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GLOBAL, EUROPEAN AND NATIONAL DRIVERS OF LITHUANIAN BIOECONOMY STRATEGY

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This paper contributes to the comprehensive approach for sustainable and balanced development of bioeconomy as a cross-cutting economic sector and focuses on the drivers of Lithuanian bioeconomy strategy.
Lithuanian bioeconomy strategy development can be motivated by country's specialization and, compared with other EU member states, strong performance in terms of recent growth in all biomass production and fully bio-based manufacturing sectors. However, Lithuanian bioeconomy strategy depends not only on the current state and trends of its subsectors, but also on the drivers that will be forcing and shaping them in the future. The authors decomposed these drivers into global, European and national. Using content analysis of the EU, OECD and European countries' legal acts, global drivers such as depletion of natural resources, growing population, increasing environmental pressures and climate change were identified. Applying content analysis of the EU and European countries' bioeconomy strategies and analysis of case studies of good practices in European countries and regions, the following drivers at European level were identified: common EU bioeconomy policy, strategy and action plan; assurance of biomass availability and sustainability, as well as efficient biomass value chain; the need to strengthen markets and competitiveness of the bioeconomy subsectors; the necessity of close cooperation among all stakeholders, namely politicians, business people, scientists and the public; the need of the development of new technologies and processes, especially industrial biotechnology.
The research revealed that the bioeconomy development in Lithuania has been regulated and promoted through certain sectoral policies: agriculture, forestry, fisheries, energy, environment (including waste management), scientific research, innovation and biotechnology development. In the future, the cross-sectoral links and interactions in the Lithuanian bioeconomy will increase due to the scarce biomass, applying the cascading principle in the biomass refinement, transition towards circular economy, and the development and implementation of innovations.

Keywords: bioeconomy, biomass, cascading principle, food security, strategy drivers, sustainable use

INTRODUCTION

Long-term projections suggest that, without essential policy changes, the current trends of global economic growth and development will have serious impacts on natural resources and the ecosystem (OECD Work on…, 2015). Europe and the world are facing the challenges of growing populations that must be fed, depletion of natural resources, impacts of ever increasing environmental pressures and climate change (European Commission, 2017). This highlights the necessity to move to a new economic growth path that is consistent with the protection of the environment and sustainable use of scarce natural resources while still achieving sizeable gains in ensuring higher living standards and reducing poverty.

The development and application of innovative biotechnology methods and processes in agriculture, health, chemistry, and energy sectors has been recently seen as one of the solutions to accelerate sustainable growth and development (Nordic Council of Ministers, 2016). By focusing more on scientific research and innovations, new bio-

based products and services needed for the development of the bioeconomy would be created, helping to reduce climate change, waste and create new jobs (Rönnlund et al., 2014). Nevertheless, the bioeconomy is highly complex and cuts across many sectors. Stakeholders at various levels engage in the bioeconomy for a number of different reasons and to reach a number of different objectives. Therefore, the bioeconomy does not fit neatly into one specific policy area but must rather be addressed through concurrent efforts within different policy areas (Nordic Council of Ministers, 2016). Another major issue of the emerging bioeconomy is the lack of capital and funding, since on the one hand, the investments have a long life cycle and are capital intensive, and on the other hand, the emerging bioeconomy sector is not familiar to investors and even to potential customers (Rönnlund et al., 2014).

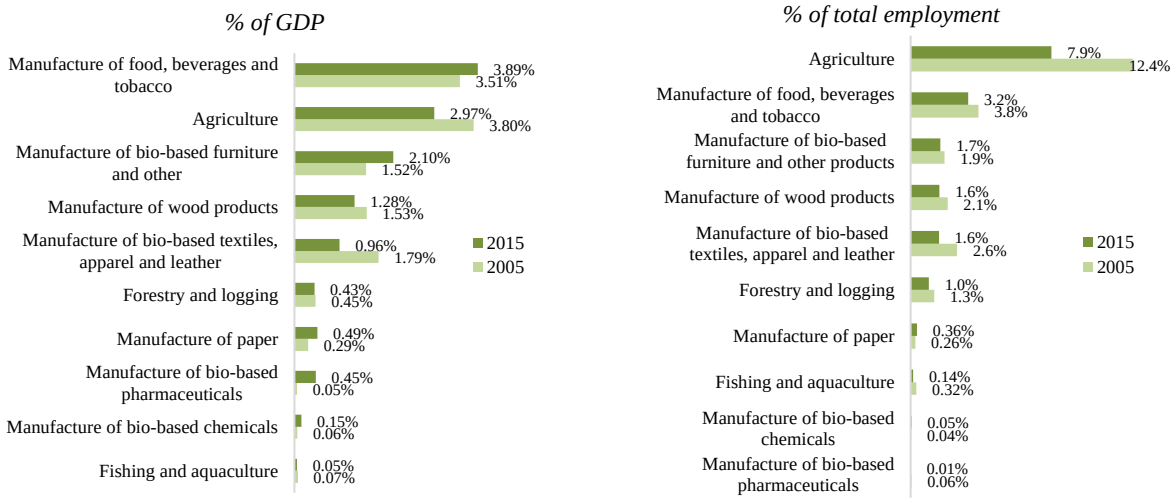
Taking into account the importance and complexity of the bioeconomy development, this paper is dedicated to explore the question whether the bioeconomy strategy is necessary for Lithuania and, if yes, what are the main drivers of such strategy. Methods of content analysis and synthesis, statistical analysis of data, quantitative survey and analysis of case studies were used to complete the research.

