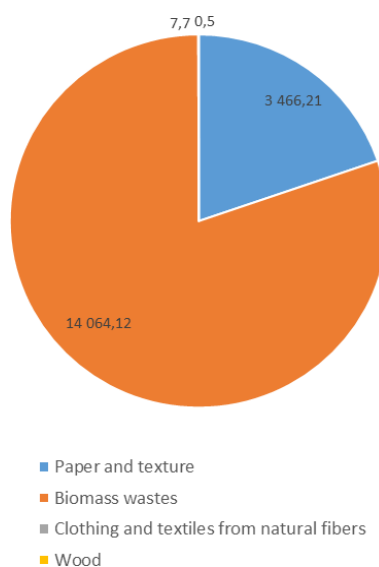


Figure 5.11. Organic wastes in Warmia and Mazury Region [tons]

West Pomeranian Region

Table 5.29. The morphological composition of municipal waste

No.	Kind of waste	Mass [tons]
1	Paper and texture	1.018,2
2	Glass	774,4
3	Metals	1,1
4	Plastics	108,6
5	Bulky waste	11.300,4
6	Other fractions	3.707,0
7	Textiles	21,5
9	Wood	589,4
10	Electric and electronic	875,73
11	Batteries	10,5
12	Other wastes	414.217,4
13	Organic wastes	25.643,8

Table 5.30. The morphological of organic wastes in West Pomeranian Region

N.	Kind of waste	Mass of wastes [tons]
1	Paper and texture	1.018,2
2	Biomass wastes	25.643,8
3	Clothing and textiles from natural fibers	21,4
4	Wood	589,4

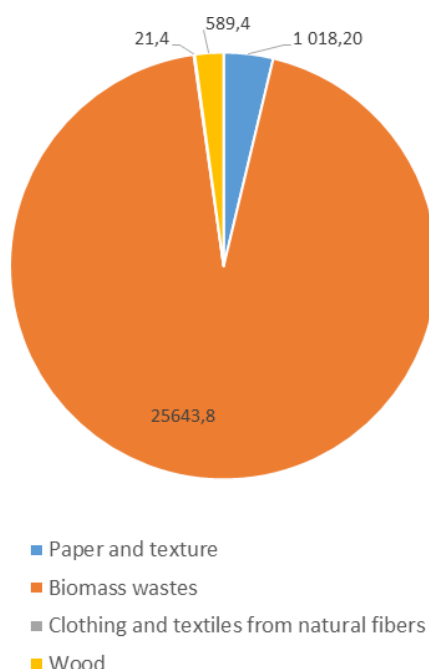


Figure 5.12. Organic wastes in West Pomerania Region [tons]

5.3.3 Biomass opportunities in Polish regions of the South Baltic Area

The biorefining and agri-food industries are the noticeable sectors within the bioeconomy in the regions today. Future opportunities for innovation and development within the bioeconomy is also found in relation to these sectors. We have here selected a few areas with promising business opportunities that could be interesting for enterprises in the Pomeranian Region.

Biogas production

In 2011–2014, the amount of agricultural biogas produced in Poland increased by 137,29 million m³ from the level of 36,65 million m³ in 2011. In the analysed years, the amount of electricity and heat generated from agricultural biogas increased by 281,48 GWh and 291,06 GWh respectively. The table below presents data on the production of biogas, electricity and heat produced from agricultural biogas in Poland in the years 2011–2014.¹⁵⁵

Table 5.31. Biogas potential over the years in Poland ¹⁵⁵

Year of production	Amount of produced agriculture biogas [Mm ³]	Amount of electricity produced from agriculture biogas [GWh]	Amount of heat produced from agriculture biogas [GWh]
2011	36.646	73.433	82.638
2012	73.152	141.804	160.128
2013	112.412	227.880	246.557
2014	173.932	354.916	373.695

This is not much in terms of the potential of the agricultural biogas economy in Poland. The theoretical potential is 5 billion m³ of biogas per year, while the real potential is approx. 1,7 billion m³ of biogas per year. The development of the agricultural bio-power sector can become a stimulator for the development of agriculture and agribusiness in Poland in the coming decade. The real economic potential of agricultural biogas in Poland by 2020 is presented in the table below. The plants located in the Pomeranian province have the highest annual capacity for agricultural biogas production (a total capacity of 38.060.655 m³/year, i.e. 15,6% of the overall capacity in Poland). Also, the plants located in Warmia and Mazury, and West Pomerania have relatively high total capacities for agricultural biogas production (exceeding 20.000.000 m³/year).¹⁵⁶

Pre-treatment technologies for agro-food waste and crop residues are already being tested today. Further implementation will make it possible to utilise new type of biomass as feedstock and enhance biogas yields in planned and existing biogas plants. The region has substantial amounts of unutilised crops residues (e.g. straw) and other types of agro-food waste that is today mainly used for soil-improvement (e.g. mash and sugar beet tops).

