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MIECZYSŁAW ADAMOWICZ
Pope John Paul II State School of Higher Education
Biała Podlaska

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BIOECONOMY – CONCEPT, APPLICATION AND PERSPECTIVES*

Abstract

The paper presents the theoretical and practical view on the concept of bioeconomy. It presents methods of the term's definition, the idea behind it, reasons for its development, its theoretical and practical roots, historical development in Europe and the US and its volumes expressed in production and in employment levels.

The paper discusses the links between bioeconomy and the theoretical concepts of agribusiness, food economy, diffusion of innovation and sustainable development theory. Its connections to regional development issues were also demonstrated. Additionally, the paper shows the concept's connections to the practice of programming development strategies and implementation of sector practices in the European Union. The author also presented the outline of the European strategy for bioeconomy development, its pillars and action plan for bioeconomy. Finally, the paper indicates the directions and significance of bioeconomy for development of the sectors of the economy, regional development and research.

Keywords: biotechnology, bioeconomy, biomass, development strategies.

JEL Cods: O13, Q57, Q16.

Introduction

The concept of bioeconomy appeared increasingly more often both in theoretical concepts and strategic planning as well as in economic life practice of the European Union Member States at the beginning of the second decade

* The article is an extended version of a paper presented at the 23rd Congress of the Polish Association of Agricultural and Agribusiness (September 7-8, 2016, Biała Podlaska).

of the 21st century. Bioeconomy is, on the one hand, a new theoretical and analytical concept and, on the other, a dynamically developing sector of the modern economy. Therefore, the concept of bioeconomy often appears in different strategic documents and development programmes of the European Union of respective Member States and their regions.

This paper aims at getting to know the concept of bioeconomy, its essence, manner of definition, premises, challenges and development factors and the possibilities of its current and prospective use. The theoretical and analytical paper was based on literature review and various documents of the European Union authorities, national governments and territorial self-government bodies as well as reports and analytical documents prepared by specialised institutions. The presentation of the European concept of bioeconomy refers to different, old and new, theoretical and development concepts pertaining to agribusiness and sustainable development of agriculture and rural areas.

The concept and essence of bioeconomy

Bioeconomy can be considered in general categories and from the perspective of a specific field or discipline of science. In the general categories, bioeconomy can be recognised as:

- A new analytical and cognitive concept;
- A modern economy sector;
- A supra-sectoral, strategic form of analysis and programming of scientific and practical activity;
- An elaboration and a new use for the earlier known development concepts referring to the development of agriculture and agribusiness.

The first view on bioeconomy means that it is not yet treated as a new theoretical concept, but rather as a new analytical and cognitive concept in the economy, growing out of the needs of science and practice, which facilitates to the scientists the research process and gives to the recipients the possibility to understand the essence and relations taking place between different components thereof. It is not a brand new concept, but a view of reality that has been changed, extended and adjusted to the contemporary needs as compared to e.g. the concept of agribusiness or food economy. A new challenge for this concept is its integration with the concept of sustainable development.

The second view shows that bioeconomy is a comprehensive, dynamically developing sector of the contemporary economy using biological resources in the economic processes – live organisms, biotechnologies, bioproducts and bioprocesses – to produce new products and services. The used bioproducts are manufactured by different sectors of the economy – agriculture, forestry, fisheries, hydrocultures, etc. The use of new products goes far beyond the food manufacturing sector, especially into the sector of manufacturing medicines, industrial products and energy.

The third aspect refers to bioeconomy as a strategic form of smart actions integrated into the interdisciplinary planning and financing of academic research and use of the human capital. Bioeconomy can be also seen as a creative elaboration and new use of previously known development concepts referring to agribusiness, agriculture and rural areas, as extended to other sectors: forestry, fisheries, energy generation or use of waste. It is not true, though, that the concept of bioeconomy stems directly from the concept of agribusiness and simply extends it.

Reasons behind bioeconomy development

In relation to different views on the concept of bioeconomy, it is possible to specify different groups of reasons for bioeconomy creation and development. Each new concept grows out of the past, has its roots in practical activity and in activity attempting its scientific description. Starting an academic description of the concept of bioeconomy, three key groups of reasons for its creation should be noted:

- General reasons;
- Reasons in the area of science and technology;
- Reasons referring to previously separated theoretical approaches.

General reasons

In this group, it is possible to separate five groups of general phenomena creating conditions for existence and development of countries and communities worldwide. General reasons include the following (EC, 2012; Chyłek and Rzepecka, 2011; Gołębiewski, 2013; Medard et al., 2011; Schmid, Padel and Levidow, 2012; McCormick and Kautto, 2013):

- Global population growth, growth in income and overall well-being in many countries worldwide, generating differences in preferences of consumers and growth in volume of demand;
- Limited growth in production capacities using different forms of progress and resultant growth in market supply;
- Need to seek for a rational and economical resources management, especially non-renewable energy resources;
- Internationalisation and globalisation of the economy;
- Development of international integration, especially European, creating possibilities of a broad and international scale of well-informed formation of the development strategies and policies.

Despite diversified trends in the regions, global population figures continue to grow. In many countries, income and overall well-being of the population improved, especially in a large group of developing countries which underwent or are in the process of socio-economic transformation. This favours overall growth in demand and differentiation in consumer preferences. To ensure food

security and satisfy greater and more varied demand, traditional production methods and techniques are not enough, though. Thus, the level of biological materials processing deepens and extends, new processing branches develop and new products emerge. Development of different forms of progress and new technologies increase the production capacities, market supply and diversity of the production offer. This allows to limit the scope of barriers for a growth in agricultural production and other forms of production connected to the use of biological resources, resulting from a slower pace of growth in food consumption along with an increase in population income.