CURRENT STATE AND TRENDS OF LITHUANIAN BIOECONOMY

Various political documents, researches and statistical reviews analyse different composition of bioeconomy in terms of economic activities and sectors. For example, the Strategy for Sustainable Bioeconomy approved by the European Commission (European Commission, 2012) attributes agriculture, forestry, fisheries, manufacture of food, wood and paper, as well as the industries of chemicals, energy and technology to the bioeconomy sector. The National Bioeconomy Profiles published by the European Commission (2014) provide the classification of bioeconomy sectors by distinguishing three types of economic activities, i.e.:

- *Biomass production sectors*: agriculture, forestry and fisheries;
- *Fully (100 percent) bio-based manufacturing sectors*: processing biomass to higher added value products, which includes manufacture of food, beverages and tobacco; manufacture of wood, cork and their products, except for furniture; manufacture of paper and its products and manufacture of leather and related products;
- *Partly (less than 100 percent) bio-based manufacturing sectors*: manufacturing activities where biomass is used as a part of materials, which include manufacture of textile and apparel, chemicals, pharmaceuticals, rubber and plastics, furniture and other bio-based manufacturing.

The analysis of Lithuanian bioeconomy statistical indicators (gross value added and employment) was conducted according to the aforementioned types of activities and statistical classification of economic activities NACE REV. Almost 4.7 billion EUR of GVA was created in Lithuanian bioeconomy in 2015, which accounted for around 13 percent of GDP. 234.4 thousand persons were employed in bioeconomy, accounting for 17.6 percent of the total employment in Lithuania in 2015. The contribution of separate Lithuanian bioeconomy sectors to country's GDP and labour market is presented in Figure 1.

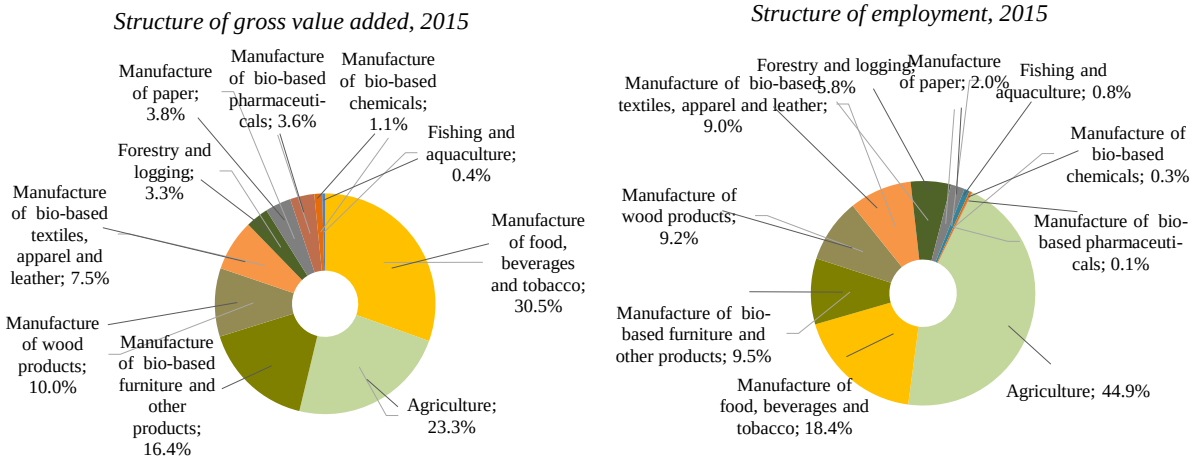


Note: in partly bio-based manufacturing industries, indicators of the gross value added and persons employed are calculated based on the share of products that are wholly or partly made from biological materials in sales of all products separately for each type of economic activity under the analysis. Data source: authors' elaboration based on Eurostat database (National accounts aggregates by industry (up to NACE A*64)).

Figure 1. Contribution of bioeconomy sectors to the whole Lithuanian economy

Food industry (including manufacture of beverages and tobacco) together with agriculture are the largest subsectors of the Lithuanian bioeconomy in terms of turnover and create more than a half of the total GVA generated in the country's bioeconomy (Figure 2). Manufacture of bio-based furniture, manufacture of wood products and manufacture of bio-based textiles, wearing apparel and leather create, respectively, a sixth, a tenth and slightly less than a tenth of the total GVA generated in the Lithuanian bioeconomy. In terms of turnover, all the three industries are medium-sized sectors. Meanwhile, small, knowledge-intensive and industrial biotechnology-based sectors of manufacture of pharmaceutical and

chemical products do not have any significant contribution to the Lithuanian bioeconomy so far, despite the fact that the manufacture of pharmaceutical products has experienced a very rapid growth in the recent years.