¹⁵⁵ Arkadiusz Piwowar, Maciej Dzikuć, Janusz Adamczyk, Agricultural biogas plants in Poland – selected technological, market and environmental aspects, *Renewable and Sustainable Energy Reviews* 58 (2016) 69–74

¹⁵⁶ The real economic potential of agricultural biogas in Poland by Wiśniewski G, editor. *Ekspertyza dla Ministerstwa Gospodarki*. Warszawa: Instytut Energii Odnawialnej; 2007.

Table 5.32. Biogas production potential according to type of substrate ¹⁵⁶

Year of production	Real technical potential [TJ]	Real economic potential–final energy [TJ]	Market potential 2020 [TJ]
Biomass, including:	929.564	600.167	600.167
Agricultural wastes	178.422	123.066	123.066
Energy crops, including:	479.167	286.719	286.719
Maize silages	116.626	81.638	81.638

Biorefining of ingredients for food products

Biorefining of high-value food ingredients from residuals from the regional food industry also offers promising business opportunities for enterprises in the region. Today, a high-value product with huge amounts of sugar is already being produced in the Sugar Factory in Malbork. Moreover, the food waste can be utilized as a substrate in the process of alcohol production. There is one distillery with its own biogas plant in Mielno (close to the south border of the Pomeranian Region, ca. 50 km to Malbork), which uses bakery waste, other organic waste and beet pulp to produce alcohol. There is an opportunity for cooperation with Sugar Factories in Malbork, Distilleries in Mielno, Fruit Processing Plants in Kwidzyn and Slaughterhouses Goodvalley (former Poldanor S.A). Also, waste from a few local breweries (Bytów Browar Kaszubski) has interesting potential.

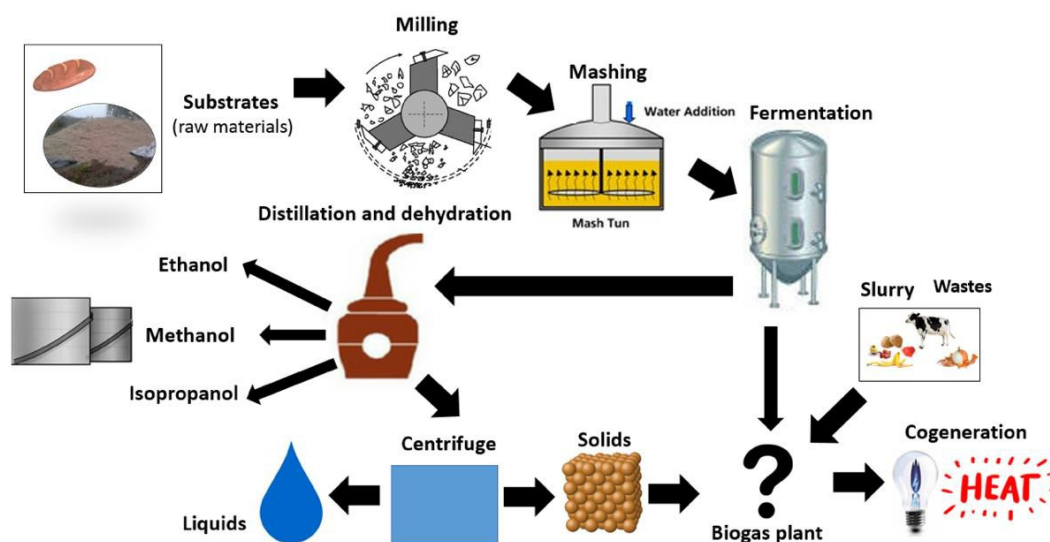


Figure 5.13. Bioeconomy cycle in Mielno distillery and biogas plant

Straw-bale building in Poland¹⁵⁷

One possible way towards more sustainable architecture is a combination of consciously simple building technologies, raw and naturally grown materials, the use of hands-on human labour

