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Lyamar V.V.

*PhD in Economics, Senior Lecture,
Separated Subdivision of NULES of Ukraine
«Nizhin Agrotechnical Institute»*

BIOECONOMY CONCEPT: SCIENTIFIC APPROACHES TO UNDERSTANDING

КОНЦЕПЦІЯ БІОЕКОНОМІКИ: НАУКОВІ ПІДХОДИ ДО РОЗУМІННЯ

ANNOTATION

The article is devoted to the urgent scientific problem of scientific approaches to understanding of bioeconomy concept. It is analyzed literature and given several examples of bioeconomy definitions. It is concluded that bioeconomy as a whole can be split into three distinct market segments; the sectors that supply biomass, those that convert biomass into intermediate products and those that bring biobased end-products to market. The research strategy lays out five priority fields of action for further development towards a knowledge-based, internationally competitive bioeconomy. These are: global food security, sustainable agricultural production, healthy and safe foods, the industrial application of renewable resources, and the development of biomass-based energy carriers. Today the bioeconomy concept covers all nations and economies and it faces such global challenges: management of resources; sustainable and smart production; developing and insuring public health; mitigating climate changing; integrating social development; global sustainable development challenges.

Keyword: bioeconomy concept, global challenges, biomass, climate changing, biobased products.

АНОТАЦІЯ

Статтю присвячено вивченню наукових підходів до розуміння поняття біоекономіки. Проаналізовано літературу та надано декілька визначень даного поняття. Визначено, що в цілому біоекономіка представлена трьома сегментами, це: сектори, що формують пропозицію біомаси; галузі, що переробляють біомасу; галузі, що постачають біопродукцію на ринок. Виділено п'ять пріоритетних напрямків розвитку знаннєємної конкурентоспроможної біоекономіки, а саме: охорона глобального продовольства, стійке сільськогосподарське виробництво, промислове використання відновлюваних ресурсів, виробництво екологічних продуктів харчування, виробництво біоенергії. Визначено, що на сьогоднішній день концепція біоекономіки охоплює всі країни та має відповісти на такі глобальні виклики, як: управління ресурсами, стійке та розумне виробництво, охорона здоров'я, пом'якшення впливу на довкілля, глобальний стійкий розвиток.

Ключові слова: концепція біоекономіки, глобальні виклики, біомаса, зміна клімату, виклики розвитку.

АННОТАЦИЯ

Статья посвящена изучению научных подходов к пониманию понятия биоэкономики. Проанализирована литература и предоставлено несколько определений данного понятия. Определено, что в целом биоэкономика представлена тремя сегментами, это: секторы, которые формируют предложение биомассы; отрасли, которые перерабатывают биомассу; отрасли, которые поставляют биопродукцию на рынок. Выделено пять приоритетных направлений развития знаниеемкой конкурентоспособной биоэкономики, а именно охрана глобального продовольствия, стабильное сельскохозяйственное производство, промышленное использование возобновляемых ресурсов, производство экологических продуктов питания, производство биоэнергии. Определено, что на сегодняшний день концепция биоэкономики охватывает все страны и должна ответить на такие глобальные вызовы, как: управление ресурсами, стабильное и разумное производство, здравоохранение, смягчение влияния на окружающую среду, глобальное устойчивое развитие.

Ключевые слова: концепция биоэкономики, глобальные вызовы, биомасса, изменение климата, вызовы развития.

Formulation of the problem. Over the coming decades, Europe must ensure a safe, healthy and prosperous environment for current and future generations. Successfully addressing major environmental, social and economic challenges will change the way we live and work. The bioeconomy will make this a change for the better if its potential for sustainable production and conversion of biological material is fully exploited. The mature, sustainable bioeconomy will help deliver global food security, improve nutrition and health, create smart bio-based products and biofuels, and help agriculture, forestry, aquaculture and other ecosystems to adapt to climate change [1, p. 469].

The bioeconomy is widely recognized as a concept whose core function is the use of natural resources by applying the cross sectorial and innovative approach, with a basis in circular economy. In the circular economy the material flows are of two types: biological nutrients, designed to reenter the biosphere safely; and technical nutrients, which are designed to circulate at high quality without entering the biosphere [2]. Thus, as Maciejczak emphasizes "bioeconomy is perceived as a concept that could contribute to more sustainable growth in various ways, achieving a positive environmental and social impact, while ensuring economic growth through innovative products and the preservation of traditional sectors, such as food production. As such, bioeconomy is perceived very holistically in a wide systemic approach" [3, p. 137].