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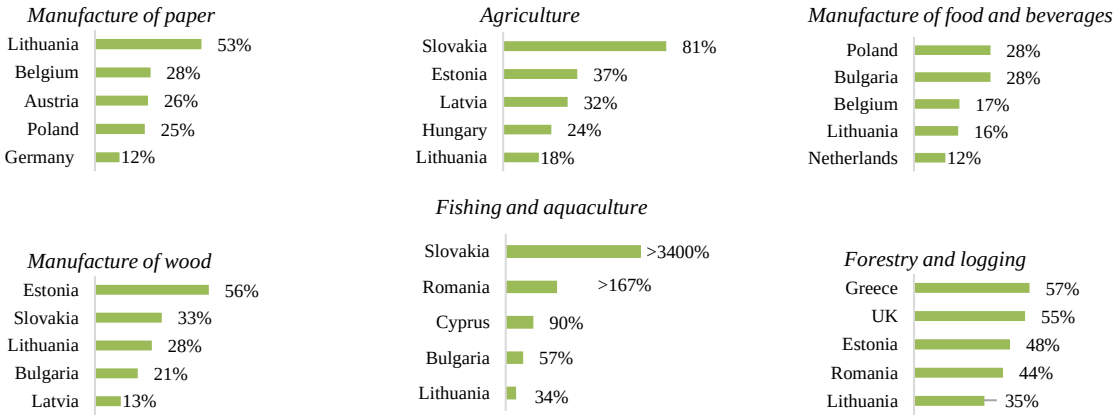
Data source: authors' elaboration based on Eurostat database (National accounts aggregates by industry and National Accounts employment data by industry (up to NACE A*64))

Figure 2. Lithuanian bioeconomy structure in terms of gross value added and employment

Almost two thirds of persons working in the Lithuanian bioeconomy were employed in the agri-food sector in 2015 (Figure 2). Slightly more than a fourth of them worked in the forest-based subsectors, less than a tenth – in manufacture of bio-based textiles, wearing apparel and leather, and a very small share (0.4 percent) – in subsectors of manufacture of bio-based chemicals and pharmaceuticals. The share of persons employed in the agri-food sector and manufacture of bio-based textiles, wearing apparel and leather decreased over the decade (by 2.7 and 1.5 percentage points, respectively). The proportion of persons employed in the remaining sectors increased: by 4.1 percentage points in the forest-based subsectors and by 0.1 percentage points in manufacture of bio-based chemicals and pharmaceuticals.

Since 2010, Lithuania has been among the leaders of bioeconomy created GVA growth in the EU in all biomass production and fully bio-based manufacturing sectors: the first in terms of the growth of manufacture of paper products; the third in terms of the growth of manufacture of wood products (excluding furniture); the fourth in terms of the growth of manufacture of food and beverages, and the fifth in terms of the growth of forestry and logging, fishing and agriculture (Figure 3).



Data source: authors' elaboration based on Eurostat database (National accounts aggregates by industry (up to NACE A*64)).

Figure 3. EU countries leaders in terms of bioeconomy created gross value added growth between 2010 and 2014

In order to get an insight into how different subsectors of the Lithuanian bioeconomy could develop in the future, a quantitative survey of business entities operating in the country's bioeconomy was conducted during the period from 17 April 2017 to 12 June 2017. The respondents were asked to make strategic assessments of the change of performance indicators of their company in short-, medium- and long-term (till 2020, 2025 and 2030, respectively) compared to the current situation according to performance results of 2016. From over 600 business entities included into the survey, 102 responses, i.e. fully filled online questionnaires, were received. This sample size meets the requirement of 90% confidence level (with $p < \alpha = 0.1$), having in mind that there are around 177 thousand business entities in agriculture and other bioeconomy subsectors in Lithuania (based on 2013 data).

Results of the survey revealed that the greatest growth according to all business performance indicators included in the analysis is expected in the manufacture of bio-based chemicals and pharmaceuticals till 2030 (Table 1). Business

entities' reported foreseen increase of material investments, sales, the number of employees and investment in R&D in this particular subsector is a few times greater than in other subsectors of the bioeconomy.