¹⁵⁷ Strawbale Building in Poland, M. Jagielak [source: http://osbn.pl/sites/default/files/pliki/Strawbale%20building%20in%20Poland_Maciej%20Jagielak_0.pdf]

and learning from traditional and vernacular building methods. Such a set of characteristics can be described as low-tech architecture. It can be seen as an architectural implementation of the idea of 'appropriate technology' defined by E.F. Schumacher. Straw-bale is one of building technologies which follows the principles mentioned above. Because of its many advantages, especially high isolation value, it has a growing number of dedicated enthusiasts in the USA and in many European countries, including (in the last decade) Poland. No longer is straw-bale just an experiment, it has developed to be a viable alternative to conventional construction technologies. Official tests and following building regulations carried out in many countries are a proof of this transition. In the year 2000 construction of the first straw-bale house started in Poland. In 2011 there were more than 30 buildings that were either finished or in construction. Research carried out by the author, shows that straw-bale building is currently in a stage of rapid development and professionalization of workmanship. As a result, it is likely to play an important role in the future of sustainable building in Poland.



Figure 5.14. Prototype of open-source house 'Nano-habitat' during a) wall construction, b) plastering.
Photo courtesy of Paweł Sroczyński ¹⁵⁷

5.4 Mecklenburg-Western Pomerania

There are some important regional drivers, which can support the development of bioeconomy. Mecklenburg-Western Pomerania has an area of 23.211,05 km² and 1,6 million inhabitants, which is the lowest population density in Germany. The economic structure is shaped by agriculture. One fifth of the land area is covered by forest. Consequently, the timber industry is a traditional part of the economy in Mecklenburg-Western Pomerania¹⁵⁸.

Furthermore, the federal state has an approximate coast length of 2.000 km and exports wood products to neighbouring states across the Baltic Sea. The Baltic Sea is used intensively for fishing.

This area is supplemented by aquaculture, algae and seaweed usage. Besides the present biomass, Mecklenburg-Western Pomerania has several excellent research Institutes, which explore and develop projects in the areas of plant cultivation, animal breeding and farming as well as the fight against animal epidemics and institutes working in the fields of aquaculture and algae growth.¹⁵⁹

5.4.1 Regional strengths and weaknesses

Regarding the region Mecklenburg-Western Pomerania there are no reliable statistics concerning bioeconomy. Moreover, statistics concerning bioeconomy in Germany are rare as well and if there are statistics, they are rather old and not representative. The following statistics show the status quo of bioeconomy in Germany from 2012. This is the only statistic so far.¹⁶⁰ During the course of the project new data may become available. There are several projects and associated partners who are working on new data.

Economic importance of the bioeconomy	
<ul style="list-style-type: none"> • 12,5% of the employees • 7,6% of the gross value added 	
Employment effects of the bioeconomy	
<ul style="list-style-type: none"> • 18% in the primary sector (agricultural and forestry production) • 37% in the secondary sector (processing industry) • 45% in the tertiary sector (trade and services) 	
Where does the added value in the bioeconomy take place?	
Economic sector	Production sector
<ul style="list-style-type: none"> • 12% • 52% Processing industry • Trade and bio-based services 	<ul style="list-style-type: none"> • 66% Agriculture and nutrition • 34% Forestry and timber

¹⁵⁸ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.10.

¹⁵⁹ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.7.

¹⁶⁰ Volkswirtschaftliche Bedeutung der biobasierten Wirtschaft in Deutschland“, Thünen-Institut, 2012, http://literatur.ti.bund.de/digbib_extern/dn051397.pdf (Last access: 03.01.2018)

In the following a SWOT analysis was made by the Eco4Life-project¹⁶¹. This analysis is old as well and dates back to 2013.