Analysis of recent studies and publications. There are a lot of papers devoted to understanding of bioeconomy concept. Researches study different aspects of such issue. In the given paper it will be analysed materials both Ukrainian and foreign researchers. The paper is based on materials of Lyamar V. [1], Maciejczak M. [3], Talavyrya M. [4], Dulaska I. [5], Baidala V. [6], Carlson R. [7] and others.

The data for the paper is taken from publications and reports of the European Commission (2008-2013), Annals of the Polish Association of Agricultural and Agribusiness Economists (2015), Nobel Economy Herald (2012), Scientific Letters of Academie of Michal Baludansky (2015), Materials of the XI International Scientific and Practical Conference "Fundamental and Applied Science".

Defining unresolved parts of the general problem. Analysis of scientific literature has allowed

defining a lot of bioeconomy definitions. It is a modern concept but it isn't a new phenomenon. It is necessary to summarize scientific approaches to understanding bioeconomy concept and to highlight the main features of it because different researchers study different aspects of this problem.

The aim of the article. The main aim of the article is to study scientific approaches to the bioeconomy vision and to highlight the main features of this phenomenon.

The main material. There are a lot of papers devoted to the bioeconomy definition. Modern scientists use different approaches studying this issue. According to Talavyrya M. [4, p. 251]. bioeconomy is based on production paradigm which is connected with biological processes and use natural resources from the environment and it needs minimal energy costs and doesn't pollute the environment because entering resources are used many times and completely converted in ecosystems.

Bioeconomy is an economy which uses biological resources of the Earth and sea, production and household waste. Besides bioeconomy includes the biotechnology concept for state development branches [5, p. 81].

It is necessary to underline the bioeconomy definition given by Baidala V. According to her view bioeconomy is such subsystem of the economy which connects relations between people which appear during a process of production, change and distribution of goods taken due to biotechnology using based on the principle of energy saving, recycling, not environment polluting with the aim to high the quality of life lifelong [6, p. 220]. We can't not to agree with such definition of bioeconomy. The second part of the twentieth century is characterized by production industrialization which doesn't take into account human needs and environment protection. It is seen the user attitude to nature, air and sea. The humanity used to just use natural resources not saving and protecting it. As a result today there is the lack of fossils and ecosystems disappearance. Many of the world's ecosystems that support human societies are already overexploited and unsustainable. Climate change could exacerbate these environmental problems by adversely affecting water supplies and agricultural productivity. Biotechnology offers technological solutions for many of the health and resource-based challenges facing the world [7, p. 109].

Europe also traditionally played a key role in training agronomists and breeders from developing countries and it is essential that the decline in recent years is urgently reversed [9].

A small number of the reviewed papers included a model of the bioeconomy. Having a clearly defined understanding of the operation of the bioeconomy is key for understanding how drivers and criteria for bioeconomy development are prioritised, and how the criteria assessed in

this Work Package link to the instruments and measures that are explored in Work Package 2.

The most relevant model of bioeconomy reviewed in the literature was the SAT-BBE project [10]. This model concentrates on the demand and supply of biomass, and identifies the key drivers that feed into the bioeconomy; however, it does not break down the demand and supply-sides of the market in any great detail. An alternative model of the bioeconomy is presented in Regional Biotechnology [11], although this focuses solely on the supply side.

It is clear from the reviewed literature that an all-encompassing model of the bioeconomy must consider both the demand-side and supply-sides of the market for bioeconomy. A successful bioeconomy is one that maximises both the supply-side and demand-side of the market to ensure both that it is able to produce, and sell, bioeconomy products and services. Bioeconomy as a whole can be split into three distinct market segments; the sectors that supply biomass, those that convert biomass into intermediate products and those that bring biobased end-products to market. Clearly each of these has different priorities in terms of the supply and demand for products. The model should take account of the factors of production (which affect the supply side) and the demand for bioeconomy both within and outside of the region (i.e. the demand side). Adopting a 'factors of production' approach to the supply side enables us to evaluate separately the criteria related to each element of the supply-side [12]. Here we consider separately the three classical factors of production: land (or, in a bioeconomy context, natural resources), labour (meaning human capital) and capital (describing the processes used within the bioeconomy); as well as a fourth factor, innovation, which while not traditionally a factor of production in itself, nonetheless plays a major role in how the three factors interact to determine the overall supply of bioeconomy products. On the demand-side we have consumer, export, and business demand combined. This gives us the following overall framework.