Table 1. Trends of business performance indicators based on expectations of Lithuanian enterprises in short- and long-term

	Agri-food sector: change (±%)		Forestry and manufacture of wood products, paper and bio-based furniture: change (±%)		Manufacture of bio-based textiles, wearing apparel and leather: change (±%)		Manufacture of bio-based chemicals and pharmaceuticals: change (±%)		Bio-waste treatment: change (±%)	
	2016–2020	2016–2030	2016–2020	2016–2030	2016–2020	2016–2030	2016–2020	2016–2030	2016–2020	2016–2030
Number of qualified employees	7.3	10.5	9.1	2.5	5.8	6.9	30.0	26.0	5.0	9.3
Number of employees	8.5	13.1	28.8	0.1	7.5	13.0	30.0	23.8	5.0	4.3
R&D expenses	6.1	13.7	0.9	6.3	4.0	10.0	31.7	43.8	5.0	8.0
Material investments	23.7	27.8	-1.6	3.4	13.5	33.5	45.0	90.0	16.3	21.4
Sales in abroad market	16.8	32.4	19.2	22.7	9.6	26.1	14.0	10.0	1.0	4.0
Sales in domestic market	9.1	27.3	30.8	31.3	8.0	22.9	47.0	129.0	11.3	15.7

Note: darker green colour marks higher expected growth rate.

Data source: survey of Lithuanian business entities operating in different bioeconomy sectors (n=102).

The growth trends determined on the basis of business expectations show the potential of continuous development of the Lithuanian bioeconomy subsectors that demonstrated strong growth in the recent years, as well as the emergence of bio-based pharmaceuticals. However, future situation in global and European markets of commodities and products, as well as the EU policy directions may change these projections. For instance, changes of competitiveness of the Lithuanian bioeconomy businesses may influence foreseen sales abroad and in domestic market or changes of the EU structural and investment programmes may effect foreseen material investments and investment in R&D. Therefore, the need of the Lithuanian bioeconomy strategy and its drivers should be explored in the wider context.

GLOBAL DRIVERS FOR BIOECONOMY DEVELOPMENT

Current fossil-based economy is under pressure from depleted supplies of raw materials, a changing climate and population growth, and this pressure forms a new pathway: shifting from fossil-based economy towards bio-based economy.

Piotrowski et al. (2015) raise a question how much biomass can be sustainably produced globally by 2050? The authors assumed that the respective supply can be provided on a long-term basis satisfying sustainability criterion. The matching between supply and demand is based on a hierarchical order of uses. Only when the demand for plant-based food and animal products is globally satisfied, the demand for biomass for bio-based products could be covered which, in turn, would be prioritised over bioenergy and biofuels. They argued that technologies such as solar and wind energy exist, which provide energy more efficiently and ecologically than bioenergy and conventional systems. The authors pointed out that a review of future trends shows technologies and systems, which could allow the supply of very large quantities of additional biomass without significantly increasing the pressure on nature and biodiversity, including desert greening, the desalinization of marine water with solar energy and marine farming of the microalgae kelp. In 2050, more biomass could be supplied with the help of these technologies. Swinnen and Riera (2013) stated that recent developments in demand both in terms of quantity and quality, technology, and traditional energy and chemistry markets have reinforced the demand for non-food applications. These developments, in combination with increased consumer demand for various food characteristics, have led to a rapidly growing and globally integrated "bioeconomy". Thus, growing population of the world will require not only sufficient quantities of food, but also sufficient quality.

According to Lewandowski (2015), an analysis of the development of bioenergy has revealed that competing claims on biomass and agricultural land for its production are perceived as major obstacles to increasing sustainable biomass supply in the context of food security and environmental conservation. Staffas et al. (2013) pointed out that through the development of new technologies and biotechnological processes biomass will be used for food, feed and materials, as well as for energetic purposes. Food security and its main dimensions – food availability, accessibility, utilization and food systems' stability – mostly will be influenced by climate change. Agriculture-based livelihood systems that are already vulnerable to food insecurity face immediate risk of increased crop failure, new patterns of pests and diseases, lack of appropriate seeds and planting material, and loss of livestock. At the same time, agriculture, forestry and fisheries will not only be influenced by climate change, but also will emit greenhouse gases and can contribute to climate change mitigation through reducing greenhouse gas emissions by changing agricultural practices (Climate Change…, 2008). Changing agricultural practices will not only reduce greenhouse gas emissions, but also will increase food safety and will be one of the main causes for the global protection of biodiversity.

OECD explores the potential role of industrial biotechnology in the bio-based economy and examines emerging trends, the impact of innovation, the convergence of technologies, and goes on to identify the challenges involved. It concludes with a need for an integrated and strategic approach to allow industrial biotechnology to fulfil its potential in the struggle with climate change. Industrial biotechnology has suffered a lack of investment at all levels, and there is a serious

mismatch between future expectations of this industry and the low level of investment. Policy intervention is seen to be required across three broad criteria – social/environmental, industrial performance and economical. To make all this happen, not only national, but also international policy is necessary in a rapidly globalising world (Industrial Biotechnology..., 2011).

Dedicated strategies for a bio-based economy have been developed by the European Commission, the US, Canada, Australia, South Africa, Norway, Finland and Germany. Altogether more than 30 countries worldwide acknowledge and politically support the potential benefits of the bioeconomy (German Bioeconomy Council, 2015). Bioeconomy strategies were also developed in Flanders (in 2013), Spain and Italy (in 2016). In addition to the bioeconomy strategy, Germany has also drafted the National Strategy for the Bioeconomy Research 2030 (in 2011). The Netherlands has drafted Bio-based Economy Strategy (in 2012). Denmark set up the national bioeconomy advisory council in 2013, but it has no bioeconomy strategy so far. Ireland, Estonia and France plan to draft a bioeconomy strategy, while the Ministry of Agriculture of the Republic of Latvia is currently finishing up with the preparation of the Latvian bioeconomy strategy in cooperation with the Latvian University of Agriculture.