At the same time, rational management of available resources, especially the non-renewable ones, is increasingly more pressing. The need for reuse of raw materials and resources is growing by creating organised forms of recycling and modern waste management. Priority is given to moving away from the dependence of the economy on non-renewable energy sources and the shift to wider use of renewable energy. The indicated phenomena become an increasingly more common practice in each country and at each place, due to the processes of the economy internationalisation and globalisation and support created by the international integration processes, signing global agreements on international trade, environmental protection and climate change. The presented problems become the subject of deliberate shaping of sustainable development strategies in respective countries and at international scale. The most mature forms of these actions on the international scale under different development strategies and policies were developed in the European Union and in its respective Member States.

Reasons in the area of science and technology

Dynamic development of science, technique and technology, especially in the field of biological and IT sciences, supports bioeconomy development. Initially a huge impact was exercised by academic research and achievements in the field of genetics and molecular biology and industrial biotechnology. Presently, advanced technologies facilitating manufacture of new products from biomass spark lively interest. The Figure, presented below, of branches focused around biotechnologies shows how accommodating is biotechnology and what types of it can be differentiated (Fig. 1). Using the colour range the biotechnologies can be described as green, red and blue, which refers, respectively, to the colour of green mass of field and forest crops, animal products and products coming from fishing in inland and marine waters.

The terminology also includes clean industrial biotechnologies – white in pharmaceutical industry and health care, and grey in manufacturing specialist chemicals and energy. Black technologies are gaining economic ground. They are used in waste and sewage treatment and recycling.

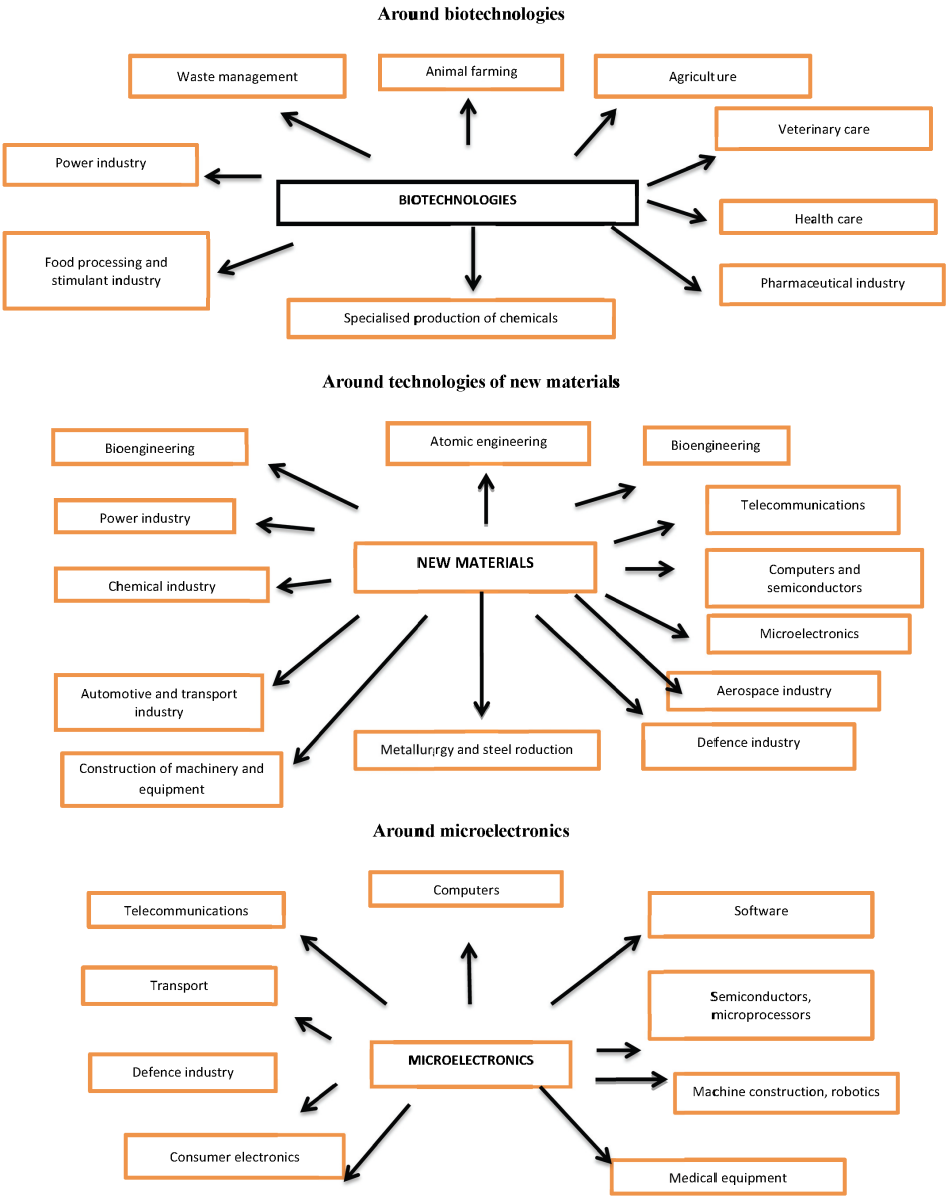


Fig. 1. Related industries focused around biotechnologies, technologies of new materials and microelectronics.