The observed outcome for bioeconomy is the area in which the supply-side and demand-side overlap; therefore the key to a successful bioeconomy is to maximise the overlap between these two. Each of the criteria that are identified in the literature (and which we expand upon below) are aimed at measuring the state of the regional market for bioeconomy: either through capturing the state of the supply side (i.e. one of the four identified factors of production), the demand side (i.e. the identified markets for bioeconomy) or the interaction between the two (e.g. the point at which demand and supply intersect).

This model does not pre-suppose an outcome. It is possible for demand and supply to have no overlap without policy intervention, and indeed, in regions with little or no existing bioeconomy, a key question to be answered through this proj-

ect is where specific strategies should be targeted within this model to maximise deployment of the regional bioeconomy.

The EU food manufacturing sector and households alone waste about 90 million tons of food annually or 180 kg per person, not taking into account losses in agriculture and fisheries. The Strategy will support more resource-efficient food supply chains in line with the Roadmap to a Resource Efficient Europe and the Blue Growth Initiative.

Agriculture, forestry, fisheries and aquaculture require several essential and limited resources to produce biomass. These include land, sea space, fertile soils, water and healthy ecosystems, but also resources such as minerals and energy for the production of fertilizers.

The EC formulated the following definition that was published in the ‘Communication on Innovating for Sustainable Growth: A Bioeconomy for Europe’ (29 February, 2012): “The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries. Its sectors have a strong innovation potential due to their use of a wide range of sciences (life sciences, agronomy, ecology, food science and social sciences), enabling and industrial technologies (biotechnology, nanotechnology, information and communication technologies (ICT), and engineering), and local and tacit knowledge» [13]. We consider, this is relatively broad and generic definition, though it is not without some drawbacks, it does not directly indicate the concept of sustainable economy (circular economy).

On this occasion the research project team The EU FP 7 SAT-BBE project: Systems Analysis Tools Framework for the EU Bio-Based Economy Strategy stresses although not explicitly

mentioned, it takes into account the important process of moving from a linear towards a circular economy by using agricultural waste streams at farm (e.g. manure), post-harvest (e.g. straw, plant residuals) and retail levels (e.g. food waste). Instead of looking at waste as a cost factor linked to currently existing bans on dumping waste, organic or biodegradable waste could be treated as a by-product or return factor of agrofood and fishery. Moreover, the definition allows for an ecosystem-driven green economic and industrial vision on the bioeconomy, i.e. in which fossil fuels are replaced by biobased substitutes, not only for energy, but also for material, clothing, plastic, and chemical applications and non-market services [14]. The transition towards a bioeconomy thus implicitly embeds a transition towards a circular economy, ensuring the sustainable use of agricultural waste and by-products, contributing to new competitive opportunities of the concerned sectors, reducing the potential harm to the environment and taking into account the value of non-market services [10].

Global challenges demand global solutions. The Bio-economy Strategy will support a global approach to more sustainable resource use. This will include developing an internationally shared understanding of biomass sustainability and best practices to open new markets, diversify production and address long term food security issues [13].

Investments in research and innovation under this societal challenge will support Europe in contributing to food security, climate protection and sustainability. It will also enable Europe to take leadership in the concerned markets and will play a role in supporting the goals of the Common Agricultural Policy, the European Bio-economy Strategy, and more broadly of the Europe 2020 strategy and its flagship initiatives ‘Innovation Union’ and ‘Resource-efficient Europe [11].

The bio-economy encompasses a range of established policy areas at global, EU, national

Table 1

The concept of the European bioeconomy

Challenge	The EU needs a holistic strategy which weaves the bio-economy into the fabric of policy making across many sectors throughout its Member States. To be successful, it is essential that we address the regulatory fragmentation that exists across the range of policy areas that can enhance the bio-economy. This is a problem which is especially keenly felt in Europe and which is much less present for the EU’s global competitors.
Opportunity	On 13 February 2012 the European Commission adopted its strategy on the bio-economy. This represents a milestone in the recognition of the potential and value of the bio-economy and its actors across Europe. Leading the world in transitioning to an economic model which uses more renewable resources is an ambitious goal. EuropaBio believes that the bio-economy strategy, as proposed by the European Commission, is an important first step toward the development of a strong and sustainable European bio-economy
Action	To harness the potential of the bio-economy we call upon EU and national decision makers to: integrate the bio-economy strategy into agricultural, environmental, energy, regional, climate and industrial policies; implement the Priority Recommendations from the Lead Market Initiative (LMI) for Bio-based products to help bridge the gap from research to EU commercialization of sustainable bio-based products. The LMI for Bio-based products Priority Recommendations address a range of measures including access to feedstock, research and development, access to markets, public procurement and communications aspects; communicate the benefits of the bio-economy with farmers, consumers, investors, industry, and policy makers via dedicated communication programs.

