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BIOECONOMY IN POLAND: CONDITION AND POTENTIAL FOR DEVELOPMENT OF THE BIOMASS MARKET

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Abstract. *The aim of the study is to determine the condition of bioeconomy in Poland. Particular attention was paid to the discussion of the objectives and priorities of the national and EU bioeconomy policies and to economic instruments to support the implementation of these policies. The study also covers the analysis of condition of the biomass production sector in Poland, taking into account regional differences. The study was based on the source literature on the subject, programming documents of the European Union and guiding principles for the national bioeconomy development policy in Poland. Statistical data by Eurostat and FAOSTAT were used for the evaluation of the potential of the bioeconomy.*

The research has confirmed that Poland has many traditional industries, which not only produce the biomass, but also process raw materials of biological origin. Bioeconomy is one of the largest and the most important segments of the Polish economy and an important component of the EU market.

Keywords: bioeconomy, biomass, bioenergy, biomaterials, economic policy

Introduction. The concept of bioeconomy is a key issue in recent years, which has emerged in the economic policy and practice. This concept is an attempt to solve many complex social problems growing worldwide and in Europe and an opportunity to accelerate the economic growth. It is based on the assumption that it is possible to make use of natural resources in a more efficient manner and to use more renewable biological resources in order to meet the needs of the consumers and counteract the effects of climate changes. It is obvious that in the coming years we will see increasing competition for scarce natural resources. The growing global population will result in an increased demand for food, and the climate change will affect the production systems in agriculture, forestry, aquaculture, fisheries and fishing. The question is how to solve these problems.

The concept of bioeconomy demonstrates that it is possible to make a way for an economic transition, which will provide conditions for the optimum use of the renewable biological resources and enable the development of sustainable production and processing systems. They will be able to produce a wider range of products using fewer resources and ensuring lower negative impact on ecosystems.

Different definitions of bioeconomy can be found in the literature. In the most general terms, it denotes a sustainable production of renewable

resources (products of agriculture, forestry, fisheries and fishing) and their conversion into food, feed, bio-based products, fibres and bioenergy. Maciejczak and Hofreiter made an evaluation of the selected definitions of bioeconomy and found that the concept was based on the sustainable use of renewable biological resources through innovation, by delivering products, to address both individual needs and public expectations[1]. In sectoral terms, bioeconomy covers the primary production sectors of the economy such as agriculture, forestry, fishing, fishery and the sectors, which use (process) biological resources, such as food sector, pulp and paper industry, as well as parts of the chemical, biotechnological and energy industries.

The concept of bioeconomy does not imply the development of new industries in the global and European economy. Its essence boils down to create efficient systems of use of renewable biological resources based on a combination of existing sectors of primary production and processing. These systems should allow not only for the better use of what we already are able to produce, but also for the efficient use of those resources, which we currently cannot use efficiently. It is assumed that the development of bioeconomy in the coming years will be an important factor stimulating the growth of the European and global economy.

The aim of the study is to determine and evaluate the condition of bioeconomy in Poland. Particular attention was paid to the discussion of the objectives and priorities of the Polish bioeconomy strategy. The study also contains an analysis of the condition and potential of the biomass market in Poland. An important aspect of the study is the evaluation of different degree of development of sectors of production and supply of biomass in the regional context.

The study was based on the source literature on the subject, programming documents of the European Union and guiding principles for the national bioeconomy development policy in Poland. Statistical data by Central Statistical Office (GUS), Eurostat and FAOSTAT were used for the evaluation of the potential of bioeconomy.

1. Political and economic base of development of bioeconomy in Poland

In the strategy published in 2011, the European Commission has set itself the objective of long-term development of a competitive, resource-efficient and low-carbon economy until 2050[2], and the concept of green economy was integrated into the overall economic policy framework of the EU. According to UNEP (2014), green economy aims to improve human well-being, while significantly reducing environmental risks (by reducing the emission of pollutants and increasing resource efficiency) and to prevent the loss of biodiversity and ecosystem service values[3].