<p>Strengths:</p> <p>Great availability of coherent landmass as well as a long coast</p> <p>Availability of biomass and bio-waste, availability of lignocellulose in lumber and forestry industry</p> <p>Efficient scientific network of universities and other research institutes</p> <p>Many European neighbours in close range, Baltic-Sea Region</p> <p>Modern seaports with regular routes to Scandinavia, Baltic region, Russia</p> <p>Connection to the south through the “North-Adria passage”</p> <p>Assessable logistic circumstances within Germany</p>	<p>Weaknesses:</p> <p>No important market for bio-based products and processes because of low density of population and the quite new character of bioeconomy, which isn't common knowledge yet</p> <p>Missing basic material industry, such as chemical, energy industry or industry for the refinement of raw materials</p> <p>Fragmented business landscape, primarily SMEs</p>
<p>Threats:</p> <p>Declining soil quality through one-sided usage of fields, e.g. energy corn</p>	<p>Opportunities:</p> <p>New companies will settle, e.g. biotechnology or industry for the refinement of raw materials (Tire company ‘Continental’ will build a factory in Mecklenburg-Western Pomerania)</p> <p>Highly qualified employees will stay in Mecklenburg Western-Pomerania</p> <p>Regional and rural development through the establishment of agricultural companies and biorefineries in rural areas</p> <p>Export of technology</p>

5.4.2 Biomass potential in Mecklenburg-Western Pomerania

It is difficult to describe the biomass potential in Mecklenburg-Western Pomerania because, as already mentioned, there is no or old data available. In order to tackle this issue, the implementation of a “bioeconomy monitoring” is planned for Germany in the future. With the help of this monitoring, data could be provided annually from Germany and for every region separately, and as a result, can help to develop the future of bioeconomy more precisely. It is not yet clear when this monitoring will be ready.

A study from 2013¹⁶² shows, that in Germany overall farmland will vary from 2,7 million ha to 3,3 million ha in 2020 and 3 million ha to 3,9 million ha in 2030. The share of farmland

¹⁶¹ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.11.

¹⁶² Biomassepotenziale und Nutzungskonkurrenzen. Kurzstudie im Rahmen der Wissenschaftlichen Begleitung, Unterstützung und Beratung des BMVBS in der Bereichen Verkehr un Mobilität mit besonderem Fokus auf Kraftstoffen und Antriebstechnologien sowie Energie und Klima. Bundesministerium für Verkehr, Bau und Stadtentwicklung (2013).

for renewable resources will vary from 27% to 34%. The federal states of Lower Saxony and Bavaria have the most potential. A federal state with a slightly lower but still similar share of farmland is Mecklenburg-Western Pomerania (a.o.).

The potential of the following biomass sources was analysed within the Eco4Life-project as well and are shown below. It must be made clear that bioeconomy in Mecklenburg-Western Pomerania is already developed in some areas, i.e. when talking about potential, we rather talk about used and unused potential (e.g. rapeseed: rapeseed as biomass is already very developed in Mecklenburg-Western Pomerania).

Sugar beets

Besides sugar cane, sugar beet is one of the most important sources of raw material for the extraction of sugar. Germany dedicates approx. 340.000 ha to the production of sugar beet and belongs to one of the main producers on the global market. In Mecklenburg-Western Pomerania approx. 25.000 ha are dedicated to the extraction of sugar beet¹⁶³.

Farmers in Mecklenburg-Western Pomerania produced 20.161,4 million tons of sugar from sugar beets, 100.000 tons more than 2015. This is 8% of the German sugar production. They used 19.300 ha of agricultural land.

Sugar production from beets produces over 80% of residues (beet pellets and molasses). Recently they have been used for: feed, yeast production, distilleries and chemicals production. The molasses is used for feed (50%), yeast production (50%), distilleries and the chemical industry. 30% - 50% of the beets' pellets seems to be unused, with the rest being fed mainly to cows.

Rapeseed

Rapeseed is traditionally used in the production of cooking oil and animal food. In the past 10 years rapeseed has become an important feedstock for bioenergy and biofuels production, as it is used in the production of Biodiesel. Moreover, rapeseed is used in the chemical and pharmaceutical industry. It can be used as a basic material for colours, bioplastics, plasticiser, surfactants and biological lubricants. It is very common in Mecklenburg-Western Pomerania. One positive aspect is that there is not much technology needed to harvest rapeseed. During rape oil production there are also a lot of residues and cascade products, which could be reused. A critical point is the high water demand during the reprocessing of rapeseed¹⁶⁴.