Summarising the global drivers of bioeconomy, the authors stress on their interconnection. Depletion of natural resources leads to the increasing use of renewable resources, and among them most important is biomass. Supply and demand for biomass is based on a hierarchical order of uses, i.e. first of all food security for growing population in the world must be assured. The major global challenge for assuring food security is impact on climate change, which can be reduced by introducing new, environmentally friendly technologies. This interconnection suggests a need for an integrated and strategic approach as well as policy measures on national and international level in the rapidly globalising world.

EUROPEAN DRIVERS FOR BIOECONOMY DEVELOPMENT

The European drivers are identified using content analysis of the EU and European countries' bioeconomy strategies and analysis of case studies of good practices in European countries and regions.

The European Commission communication "*Innovating for Sustainable Growth: A Bioeconomy for Europe*" (2012) underlines that Europe is facing unprecedented, unsustainable use of its natural resources, significant and probably irreversible climate change and continuing loss of its biodiversity, which is posing a threat to the living systems. The need for a bioeconomy strategy is based on the fact that: "In order to cope with an increasing global population, rapid depletion of many resources, increasing environmental pressures and climate change, Europe needs to radically change its approach to production, consumption, processing, storage, recycling and disposal of biological resources". By nature, the bioeconomy encompasses many sectors and therefore offers a unique opportunity to achieve sustainable economic growth and to fully address interdependent societal challenges, such as food security, lack of natural resources, dependence on fossil resources and climate change. In cross-sectoral policies, complex task interconnections can lead to disagreements, for example, on alternative uses of biomass. In other sectors, the rising demand for biological resources may interfere with food security, as well as raise environmental concerns. Priority is given to the consistency of the political framework and it is emphasized that only a strategic and comprehensive approach covering a wide range of policy areas is appropriate for multi-dimensional issues. The importance of better communication with the public is also emphasised.

The bioeconomy strategy will contribute to the development of low GHG production systems, together with the implementation of the EU commitment under the 2016 Paris Agreement to reduce the GHG emissions in all sectors of the economy by at least 40 percent, compared to the level of the 1990, by 2030.

The Finnish Bioeconomy Strategy (2014) emphasises that the decline in natural resources, the loss of biodiversity and the climate change challenges are determining the need to develop a bioeconomy based on renewable natural resources. The objectives of the Finish bioeconomy strategy are the competitive environment of the bioeconomy, the creation of new businesses, a strong base of bioeconomy competencies and the availability and sustainability of biomass.

The Flemish Bioeconomy Strategy (2013) is based on the needs of society, business and politicians. First of all, bioeconomy is necessary because of the societal challenges (climate change due to the use of fossil resources, the importance of food security for the growing population). In the future energy system based on renewable resources, biomass will be required for heating and other areas, such as aviation and shipping. The starting point is the use of primary biomass and bio-waste, ensuring the food and feed security and the raw material demand for the industry and the energy system. The EU Bioeconomy Strategy and its Action Plan provided the basis for the vision and strategy of the Flemish Government. The Action Plan is based on three pillars: the development of new technologies and processes, the strengthening of markets and competitiveness of the bioeconomy sectors and the promotion of closer inter-sectoral cooperation among all stakeholders (Bioeconomy in Flanders, 2013).

The German National Policy Strategy on Bioeconomy (2013) identifies the following key strategic objectives: security of supply, increasing competitiveness, environmental protection and structural change. Bioeconomy is treated as the opportunity of the 21st century. Climate change, rising population, depleted fossil fuel resources and growing demand for raw materials are challenges opening up new economic development opportunities. In order to take advantage of these opportunities, it is important that a structural shift is made from fossil fuel-based economy to a biomass-based economy, new life and technological science knowledge, new products and processes are created. The value created in bioeconomy depends on the sustainable and efficient use of biomass by means of non-waste production and a tiered approach. Close cooperation among all stakeholders – politicians, business people, scientists and the public – is important in the development of the bioeconomy. Regional and decentralised initiatives make it possible to plan the use of biomass for localised scale.

The Italian Bioeconomy Strategy (2016) indicates the need for the definition of a common framework for various defined and emerging policy areas, technologies and market demands, so that it were possible to share the challenges and

the experiences at global, European, national and regional levels. Agriculture, food, marine, forestry and bio-based industries have two additional and horizontal components. One is based on renewable raw materials and the other on the reuse and recycling of bio-waste. In both cases, it is important to develop the bioeconomy taking into account the local resources and equipment, the interconnection and integration of related industries and public and private interests (Bioeconomy in Italy, 2016).