Source: [15]

and regional level which share and adhere to its objectives, yet result in a complex and sometimes fragmented policy environment. The Bio-economy Strategy calls for a more informed dialogue, in particular on the role of scientific advancement, and better interaction between existing bio-economy-supporting policies at EU and Member States level. This will provide stakeholders with a more coherent policy framework and encourage private investment. Furthermore, information systems will need to be created, building on existing but often unconnected databases, to monitor the progress of the bio-economy.

The Bio-economy Strategy will support better alignment of EU research and innovation funding with established priorities of bio-economy-related policies. In the same way, it will ensure that innovation is taken into account at the onset of policy development. The upcoming European Innovation Partnerships (EIPs) will have a key role in this respect, as will Joint Programming Initiatives (JPIs). A bio-economy dialogue that improves the knowledge base and fosters informed interaction between policy measures at EU, Member State and regional level will also provide further stimulus for growth and incentives for investments.

German bioeconomy strategy vision as an example. Global food security, renewable raw materials and energy from biomass, the conservation of biological diversity, climate- and environmental protection, and Germany's competitiveness are some of the major challenges facing this country at the beginning of this century. Meeting these challenges will require not only great social, economic and political effort, but also intense research efforts and new approaches to research and innovation.

This is the endeavor of the Federal Government's new research strategy, which has been created to expand the groundwork for the further development of a knowledge-based and internationally competitive bioeconomy. The National Research Strategy BioEconomy 2030 is a component of the High-Tech Strategy and provides vital impetus for the demand areas energy/climate and health/ nutrition, among others.

With the National Research Strategy BioEconomy 2030, the Federal Government is establishing the conditions for the vision of a sustainable bio-based economy by 2030. This carries the promise of global food supplies that are both sufficient and healthy, and of high quality products from