Source: Roobeek, A.J.M (1990). Beyond The Technology Race: An Analysis of Technology Policy in Seven Industrial Countries. New York: Elsevier Science Publishing, pp. xiii + 269, ISBN 0-414-86637-0.

Modern biotechnologies multiply the possibilities of generation of new materials and new products, for which biomaterial is the key resource used in various sectors of the economy (Fig. 1). The entire process of biotechnology development and use enables and streamlines the development of microelectronics and utility data processing systems and communication systems between participants of economic and research and development processes. Especially efficient communication processes are visible in network systems evolving in the economy and society.

A basic reason for putting forward the concept of bioeconomy is the need to find the best way to go from the economy using traditional fossil fuels to the economy based on biological renewable energy sources, bioeconomy and biosociety, whose development will be fuelled by academic research and innovations in the field of biological renewable energy sources. The concept of bioeconomy means economic use of biological resources of seas and lands as well as waste and their reuse in production processes (Adamowicz, 2014).

Theoretical and practical roots of bioeconomy

The above-described phenomena were first recognised by managing bodies of the European Union integration processes and used in the programming and implementation of development plans of the European Communities. The new concept of bioeconomy or knowledge-based bioeconomy was introduced to the practice of development programming, forecasting and modelling in a strategic dimension both at the EU level and in Member States.

What is vital for science, are the reasons for development of bioeconomy, stemming from academic theory and analysis, and reasons for its implementation. The academic roots of the bioeconomy concept can be linked to three theoretical aspects and practical actions related thereto:

- Agribusiness and food economy theory and practice.
- Sustainable development theory and practice, which is still relevant and up-to-date and discussed in numerous papers and scientific publications.
- Regional development theory, giving grounds for selection of a specialisation of the region, important especially for development of preferential regions.

The theory of agribusiness and food economy as well as the sustainable development theory are very well known to the agricultural economists in Poland; hence they do not require wider interpretation. The issues of development of peripheral regions is also often the subject of interests of experts dealing with development of agriculture and rural areas. Regional development theory, giving grounds for selection of a specialisation of the region is especially important for development of preferential regions.

Peripheral regions usually have agricultural economy, and bioeconomy can extend and take to a whole new level the possibilities of their development. Bioeconomy, for instance, became one of the three smart specialisations selected by

the authorities of the Lubuskie region, where the 23rd Congress of the Polish Association of Agricultural and Agribusiness Economists took place. Bioeconomy or its elements were included also in the development strategies of many other Polish regions developed for the next years and decades.

The roots of the bioeconomy concept go to informed actions of the European Union bodies, especially to their analyses, reports, plans and strategies, which aim at development convergence of Member States. For scientists and researchers, it is important that bioeconomy uses, to some extent, instruments such as the information system, the observatory, the platform for gathering knowledge and other as well as it was embedded into many varied development strategies, such as e.g. "Europe 2020. A strategy for smart, sustainable and inclusive growth" or "Horizon 2020 – the Framework Programme for Research and Innovation". At the EU level, these processes are reflected by national actions exemplified by the research programme BIOSTRATEG, 23rd Congress of the Polish Association of Agricultural and Agribusiness Economists targeted at the issues of bioeconomy or increasingly more numerous academic publications on the issue.

Definition of bioeconomy

Lively interest in bioeconomy resulted in elaboration of numerous definitions of the term. How bioeconomy is defined matters because the approach and components of the definition are directly translated into the formulation of the policy and programmes and strategies of economy development (Maciejczak and Hofreiter, 2013). Respective definitions underline different technological and economic or social aspects and priorities, and refer to different development conditions and concepts, such as sustainable development or innovative development.

The first attempts at defining bioeconomy appeared in 1997-1998, and gained momentum as of 2007. Upon creation and dissemination of new definitions, some general regularities can be observed, namely a tendency to move from simple terms to more elaborate ones, and to match the manner of definition and use of the definition to the national conditions and needs of the analysis. The European Union institutions and especially the Directorate-General for Research, OECD and different institutions in the US had a major impact on the development of the concept of bioeconomy. There are clear differences in the approach to the concept in Europe and in the United States, where the area of bioeconomy often excludes the traditional agriculture and the agribusiness sector.

Bioeconomy can be differently perceived not only in respective countries but also by entities in different sectors of the economy. It has suprasectoral character, though. A common feature, regardless of the sector, is consideration of the concept from the perspective of innovation and economic benefits, which can result from its development, given also the inherent risks associated thereto. Despite this differences, it is commonly recommended to support bioeconomy development by the state policy and institutions appointed for the purpose.

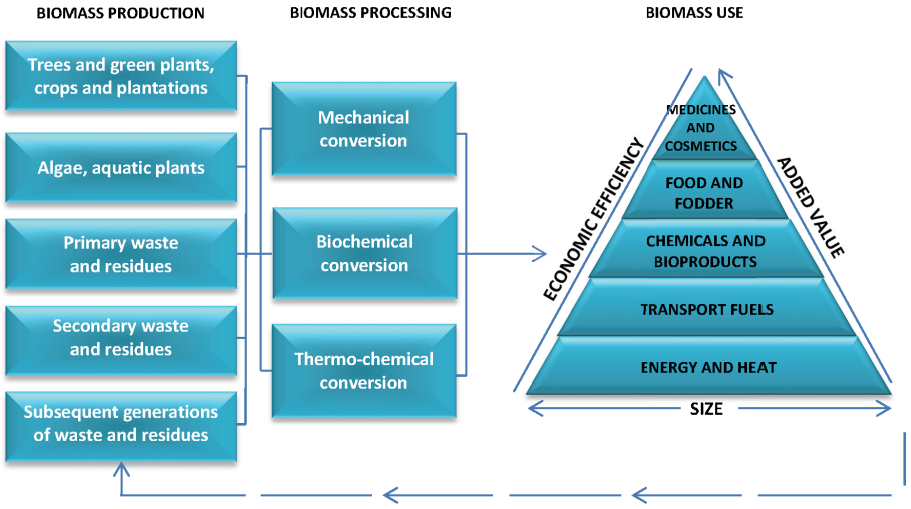


Fig. 2. Biomass-based concept of the economy.