[1] Maciejczak M., Hofreiter K., How to define bioeconomy?, Annals of the Polish Association of Agricultural and Agribusiness Economists, Vol. 15, No. 4, 2013.
[2] A Roadmap for Moving to a Competitive Low Carbon Economy in 2050, EC, Brussels, 2011.
[3] Green Economy Initiative, UNEP, 2014, http://www.unep.org/greeneconomy/

The concept of green economy is a foundation for the main EU horizontal strategies, including two flagship initiatives under Europe 2020, that is, "An integrated industrial policy for the globalization era"[4] and "Resource Efficient Europe[5]. Within the flagship initiative, which refers to the industrial policy, it has been concluded that "*The Commission will seek to promote the core competitiveness, processing industries and services in Europe and to promote the use of potential of globalization and green economy*". The aim of the resource initiative is to support the transition and resource-efficient low-carbon economy, which will use all the resources effectively. This initiative aims to contribute to economic growth in Europe.

Within the broad concept of green economy, the guiding principles of bioeconomy focus on use of renewable resources, development of applied research, development of innovation and industrial biotechnology in the sectors such as: food production, feed production, paper production, chemical products and pharmaceuticals, biofuels, etc. Compared to green economy, which puts the emphasis on the environment, bioeconomy focuses on search for new growth opportunities both in traditional and emerging sectors based on biological resources, taking into account the global challenges (including security of supply of raw materials), the limited availability of natural resources and environmental protection[6], [7]).

Bioeconomy is based on biotechnology. The OECD defines biotechnology as "*the application of science and technology to living organisms*"[8]. In the approach adopted by the European Commission, bioeconomy includes "*the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products*", including traditional and emerging sectors, that is "*agriculture, forestry, fisheries, food, pulp and paper production, as well as parts of chemical, pharmaceutical and energy industries*"[9].

In order to establish guiding principles of the development of bioeconomy, the European Commission has presented a European strategy for building a sustainable bioeconomy, which will support the solution to many of today's social challenges. The adopted strategy integrates a few autonomous areas of the EU policy, including primarily climate policy, agricultural and industrial policies, research and development policy and environmental protection policy. By introducing bioeconomy, the strategy proposes a comprehensive approach addressing five social issues: food security; management of natural resources in a

[4]A Resource efficient Europe. Flagship Initiative Under the Europe 2020 Strategy, EC, Brussels, 2011.
[5]Roadmap to a Resource Efficient Europe, COM (2011) 571, EC, Brussels, 2011.
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[8]OECD, 2015. ⟨http://www.oecd.org/sti/biotech/statisticaldefinitionofbiotechnology.htm⟩.
[9]Bioeconomy Strategy, "Innovating for Sustainable Growth: A Bioeconomy for Europe, EC, Brussels, 2012a

sustainable manner; reducing dependence on non-renewable resources; mitigation and adaptation to climate change; creating new jobs and maintaining competitiveness of the European economy. Bioeconomy strategy focuses on three areas: investment in research and innovation; increasing the influence of the policy as well as strengthening the markets and the competitiveness of bioeconomy[10].

In addition to the strategy adopted by the European Commission, many EU Member States developed national bioeconomy strategies. In Poland there is no 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 Medium-Term Strategy for the Development of the Country. Medium-Term Development Strategy of the Country 2020 defines development goals for Poland until 2020[11]. This document puts much emphasis on the development of Poland in three areas: competitive and innovative economy, effective and robust state, evening the differences in development of the provinces. Considerations for the development of bioeconomy cover integrated strategies, including primarily: Strategy for Innovation and Efficiency of the Economy[12], Strategy of Energy Safety and Environment[13] and Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries[14].

2. Importance of bioeconomy sector in Poland

Bioeconomy sector comprises many branches of material production and industry. According to the classification used by the European Commission[15], it can be divided into sectors producing biomass (agriculture, forestry, fishing and fisheries), sectors wholly based on raw materials of biological origin (food industry, production of beverage and tobacco, wood industry, paper industry, production of leather goods) and sectors partially using raw materials of biological origin (chemical industry, pharmaceutical industry, furniture industry, production of rubber and plastics, construction). Important branches of bioeconomy are also sectors of production of bioenergy and biofuels as parts of the fuel and energy sectors.