The main objective of the Spanish Bioeconomy Strategy 2030 Horizon (2016) is to create a bioeconomy as an essential part of the country's economic activity characterised by technological innovations, based on closer public-private cooperation and interaction between the Spanish and the international science and technology systems.

The Norwegian Government's Bioeconomy Strategy (2016) state Norway's ambition to become the most innovative country of bioeconomy. It is emphasised that a full shift to bioeconomy will require significant changes in the use of resources. The strategy stresses new needs for R&D and innovation, declares the intention to support large-scale interdisciplinary research in the field of bioeconomy, prioritise projects involving partners from various scientific fields and sectors and encourages the development of sustainable bioeconomy-driven industry. The Government of Norway will seek to promote the creation of greater value and employment, the reduction of the GHG emissions and more sustainable and efficient use of renewables. The strategy emphasises the new needs for state-funded scientific research, innovation system and its users (The Government's Bioeconomy strategy).

The analysis of bioeconomy strategies and policies in the Baltic Sea region countries (Nordic Council of Ministers, 2016) shows that bioeconomy development could accelerate the sustainable growth of the Baltic Sea region. The need for strategic development of the joint Baltic Sea region and the EU member states is linked to the value added of cooperation in fisheries and aquaculture, increasing the knowledge of sustainable forest management, involvement of the business community, sustainable development of bioeconomy in the Baltic Sea region and its contribution to the development of the European bioeconomy through the best practices of the Baltic Sea region. This justifies the need for development of strategically oriented bioeconomy in Lithuania.

Content analysis of the EU, EU countries' and Norway's strategic documents, as well as of good practices of the EU countries and Norway (Nordic Bioeconomy, 2017) allowed determining that bioeconomy or related strategies and action plans are based on the following 3 principles: 1) to give the priority to food security; 2) to combine food security with sustainable use of renewable resources for industrial purposes and assurance of environmental protection; 3) to apply the cascading principle in the biomass value chain, first of all using biomass in the production of the highest value added products. The analysis of research of the EU countries and good practices of bio-products created by their companies revealed the following trends: use of waste as biomass; integration of sectors of bioeconomy; use of biomass in the production of high value added products; replacement of one type of biomass by another; searching for alternative forms of biomass; development of circular economy.

Merging into clusters is one of the opportunities to expand into export markets, because competing for a single company is rather complex. Clusters also can help to pool resources and competences to develop and implement innovations. Good practices of primary biomass sector clusters were found in Finland, Lower Bavaria (Germany) and the Netherlands. Central Finland is also considered to be an example of good practice in other sectors of bioeconomy, such as pulp, paper and energy. North Rhine-Westphalia, Manchester, Toulouse and Ghent are examples of good practice in the chemicals and polymers industry, with Ghent also being an example in the energy industry. Manchester is very strong in research. However, so far there is a lack of good practice examples in construction, textile and apparel sectors (Good practices…, 2015).

Content and case study analysis revealed that there are five European drivers of bioeconomy strategy. First driver is common EU bioeconomy policy, strategy and action plan. Policy and strategy are based on the global challenges and goals of the EU development. Action Plan is based on three pillars: the development of new technologies and processes, the strengthening of markets and competitiveness of the bioeconomy sector and the promotion of closer inter-sectoral cooperation among all stakeholders. Sustainable development of bioeconomy in the Baltic Sea region is also impossible without coordination of actions between the countries of this region. Second driver is assurance of biomass availability and sustainability, as well as efficient biomass value chain. The basis for efficient biomass value chain are using cascading principle, minimising waste, using waste as biomass, replacing one type of biomass by another, and searching for alternative forms of biomass. Third driver is the need to strengthen markets and competitiveness of the bioeconomy subsectors. Using public and green procurements, motivating business to market new bio-products, developing short supply chains and promoting exports of higher value added bio-products are the complex means, which have to be strategically oriented. Fourth driver is the necessity of close cooperation among all stakeholders, namely politicians, business people, scientists and the public. Strengthening policy interaction and participation of all stakeholders are necessary for the development of sustainable bioeconomy. Fifth driver is the need of the development of new technologies and processes, especially industrial biotechnology. This development is impossible without close cooperation between the scientists and business, and first of all at the European level. Advances in bioeconomy research and implementation of innovation would create conditions for Europe to improve the management of biological resources, open up new and more diverse markets of food and biotechnology products.

NATIONAL DRIVERS FOR BIOECONOMY DEVELOPMENT

The bioeconomy development in Lithuania has been regulated and promoted through certain sectoral policies: agriculture, forestry, fisheries, energy, environment (including waste management), scientific research, innovation and biotechnology development, etc. It was found that interfaces exist only between certain sectoral policies: forestry and energy, agriculture and food industry, forestry and wood industry and so on. Moreover, the analysis of Lithuanian legal

acts revealed that certain documents contain different, i.e. uncoordinated developmental targets for the same sectors. On the other hand, most of the targets are planned for 2020 or the years that follow.