Source: own study based on: Bas Eichaut Saerates Schauten. Concept van den Biobased Economy, http://biobasedeconomy.nl.

In general, bioeconomy can be defined as economy in which the key components of production – manufacture of materials, chemical products and energy – is based on biological and renewable resources (McCormick and Kautto, 2013). Bioeconomy, in production process, uses biomass (biomaterial) obtained from renewable biological resources of plant or animal origin, which are processed in a mechanical, biomechanical or thermal and chemical manner (Fig. 2). Apart from trees, bushes, crops and plantations, the used materials cover also algae and aquatic plants, primary waste and residues, secondary waste and residues, and subsequent generations of waste and residues. Biomass can be used in production of thermal energy, liquid fuels, chemicals, bioproducts, food and fodder as well as cosmetics and medicines.

Such definition of bioeconomy was formulated on an evolutionary path – starting from an original definition of 1997 by Juan Enriquez and Rodrigo Martinez, which officially sparked off the interest of the European Union bodies in bioeconomy through a number of the EU definitions drawn up between 2005 and 2007, and the 2009 OECD definition to more elaborated definitions prepared by the European Commission between 2010 and 2012 and comprehensive interpretations matching the challenges of today's world in 2013-2016. The definition of bioeconomy was disseminated by numerous national and international institutions and organisations dealing with conducting and implementing research and innovations in the economic practice.

One of the earlier definitions of Enriquez and Martinez informed that bioeconomy stands for business activity based on academic research and implementation focused on understanding the mechanisms and processes at the molecular (genetic) level to be implemented and used in industrial processes (Martinez, 1998). The first stage of the concept development involved dynamic development and achievements in the field of biology and biotechnology. Later on, the links between bioeconomy and the natural environment were emphasised which meant, at the same time, a link with ecodevelopment and sustainable development. The definition of 2005, formulated by the European Commission's Directorate-General for Research, argues that "bioeconomy is environment-friendly eco-efficient transformation of renewable biological resources into food, energy and other industrial products" (DG Research, 2005). Following this line, in 2006 DG Research elaborated on the concept of bioeconomy by defining that it contains "all production systems that use biochemical and biophysical processes, including all the natural sciences and related technologies commonly used and necessary to produce useful products, including biotechnology used in agriculture and industry." Bioeconomy covers also biorefineries, production of bioenergy and biochemicals, innovative forms of use of land and sea to create public goods as well as the use of materials commonly considered as waste (KE DG Research, 2006).

Countries having well-developed agriculture and biotechnologies, and significant natural bioresources draw attention to the development of knowledge--based bioeconomy. During the German Presidency in the European Union in 2007, a conference was organised during which a view was formulated that "bioeconomy includes the production of renewable bioresources and their processing into food, fodder, medicines, and other bioproducts and bioenergy". This visionary document emphasised that biotechnology will become the basic element of the European economy by 2030. It suggested, in particular, a growth in share and significance of products of the so-called white biotechnology (medicines, cosmetics, etc.) and bioenergy in industrial production in Europe (McCormick and Kautto, 2013).

The OECD defined the concept of bioeconomy in 2006 and determined its use in development policy. According to OECD "bioeconomy is an aggregated set of economic operations in the society, which uses hidden (latent) values inherent in biological products and processes to speed up growth and achieve well--being for the citizens and nations (OECD, 2006). In 2009, the OECD stated that "bioeconomy means a change in knowledge derived from the natural sciences to new, environment-friendly, eco-efficient and competitive products" focusing on seeing bioeconomy as a reality, in which biotechnology is an important factor influencing economic growth (McCormic and Kautto, 2013). Elaborating on the concept the OECD points out that bioeconomy covers three elements:

– Use of advanced knowledge about genes and cellular processes for programming and development of new processes and products;

– Use of renewable biomass and efficient bioprocesses to stimulate sustainable production;
– Integration of biotechnological knowledge to be used in many sectors.

Biotechnologies and bioeconomy can solve many global problems linked to health and nutrition by facilitating major changes in the global economy over three decades. In the formulation of the concept the OECD used the achievements of different European and American institutions, including the definition of the British minister from the Department for Environment Food and Rural Affairs (DEFRA). In 2007, DEFRA defined bioeconomy as "economic activity, which captures a value hidden in biological processes and renewable bioresources, which results in better health, environment-friendly growth and development" (DEFRA, 2007).

In 2007, the concept of bioeconomy was fairly new and poorly known (Hilgartner, 2007). The term spread quickly between 2010 and 2013, as a result of actions of various European Union bodies. According to the concept formulated in the project of the platform gathering information for the bioeconomy – BECOTEPS (2010), "bioeconomy means all sectors whose products are derived from biomass", and also it is "this part of the economy which generates growth through development and creates jobs in the process of using and processing bioresources in an environment-friendly manner" (Maciejczak and Haffreiter, 2012).