Poland has many well-established traditional industries involved in the production of biomass, operating based on the materials of biological origin. Table 1 shows the importance of the bioeconomy sectors in the national

[10]Commission Staff Working Document Accompanying the Document Communication on Innovating for Sustainable Growth: A Bioeconomy for Europe, EC, Brussels, 2012b

[11] Strategia Rozwoju Kraju 2020, Ministerstwo Infrastruktury i Rozwoju, 2012, https://www.mir. gov.pl/strony/zadania/polityka-rozwoju-kraju/strategia-rozwoju-kraju/ [Access: 18.09.2015]

[12] Strategia innowacyjności i efektywności gospodarki, Ministerstwo Gospodarki, 2013, http://www.mg.gov.pl/ Wsparcie+przedsiebiorczosci/Polityki+przedsiebiorczosci+i+innowacyjnosci [Access: 16.09.2015]

[13] Strategia Bezpieczeństwo energetyczne i środowisko, Ministerstwo Gospodarki, 2014, http://bip.mg.gov.pl/node/21165 [Access: 20.09.2015]

[14] Strategia zrównoważonego rozwoju wsi, rolnictwa i rybactwa na lata 2012-2020, Ministerstwo Rolnictwa i Rozwoju Wsi, 2013, http://www.minrol.gov.pl/Informacje-branzowe/ [Access: 18.09.2015].

[15] https://biobs.jrc.ec.europa.eu/research/private-investment [Access: 20.09.2015]

economy. 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 averaged annually to about 63.5 milliard euro, representing more than 19% of gross value added produced in the national economy.

1. Gross value added and employment in the bioeconomy sector in Poland (average in the years 2009–2013)*

Specification	Value added, gross 2009–2013		Total employment 2009–2013	
	mln euro	%	mln euro	%
Total – all NACE activities	324356.7	100	15511.14	100
Biomas production - Agriculture, forestry and fishing	10159.9	3.1	1978.5	12.8
Crop and animal production, hunting	8627.7	2.7	1905.2	12.3
Forestry and logging	1116.5	0.3	67.4	0.4
Fishing and aquaculture	51.2	0.0	6.0	0.0
100% bio-based sectors	14261.6	4.4	735.9	4.7
Manufacture of food products; beverages and tobacco products	10450.9	3.2	511.7	3.3
Manufacture of wood and of products of wood	2134.4	0.7	168.5	1.1
Manufacture of paper and paper products	1676.3	0.5	55.7	0.4
Part bio-based sectors	39138.6	12.1	2053.8	13.2
Manufacture of textiles, wearing apparel, leather and related products	2079.9	0.6	256.3	1.7
Manufacture of chemicals and chemical products	2831.4	0.9	95.6	0.6
Manufacture of basic pharmaceutical products	1129.1	0.3	38.0	0.2
Manufacture of rubber and plastic products	4015.1	1.2	161.6	1.0
Manufacture of furniture	3238.1	1.0	281.6	1.8
Construction	25845.0	8.0	1220.7	7.9
Biogospodarka ogółem	63560.0	19.6	4768.1	30.7

*Source: Author's elaboration based on: National Accounts aggregates by industry (up to NACE A*64), Eurostat, http://ec.europa.eu/eurostat/data/database [25.09.2015].

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 of employment it was about 17.5%. Agriculture and agri-food industries are the most important nodes of the Polish bioeconomy.

3. Supply of agricultural biomass in Poland

Table 2 provides the estimates made by the European Commission regarding the total biomass resources in the EU. Against this background, also

estimates for the supply of biomass in Poland were presented. These data include biomass sourced primarily in agricultural production and forestry. But they do not include biomass received from water resources and various types of waste generated in the food industry as well as in trade and consumption of food. Biomass resources extracted in the economy include both raw materials extracted from the environment (e.g. grains, tubers of potatoes), which are materials used by the economy in other production processes (e.g. food industry) as well as residues, which are often used in the economy. Nonetheless a significant proportion of the biomass remains unused for economic purposes.