Potatoes

Potatoes are one of the world's most important basic foods, but in Mecklenburg-Western Pomerania, as well as in the rest of Germany, the cultivation of potatoes is declining. Only 1,3% of the fields are used to grow potatoes. An essential reason is the rising importance of soy as animal food. Nonetheless, the potato represents essential potential for the bioeconomy, due to the high starch content of potatoes. A positive side effect of the cultivation of potatoes is the improvement of soil quality¹⁶⁵.

¹⁶³ See: <https://de.statista.com/statistik/daten/studie/186787/umfrage/anbauflaeche-von-zuckerrueben-nach-bundesland/> (last access: 14.02.2019)

¹⁶⁴ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.12.

¹⁶⁵ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.13.

Corn

Maize is one of the most important culture plants, because it can adapt to different regional climate circumstances. Most of the corn grown in Germany is used as feed. A small part is used in the food industry. A growing importance on corn as an energy plant is also visible (e.g. biofuel: bioethanol). After the Renewable Energies Act¹⁶⁶ biogas production benefitted and maize cultivation for energetic causes multiplied. For material usage, corn starch still plays an important role. Corn starch is also essential for the production of bioplastics. A big advantage of corn in comparison to potatoes is that production is possible throughout the year. The utilisation of residues can cover up to 80% to 95% of the production costs of corn starch. One critical point is the one-sided cultivation of corn fields and the fact that soil erosion can take place as a result of the long growth phase¹⁶⁷.

Cultivated pasture

The use of cultivated pastures in Mecklenburg Western-Pomerania is slightly decreasing, but the bioeconomy could lead to a growth of it, which would lead to a growing habitat for insects and other animal species. Biomass from cultivated pastures is mostly used in biogas plants.

Wood residues

Wood residues in Mecklenburg-West Pomerania (MV) have an average of appr. 1 million tons DM/a. Although, wood residues are comparably small in the German perspective, there is still a reasonable potential in the German Baltic Sea region¹⁶⁸.

Abbildung 10: Technisches Brennstoffpotenzial für forstwirtschaftliche Biomassen auf Bundeslandebene, Ø 2002-2008 (BMVBS, 2010)

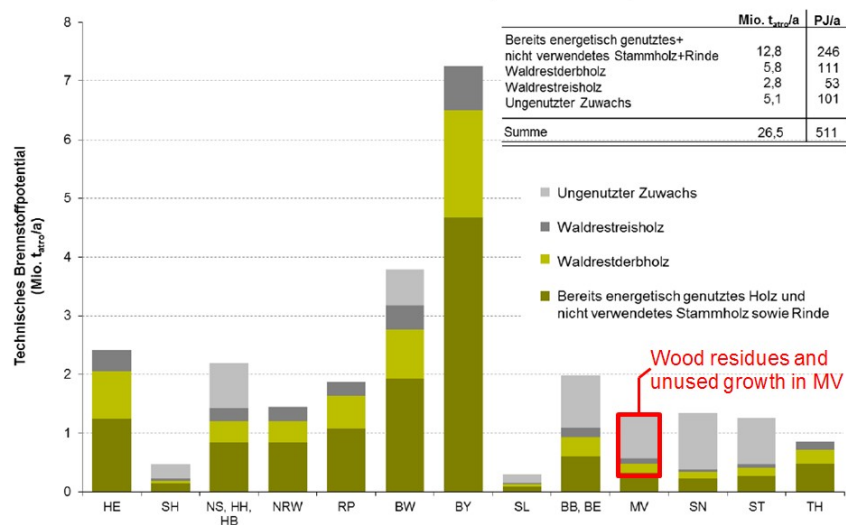


Figure 5.19. Fuel potential of forest biomass at federal state level, 2002-2008

Straw and other residues from agriculture

There is one particular example of the successful utilisation of the material use of straw. Straw was successfully used in the construction of fire protection plates for the installation of dry walls. These unique materials work without glue. They are produced solely by using pressure and heat. More

¹⁶⁶ Erneuerbare-Energien-Gesetz (EEG)

¹⁶⁷ Weingärtner, Mareike; Graage, Frank: BioCon Valley (Dez 2013): Potentialanalyse Portfolio. Bioökonomie Mecklenburg-Vorpommern. Markt Studie im Rahmen des Eco4Life Projekts. S.14.