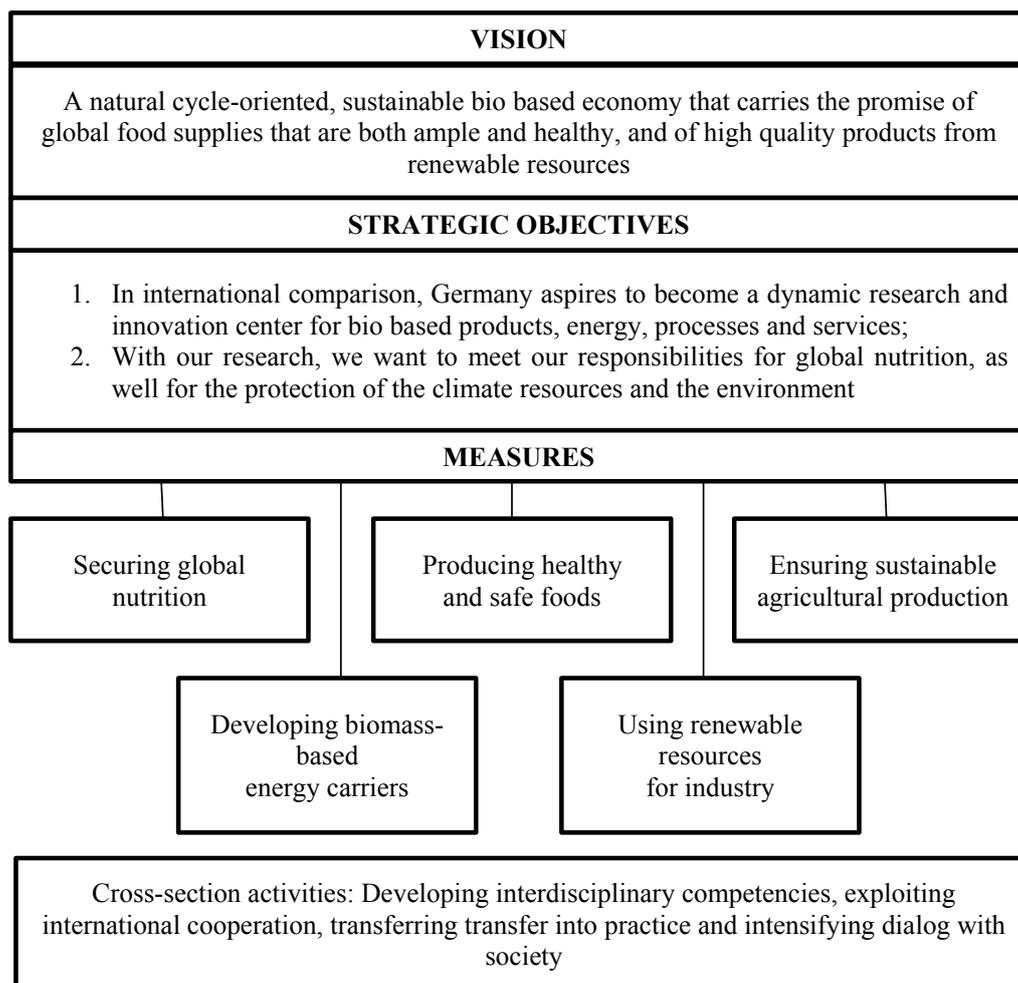


Fig. 1. The vision of the National Research Strategy Bioeconomy 2030

Source: [17]

renewable raw materials. This vision derives from the development of a free, dynamic, and innovative knowledge-based society. Therein, results from the life- and technological sciences will be accommodated with open-mindedness and curiosity, and (bio) technological progress and globalisation regarded as decisive opportunities. The central objective is the optimal utilisation of the chances created by the knowledge-based bioeconomy, and to translate these into enduring economic growth.

The concept of the bioeconomy covers the agricultural economy and all manufacturing sectors and associated service areas that develop, produce, process, handle, or utilise any form of biological resources, such as plants, animals, and microorganisms. This spans numerous sectors, such as agriculture, forestry, horticulture, fisheries and aquaculture, plant and animal breeding, the food and beverage industries, as well as the wood, paper, leather, textile, chemicals and pharmaceutical industries, and aspects of the energy sector. Bio-based innovations also provide growth impetus for other traditional sectors, such as in the commodity and food trade, the IT sector, machinery and plant engineering, the automotive industry, environmental technology, construction, and many service industries.

The research strategy lays out five priority fields of action for further development towards a knowledge-based, internationally competitive bioeconomy. These are: global food security, sustainable agricultural production, healthy and safe foods, the industrial application of renewable resources, and the development of biomass-based energy carriers. Thereby, food security always takes the highest priority. Holistic approaches are essential to resolve conflicting aims between these fields of action, to give equal consideration to environmental, economic and social issues, and for these to be integrated in terms of sustainable solutions.

Serving as guidelines in the implementation of the research strategy are thus the sustainable provision of foods, renewable raw materials, products and energy, the identification of all biomass-based paths of application, as well as the consideration of entire value creation chains.

The National Research Strategy BioEconomy 2030 identifies the measures that are required for each of these fields of action. These measures also serve to build on current strengths in science and industry, and to compensate for weaknesses and remove obstacles to innovation. Here, it will be crucial to attain interdisciplinary competencies, to accelerate the transfer of technology, to expand international cooperation, and to intensify the dialogue with the public.

The National Research Strategy BioEconomy 2030 (Fig. 1) relies on scientists' ingenuity, innovation, and individual initiative, and aims to provide support to these ends with targeted funding. The research strategy defines priority areas

for the coming years, and adaptations to current developments, in the sense of a learning program, will also be incorporated over the duration of the strategy.

The National Research Strategy BioEconomy 2030 lays the groundwork for the development of a knowledge-based and internationally competitive bioeconomy. On the basis of this vision, priority fields of action will be determined to promote research and innovation, and corresponding objectives and measures derived.

Adaptations to current developments, in the terms of a learning programme, will also be incorporated over the duration of the strategy. As a result of the long-term lead character of research and innovation, the National Research Strategy BioEconomy 2030 represents the first and necessary step for a broad establishment of the bioeconomy in Germany. The opening up of future markets and the opportunities for society of a bioeconomy are the duties of all policy areas that help shape the conditions for the innovation behaviour of the economy and society. In accordance with the High-Tech Strategy, research promotion in the area of the bioeconomy calls for innovation-friendly framework conditions.

Conclusions. The analysis of scientific and analytical literature allows making such conclusions. The bioeconomy is considered as a concept whose core function is the use of natural resources by applying the cross sectorial and innovative approach, with a basis in circular economy. In the circular economy the material flows are of two types: biological nutrients, designed to reenter the biosphere safely; and technical nutrients, which are designed to circulate at high quality without entering the biosphere.

Today the bioeconomy concept covers all nations and economies and it faces such global challenges: management of resources; sustainable and smart production; developing and insuring public health; mitigating climate changing; integrating social development; global sustainable development challenges.

The European Bioeconomy Strategy will support a global approach to more sustainable resource use. This will include developing an internationally shared understanding of biomass sustainability and best practices to open new markets, diversify production and address long term food security issues.

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