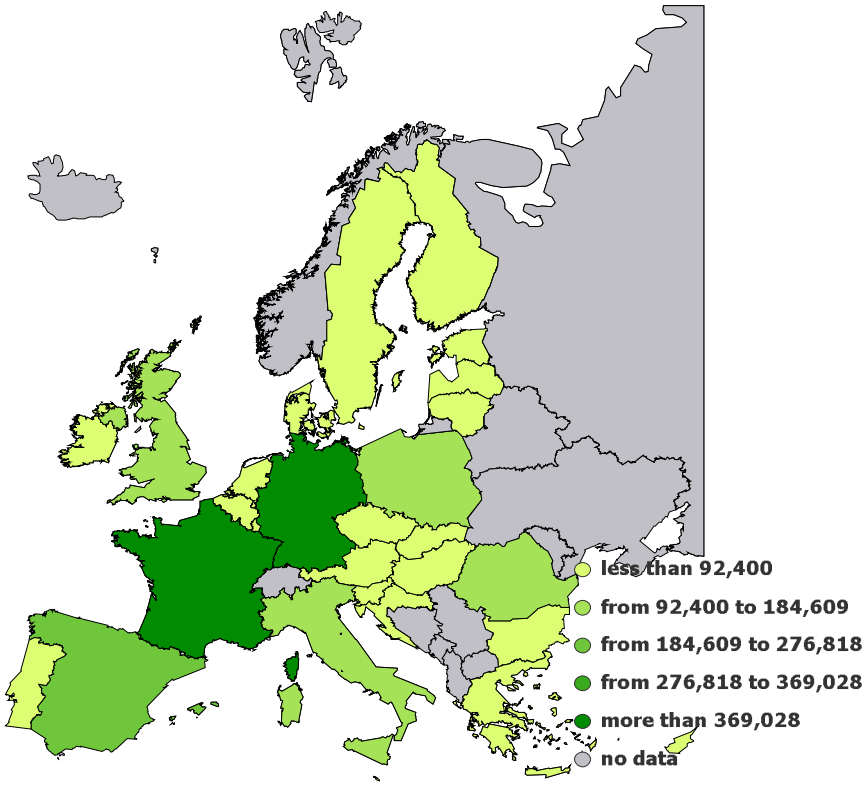
2. Poland's share in the production of biomass in the EU (average for the years 2009–2011)*

Specification	Domestic Extraction, Total	Domestic Extraction Used	Residues, Non-Used	
	Tys. ton	Tys. ton	Tys. ton	Domestic Extraction, Total [%]
EU-28				
Biomass, Total	2399350.5	1741138.3	658212.2	27.4
Crops, Total	2077288.5	1470147.4	607141.1	29.2
Animal	8253.4	6917.8	1335.6	16.2
Wood	311723.0	262515.7	49207.3	15.8
Poland				
Biomass, Total	187027.5	137919.6	49107.9	26.3
Crops, Total	161336.3	115597.1	45739.2	28.4
Animal	291.7	236.1	55.7	19.1
Wood	25399.5	22086.5	3313.0	13.0
Polish participation in the supply of biomass in the EU [%]				
Biomass, Total	7.8	7.9	7.5	X
Crops, Total	7.8	7.9	7.5	X
Animal	3.5	3.4	4.2	X
Wood	8.1	8.4	6.7	X

*Source: DataM web, provided by the European Commission / Joint Research Centre, www.datamweb.com. Data accessed on 26/09/2015. Elaboration based on original data coming from: SERI - Global material flows.

The data presented in Table 2 show that annual biomass production in the 28 countries of the EU comes to approx. 2.4 milliard tonnes, wherein the majority of the biomass comes from the crop production in the agriculture. In Poland more than 180 million tonnes of biomass are produced. About 137 million tonnes are used for economic purposes. Approximately 26% of the biomass produced is not used in the economy. Just as in the whole EU, in Poland the largest supplier of biomass is the agricultural sector.

Poland occupies an important position in the EU countries in terms of supply of biomass. Its share in the overall supply of biomass comes to about 8%. A special place in the supply of biomass is occupied by agricultural production. It is the main source of food raw materials, feed raw materials and raw materials used in various industries. Figure 1 shows the main sources of supply of agricultural biomass in the EU countries.



Biomass of Crops, Total in the EU 28 in 2013 (Domestic Extraction, Total, 1000 T fresh matter)*

*Source: DataM web, provided by the European Commission / Joint Research Centre, www.datamweb.com Data accessed on 27/09/2015. Elaboration based on original data coming from: DataM - Biomass estimates.

Structure of agricultural production of biomass in Poland in 2013 is shown in Table 3.