In the future, the cross-sectoral links and interactions in the Lithuanian bioeconomy will increase for a number of reasons: (a) the increased demand for biomass not only in the traditional fields of manufacturing (food, feed, wood, furniture, paper, textiles, clothing and leather) and bioenergy, but also in chemical, pharmaceutical and plastic manufacturing industries, construction or the like, leading to the potential disagreements on alternative uses of biomass; (b) the need to increase the production of higher value added bio-products, i.e. to generate higher value applying cascading principle, leading to the potential conflicts of interest of various stakeholders; (c) the transition towards circular economy will foster biomass and bio-waste reusing and recycling in various subsectors of the bioeconomy, meaning that the waste from the biomass refinery in one subsector will become the biomass for another subsector; (d) the development and implementation of new innovations (technologies and bio-products) in the bioeconomy will require the promotion of R&D by increasing multidisciplinary and cross-sectoral research in this area and by fostering business and science collaboration involving partners from various scientific fields and sectors.

As a result, on the one hand, the development of the Lithuanian bioeconomy requires a consistent cross-sectoral complimentary-based approach in various policy areas and strengthening of their interactions. As highlighted in the European Commission communication "*Innovating for Sustainable Growth: A Bioeconomy for Europe*", such multidimensional issues can only be addressed by a strategic and comprehensive approach covering a wide range of policy areas. On the other hand, bioeconomy encompasses many interconnected sectors, which means that the stakeholders at all levels participate in bioeconomy for a variety of purposes. For both of these reasons, there will be a need for closer interaction between the stakeholders (business, science, politics and society) and policy coordination at both public and private interest levels, as food security will have to be prioritised and combined with sustainable use of renewable resources for industrial purposes and energy, as well as environmental protection. Institutional framework and a coordinating policy are important to ensure this interaction. As the experience of the EU and other European countries shows, these issues should also be addressed politically in Lithuania, ensuring a strategically oriented development of the bioeconomy and the inter-institutional interaction of all stakeholders in tackling the strategic bioeconomy development issues, i.e. creating the Lithuanian bioeconomy strategy and establishing the National Bioeconomy Council.

Potential Benefits of National Bioeconomy Strategy

Taking into account trends of the Lithuanian bioeconomy and strategy drivers discussed in this paper, the bioeconomy strategy development in Lithuania could be motivated by the potential to increase country's competitiveness, ensure contribution to the EU sustainable growth and demonstrate solidarity in addressing global environmental and social challenges (Figure 4).