¹⁶⁸ Majer, Stefan et al: Biomassepotenziale und Nutzungskonkurrenzen, DBFZ

specifically, they are produced by using the renewable raw materials of crop straw, paddy straw or reed from paludal cultures.

Another example of straw use is a straw heating plant for a local heating network, which was inaugurated as the country's first plant of its kind, in Gülzow (Mecklenburg Western-Pomerania) at the Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe e.V.). The straw heating plant is used as a demonstration.

Technically available straw potentials in the German Baltic Sea region are in the range of 5-7 GJ/ha (for 2017 and estimations for 2020). Overall straw potentials are the highest in Germany (with a few other German regions)¹⁶⁹.

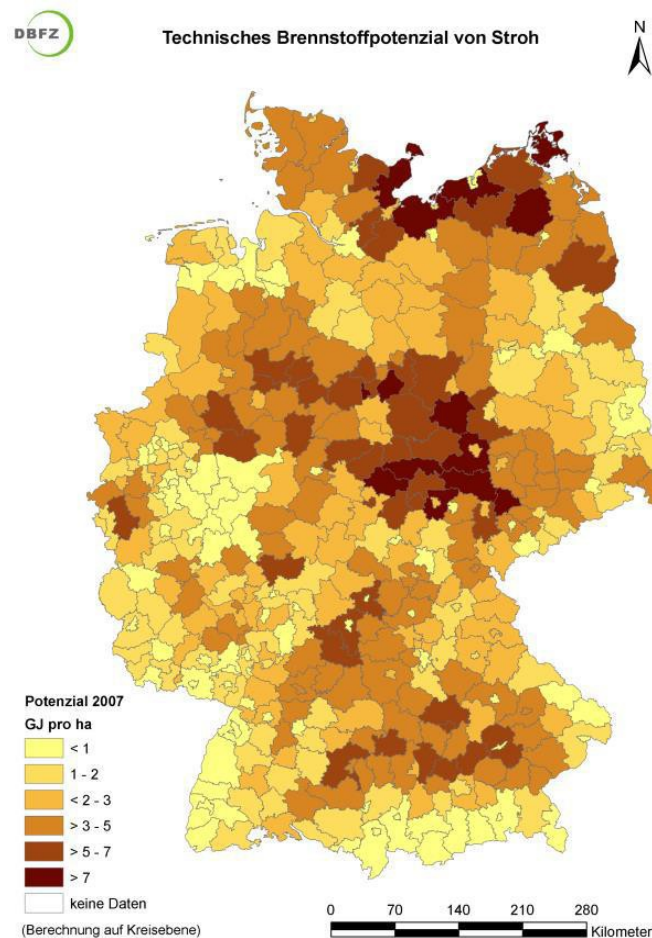


Figure 5.19. Fuel potential of straw in Mecklenburg¹⁶⁹

Other cultivated pasture and plant elements (dandelion)

Furthermore, Caucasian dandelion is cultivated on a small scale. It is used as residue to produce rubber (e. g. for car tires).

¹⁶⁹ Majer, Stefan et al: Biomassepotenziale und Nutzungskonkurrenzen, DBFZ. s. 25-26.

Food industry waste”

Food industry waste potentials in Mecklenburg-Western Pomerania are low. Food industry waste is reasonable in stronger populated regions. Thus, Mecklenburg-Western Pomerania, with a relatively dense population (70 inhabitants/ km²), has only limited potentials.

5.4.3 Bioeconomy opportunities in Mecklenburg-Western Pomerania

Mecklenburg-Western Pomerania complies with a variety of conditions which are needed to unlock the biomass potential in the region¹⁷⁰. A supportive infrastructure is available and there are excellent universities and other research institutes. Infrastructure, logistics, human resources, research and science are the backbone of a future bioeconomy in the region¹⁷¹.

- 1) The region has efficient harbours and well-developed road and rail transport infrastructure.
- 2) Several education facilities, which provide and offer highly qualified employees to companies.
- 3) Mecklenburg-Western Pomerania has two long-standing universities, three universities of applied science and several other scientific research centres, which are co-financed by the federal state and that do research in the fields important to the bioeconomy.