The European Commission in 2010 in the document "Bioeconomy for Europe" presented production models based on biological processes and natural ecosystems, with the use of natural materials, which use up minimum energy, do not generate waste, because all waste crated in it as a result of a single process are a material for the next process, thereby are reused in the ecosystem (EC, 2010). Bioeconomy was similarly defined in the European Union documents published in 2011 (ETP, 2011; Europa Bio, 2011), i.e. as "sustainable production and processing of renewable mass into a wide range of food, medicinal, industrial and energy products and services, namely into different biomaterials to be used directly and as raw materials for manufacture of other products".

The definitions of bioeconomy in the United States point to many similarities to those prepared by the OECD and the European Union. The definition of 2012 published in the documents of the White House states that "bioeconomy is an economy based on the application of research and innovation in life sciences to drive economic activity and public income generation" (The White House, 2012). In this country more attention is drawn to industrial biotechnologies, biofuels, biorefineries, chemical industry, transport or recycling. The above-mentioned sectors are mainly included in the scope of the so-called grey bioeconomy.

The definition formulated by the European Commission in 2012 should be considered as the most complex and comprehensive one. It was drawn up on oc-

casion of preparing the strategy for the use of renewable bioresources in diverse fields of the economy (EC, 2012). According to this definition "bioeconomy means sustainable production of renewable bioresources and their processing into food products, fodder and industrial goods, and into bioenergy, which is based on agronomy, ecology, food sciences, social sciences, biotechnology, nanotechnology, ICT and engineering and covers the following sectors: agriculture, forestry, fisheries, food production, cellulose and paper production as well as elements of the chemical, biotechnological, energy and transport sectors" (EC, 2012).

Historical development of the European concept of bioeconomy

The fundaments for the European concept of bioeconomy can be found in the European Union documents for 1993-2007. First among them was the so-called White Book published in 1993, which explained the need to develop the intangible knowledge-based investments, which covered also biotechnologies. The Lisbon Agenda, adopted in 2000, contained a competitive against the US strategy of knowledge-based economy. In 2002, the European Commission stated that natural sciences and biotechnologies are probably the most prospective technology to achieve the Lisbon Strategy objectives. In 2005, the European Commission outlined the "New Perspectives on the Bioeconomy" and in 2007 the European Council defined the bioeconomy development perspective for the next two decades (German Presidency, 2007). The above-events made it possible to determine a knowledge-based bioeconomy concept used in circles shaping the European development policy (McCormic and Kautto, 2013).

From the beginning of the second decade of the 21st century, in 2010-2012, the European Union took up measures to designate a new development strategy up to 2020-2030 (Adamowicz, 2014). The basic document determining the future of Europe was "Europe 2020. A strategy for smart, sustainable and inclusive growth", which was linked to the plan of ensuring sustainable bioeconomy. The document entitled "Innovating for Sustainable Growth: A Bioeconomy for Europe" presented a concept of action for sustainable use of renewable bioresources in different areas of the economy, especially such as: agriculture, forestry, fisheries, processing industry, food management, power industry, materials management and other industry branches (EC, 2010). This plan is linked to the later announcement of the academic research programme "Horizon 2020" (EC, 2012) which considered the need to increase funding from the public resources for research on bioeconomy and innovations. From the above it follows that bioeconomy became an important area of interest for the EU bodies and it is linked to implementation of various Community practices and national policies of Member States. The bioeconomy concept is continually supplemented and enriched with new elements.

The bioeconomy development strategy and the plan of its implementation are to ensure food security and more innovative use of resources in a competitive

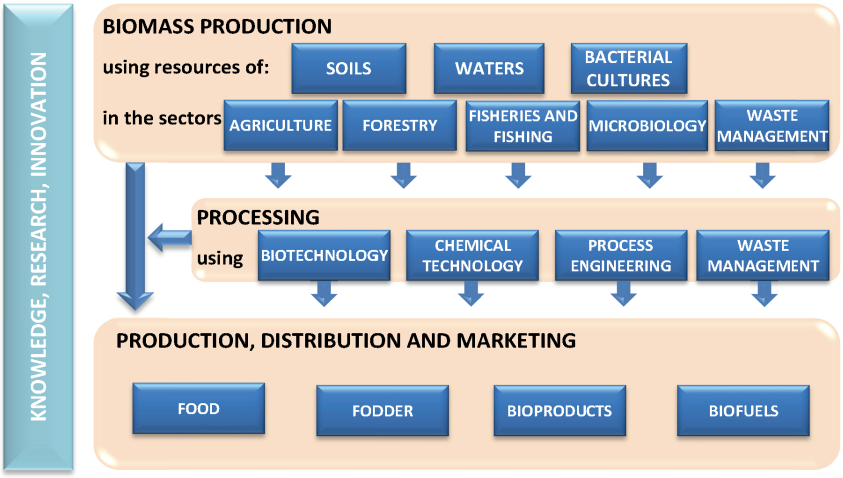
society, at the same time, ensuring environmental protection. A coordinated and coherent development policy and an involved public dialogue at the European and national level, influencing the bioeconomy development, are needed to implement the strategy. It was assumed that the coordination of the bioeconomy development programme with the Community development policies, such as the regional policy, common agricultural policy, environmental, industrial, energy and health policy can bring beneficial synergetic development effects.