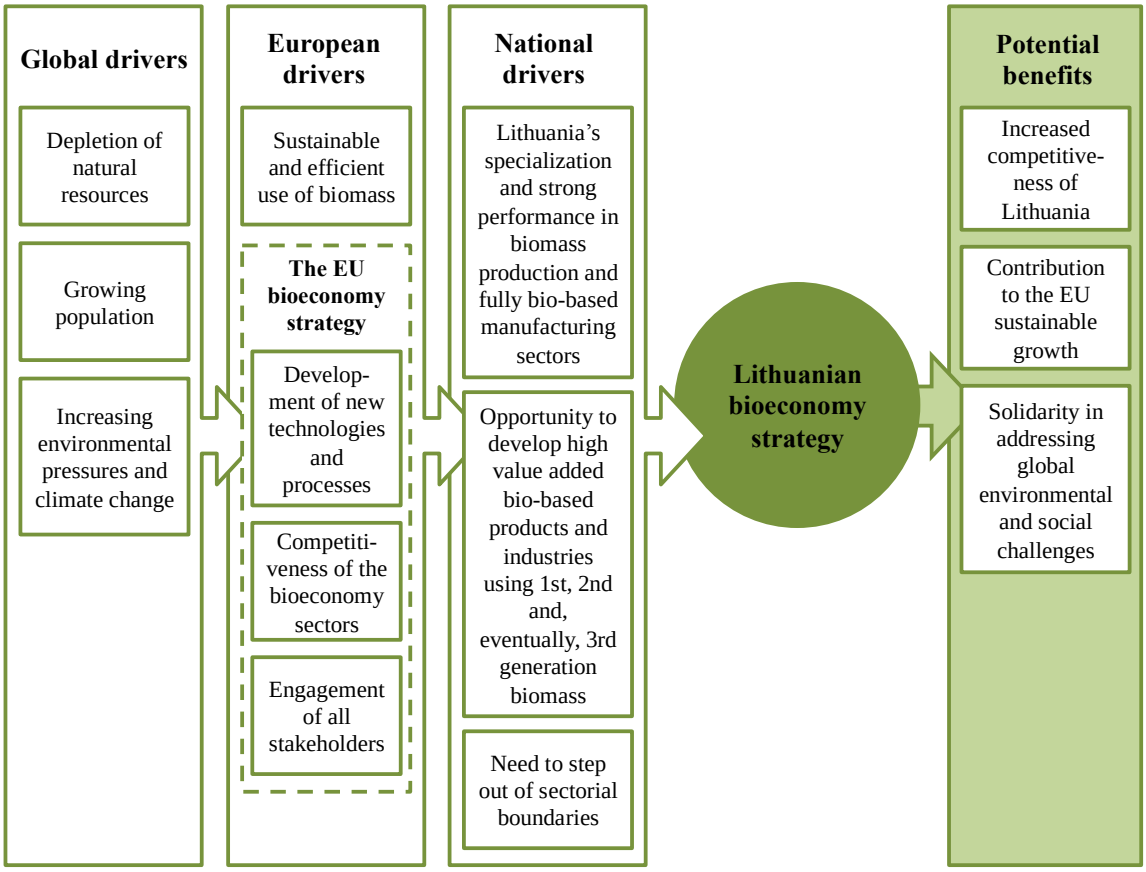


Figure 4. Drivers and potential benefits of Lithuanian bioeconomy strategy development

CONCLUSIONS

In 2015, the Lithuanian bioeconomy generated around 13 percent of GDP and employed 17.6 percent of all persons active in labour market of Lithuania. Food industry and agriculture created more than a half of total GVA generated in the country's bioeconomy. Manufacture of bio-based furniture, manufacture of wood products and manufacture of bio-based textiles, wearing apparel and leather created, respectively, a sixth, a tenth and slightly less than a tenth of the total GVA generated in the Lithuanian bioeconomy. Meanwhile, despite the rapid growth of manufacture of pharmaceuticals in the recent years, small, knowledge-intensive and industrial biotechnology-based sectors of manufacture of pharmaceutical and chemical products made very little contribution to the overall Lithuanian bioeconomy.

Since 2010, Lithuania has been among the leaders of bioeconomy created GVA growth in the EU in all biomass production and fully bio-based manufacturing sectors: the first in terms of the growth of manufacture of paper products; the third in terms of the growth of manufacture of wood products (excluding furniture); the fourth in terms of the growth of manufacture of food and beverages, and the fifth in terms of the growth of forestry and logging, fishing and agriculture. The growth trends determined on the basis of business expectations (according to the survey results) show the potential of continuous development of the Lithuanian bioeconomy subsectors that demonstrated strong growth in the recent years, as well as the emergence of bio-based pharmaceuticals.

Thus, the current state and trends of Lithuanian bioeconomy suppose the conclusion that this sector is much more important for Lithuania than for the other EU countries. Nevertheless, there are other drivers fostering the bioeconomy development and need of the strategy in the future. They can be classified into global, European and national.

Shifting from fossil-based economy to bioeconomy is caused by finite supplies of fossil fuels and raw materials, as well as by climate change issues. Climate change influences food security and its main dimensions – food availability, accessibility, utilization and food systems' stability. This is ever increasing concern, since Europe and the world face the challenges of growing population that must be fed.

At the European level, the bioeconomy development is driven by common EU bioeconomy policy and strategy, which are based on the global challenges and goals of the EU development. The EU Action Plan for bioeconomy development includes the development of new technologies and processes, the strengthening of markets and competitiveness of the bioeconomy sector, and the promotion of closer inter-sectoral cooperation among all stakeholders. Increasing demand for biomass requires assuring its availability and sustainability, and efficient biomass value chain. The basis for efficient biomass value chain are using cascading principle, minimising waste, using waste as biomass, replacing one type of biomass by another, and searching for alternative forms of biomass. Production of new bio-products requires strengthening markets and competitiveness of the bioeconomy subsectors. Using public and green procurements, motivating business to market new bio-products, developing short supply chains and promoting exports of higher value added bio-products are the complex means, which have to be strategically oriented. National bioeconomy strategies are driven by the necessity of close cooperation among all stakeholders, namely politicians, business people, scientists and the public. Strengthening policy interaction and participation of all stakeholders are necessary for the development of sustainable bioeconomy. Use of advanced technologies, such as biotechnology, is the main prerequisite for modern bioeconomy development, while knowledge-based bioeconomy may be an essential part of a viable and sustainable economic system.

In the future, the cross-sectoral links and interactions in the Lithuanian bioeconomy will increase for a number of reasons: the increased demand for biomass not only in the traditional fields of manufacturing, but also in chemical, pharmaceutical and plastic manufacturing industries, construction or the like, leading to the potential disagreements on alternative uses of biomass; the need to increase the production of higher value added bio-products, i.e. to generate higher value applying cascading principle, leading to potential conflicts of interest between various stakeholders; the transition towards circular economy will foster biomass and bio-waste reusing and recycling in various subsectors of the bioeconomy; the development and implementation of new innovations (technologies and bio-products) in the bioeconomy will require the promotion of R&D by increasing multidisciplinary and cross-sectoral research in this area and by fostering business and science collaboration involving partners from various scientific fields and sectors.

The bioeconomy strategy development in Lithuania could ensure these interactions and consensus between different stakeholders, as well as to lay the foundation for Lithuania's competitiveness in the long-term, its contribution to the EU sustainable growth and in addressing global environmental and social challenges.

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