Biomaterials/ Building with biomass (biocomposites)

There is potential for the utilisation of biomass in the construction area (e.g. round-wood) and in the isolation area (e.g. hemp, sea grass, paper). Products are available on different TRL levels. Some materials are well known, like hemp isolation mats or construction wood. Others, like sea weed, miscanthus or straw for isolation or as composite for building materials, are (still) niche products. Although there is great potential, there are also barriers, e.g. missing knowledge (architects, owners, construction firms), the higher price (compared to ‘common’ construction materials), availability of products (in general and in scale), and legislation.

Bioplastics

Mecklenburg-Western Pomerania is not a densely populated and agriculturally dominated federalstate of Germany. Industry sectors are scarce. Only a few companies are working in the field of the bioplastic supply chain. Nonetheless, a very complete chain is performed by Zucker Anklam a factory of **Suker Unie** (NL) (Local sugar beet feedstock to sugar and bioethanol (fuel), alcohol (primary matter for e.g. cosmetics), organic solvents, as well as bio gas production and bio methane upgrading¹⁷²).

Biogas

Germany (and FNR), with its 8.000 biogas plants, has vast experience in the field of biogas production. It has long lasting experience in the diversity of biogas feedstocks, logistics and storage, fermentation techniques and equipment, biogas production and upgrading as well as the concepts of coupling with further processes like the utilisation of process heat for different applications.

¹⁷⁰ The use of biomass is already developed in Mecklenburg-Western Pomerania. When talking about “biomass potential” it is possible to talk about areas, which have no or only little potential for development.

¹⁷¹ See above. S.10ff.

¹⁷² The two following companies are further examples: Enzymicals AG in Greifswald offer enzymes suitable for research and production of high-value chemicals. Beyond this point Ezymicals is not directly contributing to bioeconomic supply chain. Loick Biowerkstoffe GmbH in Teterow. Their primary matter is starch from potatoes and grain. They produce bio-based cushioning material, toys (PlayMais®) and bio-based synthetic granules for any purpose (e.g. for disposable cutlery).

Nevertheless, enhancements in the field of production price, efficiency and increased flexibility in the energy production is needed. The growing renewable energy market in Germany demands new flexible and sustainable solutions in the biogas field. New regulations in Germany, especially for biogas production among the renewable energies, require fundamental new strategies for their business cases.

Heating with straw

Mecklenburg-Western Pomerania has a series of small and large scale straw heating plants. The technique was intensely developed in Denmark. Nevertheless, according to the huge amount of straw availability (residues) in the Baltic Sea region and the NREAPs, the utilisation of residues will get priority in which straw heating can be part of the solution. There are potentials, techniques and the (political) will available to extend the utilisation of straw as an energetic resource. Besides the development of new filters (NO_x, particles, etc.) a knowledge exchange for good practice (especially in the field of harvest, preparation, logistic and storage) can support the further utilisation of straw as an energy carrier in the Baltic Sea region.

6 Final remarks

All of the regions presented in the report are striving to unlock the potentials for the bioeconomy. Out of four countries considered in the report only Germany and Sweden have national strategies dedicated to the bioeconomy and none of regions presented in the report have dedicated strategies. In some of the regions strategies are under preparation and in other initiatives have been integrated into a broader policy framework.

The report has identified large amounts of unutilized biomass within the forest and agro-food value chains that can be used for the production of biobased products and bioenergy.

Development and innovation are expected around the usual stakeholders of regional innovation systems such as government and public administration, businesses and representatives of sectoral associations and business intermediaries, as well as academic, scientific and technological institutions. It is clear that coordination among different policy areas (e.g. research and innovation, agriculture, environment) at the level of government is needed to promote the bioeconomy:

In the report presented is a bioeconomy related profile of four regions participating in the BioBIGG Interreg South Baltic Area programme. In each case, biomass potentials in participating regions are provided. The major focus of the statistics is the potential of cereals, wood, sugar beets and biofuels. Outlined are also local specific potentials. Every partner defined the strengths and weaknesses within the biomass-oriented economy and bioeconomy opportunities in the region. Major bioeconomy industries in the regions have been identified.

These companies will be the main target groups of the project during workshops and conferences. These are primarily SMEs belonging to energy and waste companies (some of these are already represented in the project partnership), food industry and pharmaceutical industry. Exemplary cases of good practices have been defined which will be developed within deliverable 3.2 in the frame of the present project.

The funding institutions together with the funding schemes have been identified in all regions. These statistics indicate a significant interest of local and state authorities towards bioeconomy.