3. Crop biomass extraction and residues in Poland (2013) in 1000 T fresh matter*

Specification	Harvested biomass	Residues, Used	Domestic Extraction Used	Residues, Non-Used
TOTAL AGRICULTURAL CROPS	97 497	22 814	120 311	39 502
Fodder crops	49 004	0	49 004	0
Total cereals incl. rice	28 428	18 818	47 246	26 336
Sugar crops	10 591	2 860	13 451	2 860
Fruits and Vegetables	9 387	188	9 575	1 690
Starchy Roots	6 334	633	6 968	5 701
Total oilseeds	2 703	502	3 205	4 520
Protein crops	376	0	376	75
Other crops	60	1	61	11
Fibre crops	0	0	0	0

*Source: DataM web, provided by the European Commission / Joint Research Centre, www.datamweb.com. Data accessed on 26/09/2015. Elaboration based on original data coming from: DataM - Biomass estimates.

In the agricultural production the most important are feed crops, cereals, sugar beet, fruit, vegetables and potatoes. The overall supply of agricultural raw materials and the residues used in the economy in 2013 was about 120 million tonnes. Estimates suggest that nearly 40 million tonnes of biomass produced in the agriculture are not used for economic purposes.

4. Regional differences in development of the production and supply of biomass in Poland

Agricultural production in Poland is characterised by considerable regional differences. It results from both the natural and the organisational and economic conditions. In this study, the differences in biomass production sector in Poland are shown by 6 regions distinguished according to the NUTS 1 classification. These regions include 2 to 3 provinces. Rate of gross value added in the agriculture, forestry and fisheries to total gross value added produced in the region as well as the participation rate of employees in the agriculture, forestry and fisheries to total employment in the region are used to show the development of the production of biomass.

4. The importance of biomass production sector (agriculture, forestry and fisheries) in economy of the regions in Poland, according to NUTS 1*

Years	Poland	Regions according to NUTS 1					
		Central	Southern	Eastern	North- Western	South- Western	Northern
The share of agriculture, forestry and fisheries in gross value added [%]							
2009	2.8	2.8	1.1	4.2	3.8	1.8	3.5
2010	2.8	2.8	1.1	4.2	3.8	1.8	3.5
2011	3.3	3.3	1.2	5.0	4.5	2.3	4.3
2012	3.8	3.9	1.4	6.0	4.8	2.7	4.9
The share of agriculture, forestry and fisheries in employment in the region [%]							
2009	13.3	12.1	7.6	25.0	12.4	8.5	12.0
2010	12.7	11.4	7.5	24.3	12.3	7.6	10.7
2011	12.6	11.9	7.6	24.1	11.5	7.3	10.5
2012	12.3	11.3	7.0	22.9	11.5	7.3	11.9

*Source: Author's elaboration based on: National Accounts aggregates by industry (up to NACE A*64), Eurostat, http://ec.europa.eu/eurostat/data/database. Access 25.09.2015.

In terms of the considered rates, most important is the production sector of biomass in the North-Western, Northern and Eastern regions (Table 4). In 2012 the share of gross value added generated in agriculture, forestry and fisheries in these three regions ranged from 4.8% (the North-Western region) to 6% in the Eastern region. The employment in the analysed sectors was averagely about 12%, from 7% in the Southern region to 22.9% in the Eastern region.

Table 5 shows the share of regions in agricultural production in Poland.

The highest share in total agricultural production value fell into three regions: Central, North-Western and Eastern. This concerned both crop and animal production. By far, the Southern region has been characterised by the lowest share in the value of agricultural production. This is in line with the lowest share of this region in employment in agriculture.

5. The share of regions in value of agricultural production in Poland (value of agricultural production at basic prices) in 2010 [%]*

Specification	Poland	Regions according to NUTS 1					
		Central	Southern	Eastern	North-Eastern	South-Eastern	Northern
Cereals (including seeds)	100	17.1	5.7	18.4	24.8	15.1	18.9
Industrial crops	100	7.7	2.8	14.7	30.2	19.9	24.7
Forage plants	100	23.3	7.3	27.8	17.7	5.6	18.3
Vegetables and horticultural products	100	28.0	12.6	18.9	22.9	5.6	12.0
Potatoes (including seeds)	100	38.6	8.1	19.0	15.1	6.0	13.2
Fruits	100	41.9	7.5	37.1	5.8	3.4	4.3
Other crop products	100	10.3	4.1	46.9	20.3	2.0	16.4
CROP OUTPUT	100	23.0	7.1	21.2	21.5	10.7	16.5
Animals	100	21.3	7.6	18.7	26.7	5.1	20.6
Animal products	100	24.3	7.1	27.0	20.8	6.0	14.8
ANIMAL OUTPUT	100	22.5	7.4	22.1	24.3	5.4	18.3
AGRICULTURAL GOODS OUTPUT	100	22.8	7.3	21.6	22.7	8.2	17.4

*Source: Author's elaboration based on: National Accounts aggregates by industry (up to NACE A*64), Eurostat, http://ec.europa.eu/eurostat/data/database Access: 25.09.2015.