Sizes of bioeconomy

The theoretical and analytical bioeconomy concept is based on the realities of economic life. The bioeconomy, as a new concept in economy, is not a new practical concept, since it was a dominating economic sector in the preindustrial area, when it was represented by agriculture, fisheries, forestry and processing of biological materials. Today, a major part of bioeconomy has gone beyond the sectors linked to natural resources management and entered the area of processing, industrial production, transport, trade and consumption integrated by scientific, research and innovative measures. Bioeconomy covers a specific chain of processing and value-creation, in which products from the biomass primary production sectors move through the processing sectors, trade and distribution chains, reaching final users in the form of food, biomaterials for further production and industrial bioproducts and consumption (Gołębiewski, 2013). Three elements: biomass production, processing and production, distribution and consumption are integrated via the system of knowledge and innovation creation and use. A simplified scheme of this real bioeconomy system in the European Union was outlined in the European Union documents of 2010 (Fig. 3).

The basic function of bioeconomy is biomass production, which – as a renewable resource – is used to produce fodder, biofuels, bioproducts and food. In the processing of biomass into more complex and refined products biotechnology, various chemical technologies and physical processes play a key part.

Bioeconomy can be considered from the micro, mezzo and macroeconomic perspective. Enterprises can be specialised in innovative production of various products and services associated with living organisms for food and utility purposes. Regions can choose bioeconomy as the leading smart specialisation of development. Sectors and industries comprising bioeconomy are characterised by major innovation potential due to basing on scientific knowledge, developed industrial technologies and latent knowledge inherent in local communities. What is important for the country is the issue of sustainable and rational use of resources, employment and creation of the national product.



BIOECONOMY SYSTEM
BE Council Report 2010

Fig. 3. Bioeconomy system elements.
Source: BECOTEPS (2010). Bioeconomy innovation. Bioeconomy Council Report.

At the beginning of the second decade of the 21st century annual bioeconomy turnover in the European Union was estimated at over EUR 2000 billion. The sector employs over 22 million people, which is approx. 9% of used labour resources in the entire economy. Approximately 55% of employment is linked with agriculture, 20% with food industry and almost 14% with forestry (Table 1).

Table 1

Sizes of bioeconomy in the EU – as of 2009-2010

SECTOR	Annual turnover		Employment	
	EUR billion	%	thousand	%
Food	965	46.5	4 400	20.0
Agriculture	381	18.3	12 000	54.5
Paper industry	375	18.0	1 820	8.2
Forestry	269	13.0	3 000	13.6
Fisheries and hydroculture	32	1.5	500	2.3
Industry based on bioresources				
Biochemicals and plastics	50	2.4	150	0.7
Enzymes	0.8	0.0	5	0.0
Biofuels	6	0.3	150	0.7
Total	**2079**	**100%**	**22 025**	**100%**

Source: European Commission (2012). Commission Staff Working Document Accompanying the document, Communication on Innovating for Sustainable Growth: A Bioeconomy for Europe.

It needs to be noted that the effects of employment in agriculture in the form of turnover are only partly counted as effects of the sector. A large part of these effects is transferred to other sectors and shows in the production value of food and other products from outside the very agriculture sector.

Bioeconomy as the category of strategic measures

Formulating the bioeconomy concept, the European Union integrated with it the zone of strategic measures reaching out to the challenges of today. Implementation of one of the key strategic objectives, which is transfer from making the economy dependant on fossil fuels to full use of renewable energy and resources, due to integration of science, economy, state and civil community measures can take place via the medium of (ETP, 2010):

– Faster accumulation of basic knowledge and development of new technologies and absorption of innovations. This can be achieved by intensification of research, improved education and implementation activity. A key role can be played by establishment of systems and networks as well as entrepreneurship development.
– Development and implementation of new adequate economic structures and efficient risk management system and implementation of international cooperation.
– Establishment of a solid ground for progress continuity by shaping research programmes, innovation support, streamlining the operation of markets and targeting education programmes.
– Getting wide acceptance and social support for implementation of the concept of bioeconomy and its constant improvement.

The European bioeconomy concept, developed in 2011-2012, aimed at overcoming many contemporary challenges and introduced relevant strategic measures (Fig. 4).

Transformation of the theoretical bioeconomy concept into an efficient system of practical action requires integrated actions of politicians, entrepreneurs, scientists, local government activists, investors and other stakeholders as well as regular citizens. To this end, what is required is an efficiently operating information system targeted at educational activities, respective support and promotion systems, availability of financial resources and favourable social climate and dialogue. It is also necessary to implement a relevant organisation and management system in the chains and networks of bioeconomy, as well as a monitoring and evaluation system. Establishment in the area of a special IT system for bioeconomy, and bioeconomic and technological knowledge platform BECOTEPS was another important step. In the field of science, an European research and innovation programme "Horizon 2020" and the European Institute of Innovation and Technology was established. Organisational support for strategic measures is provided by the Standing Committee on Agricultural Research (SCAR) and Foresight conferences, which transmit the EU concepts to the practical actions of respective countries.