Conclusions. Given the demographic processes in Europe and in the world as well as problems with limited access to natural resources, the European Commission adopted Strategy for Sustainable Use of Renewable Resources in the European Economy. The strategy highlighted the need to develop production of renewable raw materials, to provide not only safe and healthy food, but also materials, energy and other products essential to modern society.

In the study, based on the most recent data, volume of the bioeconomy in Poland was estimated, including potential sectors such as agriculture, fisheries and fishing, forestry, food industry, wood and paper industry, manufacture of textile and leather products, chemical and pharmaceutical industries and other industries using raw materials of biological origin. In measuring the importance of these sectors of bioeconomy in the Polish national economy the volume, value added and employment rates were used.

The supply of biomass by product and by region was also compared. It has been found that in Poland there are considerable regional differences in terms of agricultural production and biomass production. The most important in agricultural production are feed crops, cereals, sugar beet, fruit, vegetables and potatoes. It also can be indicated that Poland occupies an important position in the EU countries in terms of supply of biomass. Its share in production of biomass is about 8%. The most important place in the supply of biomass is occupied by agricultural production.

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БІОЕКОНОМІКА В ПОЛЬЩІ: УМОВИ І ПОТЕНЦІАЛ ДЛЯ РОЗВИТКУ РИНКУ БІОМАСИ

Я. Голебієвскі

Анотація. *Метою дослідження є визначення стану біоекономіки в Польщі. Особливу увагу було приділено обговоренню цілей і пріоритетів політики біоекономіки країни і ЄС, а також економічних інструментів для підтримки реалізації цієї політики. Дослідження також включає аналіз стану сектору виробництва біомаси в Польщі, з урахуванням регіональних відмінностей. Дослідження було засноване на вихідній літературі з даного питання, програмних документах Європейського Союзу і керівних принципах національної політики в області розвитку біоекономіки в Польщі. Статистичні дані Євростату та ФАОСТАТ було використано для оцінки потенціалу біоекономіки.*

Дослідження підтвердило, що Польща має багато традиційних галузей промисловості, які не тільки виробляють біомасу, а й

переробляють сировину біологічного походження. Біоекономіка є одним із найбільших і найважливіших сегментів польської економіки й важливою складовою ринку ЄС.

Ключові слова: біоекономіка, біомаса, біоенергія, біоматеріали, економічна політика

БИОЭКОНОМИКА В ПОЛЬШЕ:СОСТОЯНИЕ И ПОТЕНЦИАЛ ДЛЯ РАЗВИТИЯ РЫНКА БИОМАССЫ

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Аннотация. *Целью исследования является определение состояния биоэкономики в Польше. Особое внимание было уделено обсуждению целей и приоритетов политики биоэкономики страны и ЕС, а также экономических инструментов для поддержки реализации этой политики. Исследование также включает анализ сектора производства биомассы в Польше, с учетом региональных различий. Исследование было основано на исходной литературе по данному вопросу, программных документах Европейского Союза и руководящих принципах национальной политики в области развития биоэкономики в Польше. Статистические данные Евростата и ФАОСТАТ были использованы для оценки потенциала биоэкономики.*

Исследование подтвердило, что в Польше много традиционных отраслей промышленности, которые не только производят биомассу, но и перерабатывают сырье биологического происхождения. Биоэкономика является одним из крупнейших и важнейших сегментов польской экономики и важной составляющей рынка ЕС.

Ключевые слова: биоэкономика, биомасса, биоэнергия, биоматериалы, экономическая политика

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THE MAIN ENVIRONMENTAL EFFECTS OF OPERATIONAL PROGRAMME INFRASTRUCTURE AND ENVIRONMENT 2007–2013

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Abstract. *Environmental quality is considered to be one of essential public goods, central to human health and well-being. However, the more and more*