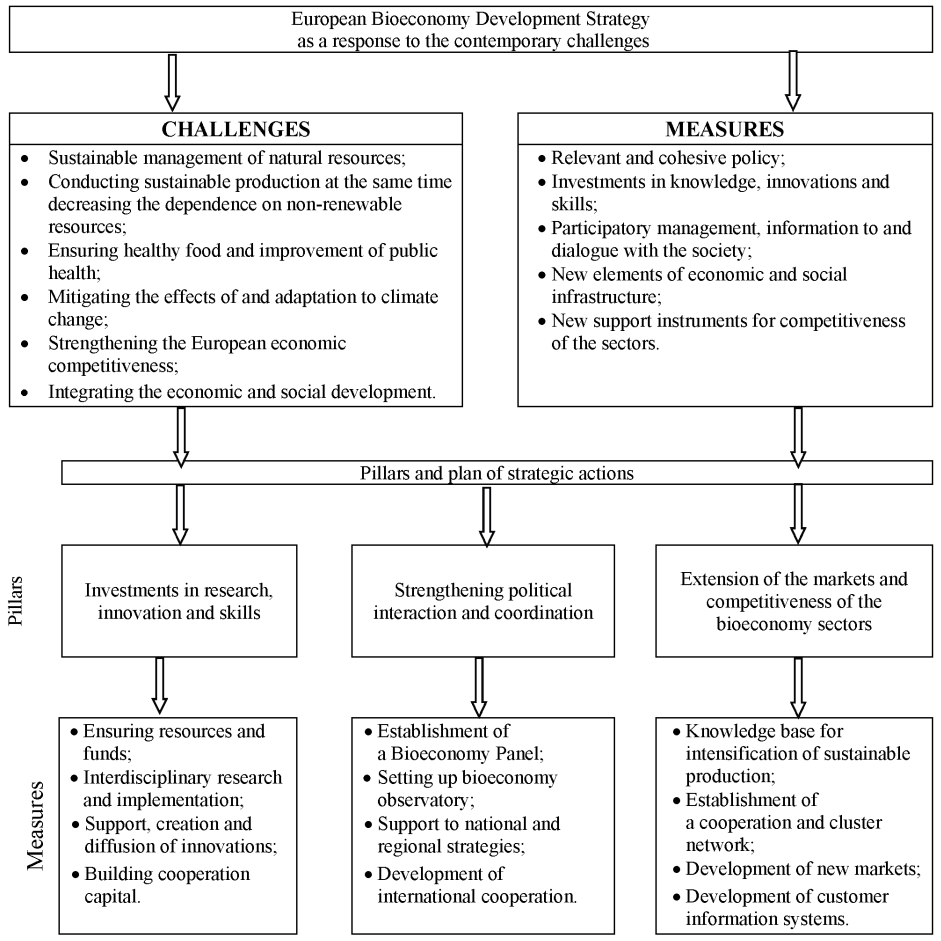


Fig. 4. European bioeconomy strategy and action plan.
Source: own study using different European Union documents.

The European strategy and action plan for bioeconomy by 2020 assumes implementation of various objectives which can be clarified as follows (EC, 2010):
- Strengthening European leadership and creativity in the field of biological research;
- Optimisation of the innovation and knowledge transfer system;
- Research ensuring safe, available and well-balanced food;
- Implementation of sustainable rural and water management systems;
- Streamlining agricultural and food products manufacture and distribution systems;
- Sustaining competitiveness of the European agriculture and food processing;

– Development of low-carbon industries;
– Reduction of emissions of greenhouse gases and waste.

The aforementioned objectives, along with other strategic programmes, outlined for 2020, which concern innovation, natural resources, finances, academic research and industry policies (agriculture, fisheries), constitute the core element of the programme of smart, sustainable, inclusive growth in Europe (EC, 2012). It was assumed that the definition of the bioeconomy concept will establish new possibilities and impulses for economic growth, higher employment, environmental, economic and social strengthening of sustainable development of rural, costal and industrial areas.

As it follows from Fig. 4, the European bioeconomy development strategy in documents of 2012 is based on three pillars (EC, 2012):

- Investments in research, innovations and skills in the field of bioeconomy funded from the EU, national and private resources and seeking synergies with other initiatives and policies.
- Strengthening interactions and political coordination as well as greater involvement of stakeholders by establishing a panel and bioeconomy observatory, and also regular organisation of conferences and consultations with interested entities.
- Market development and competitiveness in the bioeconomy sectors as a result of sustainable development of basic production and transformation of the waste stream in products with value added as well as due to the mechanism of mutual learning to facilitate production and management of resources.

Introduction of the bioeconomy concept and its development strengthened the conviction that Europe is the world leader in different areas of bioeconomy and involved technologies. This concerns especially biotechnology in the chemical, food and fodder industries. There is, however, a major competitiveness from other highly-developed countries. Taking up implementation of the concept of bioeconomy, it was attempted to create anew the areas of various development policies and to strengthen mutual relations between them. To this end, new supporting institutions, such as: European Platform, Bioeconomy Panel and Observatory, were created. Development strategy is also translated into a practical action plan, whose outline was presented in Fig. 4. The bioeconomy strategy implementation plan covers mainly actions aimed at achievement of the assumed strategic objectives with the use of the existing Community programmes and policies, including common agricultural policy, regional, industrial, environmental, climate and energy policy and others.

Perspectives of using the bioeconomy concept

One of the major challenges of the contemporary times, both in the field of economy and policy, facing the European countries and other countries worldwide is targeting economy at sustainable development by the use of human and

environment-friendly innovative and effective techniques and technologies of using natural resources. The use of the achievements of science and technique for the development objectives under sustainable production systems should consider an important element of such system, which is bioeconomy. The validity of these concepts is mentioned in numerous documents of the European Union institutions concerning the European Development Strategy and currently ongoing discussions and taken up measures to prepare different official legal and organisational solutions which can be used by Member States. Conferences of the Standing Committee on Agricultural Research (SCAR) is one of the examples of such measures which presents new results of research on bioeconomy. According to an initial report of a group of Foresight experts, presented in spring 2015 during a SCAR conference, bioeconomy has the potential to solve such problems as: food security, sustainable resources management, lower dependence on non-renewable resources, limiting adverse climate change, job creation and maintaining competitiveness. The SCAR report, presented during the conference entitled "Sustainable Agriculture, Forestry and Fisheries in the Bioeconomy – A Challenge for Europe", held in October 2015 in Brussels, included new elements involved in bioeconomy. These new elements were acknowledged by the 4th regular conference in April 2016 in Utrecht, which resulted in drawing up a manifesto "European Bioeconomy Stakeholders Manifesto". It pointed out the need for efficient resources management and closed loop recycling – from production through use to removal and processing of waste (the so-called "from the cradle to the grave" approach): building a hierarchy and applying the cascading rule in the biomass chain; establishing and strengthening the concept of "lifecycle of products" and "value chains" in bioeconomy. All these approaches draw attention to the need to strengthen the significance of the sustainability and durability concept in the development strategies and in the measures implementing the strategies – the significance of innovation and participation.

In 2016, the European Commission announced a revision of the 2012 Communication entitled "Innovating for Sustainable Growth: A Bioeconomy for Europe" (COM 2012/60), which explained the European concept of bioeconomy. The new package of circular bioeconomy provides for:

– Development of environmental standards for secondary raw materials to streamline their identification and increase potential of their use on a single market;
– Implementation of a closed-loop recycling strategy for plastics covering recycling, biodegradability and the presence of hazardous substances in plastics and sustainable development goals for reducing marine waste;
– Measures to reduce food waste;
– Changes in determining the characteristics of organic and used fertilisers, and supporting the role of biological components in fertilisers;
– Measures to reuse wastewaster.

Implementation of the aforementioned solutions is to enable achievement of municipal waste recycling indicators at 65% by 2030, and in case of packaging waste – 75%. This will also allow for reduction in the stream of waste intended for landfill to a maximum of 10% of the entire mass of waste by 2030. A total ban on landfill of segregated waste is also assumed. Establishment of circular economy will also have a major impact on reduction in the negative impact of product life cycle on the environment. Real challenges towards households and small and medium-sized enterprises play an important role in the process.

Conclusion

Development of the bioeconomy concept and its use in the establishment of the development strategies and implementation of the economic development and industry policies implementation, both at the EU level and in respective Member States, is important for further actions on the field of:

- Agriculture, agribusiness and rural areas development and functioning;
- Formulation of smart specialisation in development of respective countries and regions;
- Targeting and supporting activity in scientific research, implementation and innovations;
- Strengthening competitiveness of the European countries and sectors of the economy creating the bioeconomy complex on the international and global levels.

Agriculture and food industry sector in Poland belong to the key areas of economic and social impact under the bioeconomy. The role of other industrial structures and also power industry is strongly linked to bioeconomy. Development strategies of the entire economy as well as respective sectors should thus consider conditions, needs and possibilities of the bioeconomy development.

The bioeconomy is a category very important for shaping specialisation and regional development. The European Union authorities initiated definition and selection of specific areas of smart specialisation by the regions. Poland selected five smart specialisations associated with the agri-food sector, healthy society, agri-food bioeconomy, forest and wood and environmental bioeconomy, sustainable power industry, natural resources and waste management, innovative technologies and industrial processes. Some regions in Poland chose bioeconomy as one of the leading smart specialisations of the region, others introduced to the adopted regional specialisations selected elements from the broad set of bioeconomy components.

Bioeconomy was clearly reflected in the EU research programme "Horizon 2020", and in Poland also in launching a Biostrateg research programme. The research policy in Poland should consider the needs of bioeconomy research development ensuring relevant funds for the purpose. Another important research area should be the economic aspects of bioeconomy development.

The bioeconomy concept may meet an important integration function for different economic sectors. Development of research on bioeconomy and support to its practical development can be an important factor of raising the international competitiveness of our country.

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MIECZYSŁAW ADAMOWICZ
Państwowa Szkoła Wyższa im. Papieża Jana Pawła II
Biała Podlaska

BIOGOSPODARKA – KONCEPCJA, ZASTOSOWANIE I PERSPEKTYWY

Abstrakt

Celem pracy jest zaprezentowanie koncepcji biogospodarki od strony teoretycznej i praktycznej. Przedstawiono sposoby definiowania pojęcia, istotę biogospodarki, przesłanki jej rozwoju, teoretyczne i praktyczne korzenie biogospodarki, rozwój historyczny w Europie, w Stanach Zjednoczonych, rozmiary wyrażone w wielkości produkcji i zatrudnieniu.

Omówiono powiązanie biogospodarki z koncepcjami teoretycznymi agrobiznesu, gospodarki żywnościowej, dyfuzji innowacji i teorią rozwoju zrównoważonego. Wykazano także jej powiązanie z treściami rozwoju regionalnego. Z drugiej strony, wykazano powiązanie koncepcji z praktyką programowania strategii rozwojowych oraz realizacją polityk branżowych w Unii Europejskiej. Zaprezentowano zarys europejskiej strategii rozwoju biogospodarki, jej filary oraz plan działań na rzecz biogospodarki. W zakończeniu wskazano na kierunki i znaczenie biogospodarki dla rozwoju sektorów gospodarczych, rozwoju regionalnego i badań naukowych.

Słowa kluczowe: biotechnologia, biogospodarka, biomasa, strategie rozwoju.

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