УДК 339.5:330.15
DOI: https://doi.org/10.30838/EP.202.299-308

Tsybuliak Anastasiia
Dr. of Economic Sc.
Ukrainian-American Concordia University
Цибуляк А.Г.
доктор економічних наук
Українсько-Американський університет «Конкордія»
https://orcid.org/0009-0007-9601-0391

PROSPECTS FOR DEEPENING INTERNATIONAL ECONOMIC COOPERATION IN THE CONDITIONS OF BIOECONOMY DEVELOPMENT: THEORETICAL TRAPS VS INSTITUTIONAL COLLISIONS

The purpose of the study is to determine the substantive features of the bioeconomy as an environment for implementing international economic cooperation in the context of the institutionalization of the green agenda. The bioeconomy paradigm rethinks the traditional economy based on fossil fuels and limited resources. With the emergence of new political and economic incentives, new enterprises in the bioeconomy sector began to actively form, which prompted many countries to develop specific programs, strategies and approaches to stimulate it. Institutionally, the concept of bioeconomy was first proposed in the form of the concept of a knowledge-based bioeconomy - as a vision for the development of the European bioeconomy by 2030. The aim of this concept was to combine economic competitiveness and environmental sustainability through the implementation of circular bioinnovations that take into account climate neutrality, environmental efficiency, safety and social acceptability within planetary boundaries. Subsequently, this approach was supported by international organizations, which also proposed official programs to promote the bioeconomy. There are different approaches to the bioeconomy in academia that consider resources, processes, and implications for economic and biophysical systems. One approach classifies the bioeconomy into the following categories: bioresources, which include products created from biomass; biotechnology, which concerns innovations in the life sciences; and bioecology, which is based on sustainable processes and sustainable products. Other classifications divide the bioeconomy into an ecological economy that is compatible with the limits of the biosphere, an economy based on science and industrial biotechnology, and a biomass-based economy. Additional approaches offer a vision of the bioeconomy through socio-technical regimes, including a biotechnological bioeconomy that focuses on health, food, and the industrialization of living systems, and a biomass-based bioeconomy that aims to replace oil with biomass. Since 2012, the European Union has been implementing a strategy that combines the economy with natural resources for sustainable growth. Since then, a number of countries around the world have actively promoted the development of bioeconomy activities at the national level. These include the Netherlands, Sweden, the United States, Malaysia, South Africa, Germany, Finland, France, as well as Brazil and China, which have implemented their national programs or included the bioeconomy in state planning. The acute problem remains the coordination of various bioeconomy participants with different interests and goals in implementing the strategy, which brings the problem of effective management to the forefront. Against this background, the development of the bioeconomy is stimulated by the increasingly active participation of interregional and international organizations, which will allow coordinating the desire of countries for regionalization and specialization to achieve the goals of bioeconomy strategies.

Keywords: *sustainable development, regulation, transformation, low-carbon economy, bioeconomy, biotechnology, bioinnovation, security, energy resources, food security, competitiveness, cooperation, coordination, climate neutrality, international economics, theory, economic relations*

JEL Classification *F53; Q1; Q57; P48; R15*

ПЕРСПЕКТИВИ ПОГЛИБЛЕННЯ МІЖНАРОДНОЇ ЕКОНОМІЧНОЇ КООПЕРАЦІЇ В УМОВАХ РОЗВИТКУ БІОЕКОНОМІКИ: ТЕОРЕТИЧНІ ПАСТКИ VS ІНСТИТУЦІЙНІ КОЛІЗІЇ

Мета дослідження полягає у визначенні змістовних ознак біоекономіки як середовища реалізації міжнародної економічної кооперації в умовах інституціоналізації зеленої адженди. Продемонстровано, що біоекономіка дедалі більше визнається ключовим стратегічним інструментом для досягнення міжнародно ратифікованих кліматичних цілей в рамках екологічної та індустріальної політик, а також в рамках здійснення сталих та

інклюзивних економічних трансформацій. Відзначено, що із середини 1990-х років все більше політичних стратегій та економічних політик спрямовані на сприяння та розвиток біоекономіки в різних секторах. У розробці політики біоекономіки очевидний зсув у бік місцевого виробництва в управлінні ланцюгами поставок. Досягнення балансу між глобальною співпрацею та локалізованим виробництвом має вирішальне значення для використання переваг біоекономіки, сприяння створенню більш стійкої, сталої та інноваційної екосистеми виробництва. Біоекономіка має великий потенціал для вирішення глобальних проблем та стимулювання сталого розвитку. Використовуючи відновлювані біологічні ресурси, такі як сільськогосподарські культури, деревна біомаса, водорості та морські організми, а також нові технології, біоекономіка може сприяти зменшенню залежності від викопного палива, пом'якшенню наслідків зміни клімату та підвищенню ефективності використання ресурсів. Таким чином, біоекономіка може зробити значний внесок у досягнення Цілей сталого розвитку ООН (ЦСР) та цілей боротьби зі зміною клімату, закріплених у Паризькій угоді.

Біоекономіка також може стимулювати економічне зростання, засноване на знаннях, створювати можливості працевлаштування, сприяти інноваціям, посилювати регіональний розвиток, а також покращувати продовольчу безпеку та систему охорони здоров'я. В останні роки порядок денний біоекономіки отримав підвищену увагу в глобальних ініціативах. Хоча Цілі сталого розвитку не апелюють до біоекономіки, їхній інтегративний підхід узгоджується з теорією та концепціями біоекономіки. Глобальні саміти з біоекономіки демонструють стійкий зв'язок із Цілями сталого розвитку, із діяльністю G20, інститутів ООН та інших міжнародних організацій. Існуючі стратегії біоекономіки, такі як стратегії ЄС та деяких європейських країн, потребують оновлення із врахуванням розвитку ринку біотехнологій та реалізації політик кліматичної нейтральності, зеленого і енергетичного переходів. Впроваджені у США, Китаї, Латинській Америці та африканських країнах інноваційні політики в сфері біоекономіки можуть мати позитивний вплив одна на одну. Більше того, ці інновації можуть мати наслідки для глобальних та багатосторонніх ініціатив, особливо в рамках G20 та подальшого розвитку інститутів ООН.

Ключові слова: *сталий розвиток, регулювання, трансформація, низьковуглецева економіка, біоекономіка, біотехнології, біоінновації, безпека, енергетичні ресурси, продовольча безпека, конкурентоспроможність, кооперація, координація, кліматична нейтральність, міжнародна економіка, теорія, економічні відносини*

Introduction. The transformation of the bioeconomy into a major policy concept in Europe was the result of a concerted effort by the European Commission. One of the key figures in this process was Christian Patermann, former Director of the Biotechnology, Agriculture and Food Programme in the European Commission's Directorate-General for Research and Innovation, which manages and develops EU policy on research, science and innovation. According to his own testimony, the term "bioeconomy" was first used at a conference of environment ministers. Although the conference participants did not provide a clear definition of the concept, Christian Patermann and his colleagues saw in it a policy potential that could open up new opportunities for the EU [25]. In particular, one of the areas of bioeconomy was considered to be the economic development of the potential of biotechnology. Another promising idea was the replacement of traditional resources with biological ones, both in the energy sector and in the production of materials. The bioeconomy should create synergies with the sustainable production of renewable energy using biomass from wood, non-food agricultural and food waste. The bioeconomy should ensure the sustainable use of nutrients through more efficient use of fertilisers. It can also help restore carbon in the soil, for example by returning it to it. For example, regenerative agricultural methods help reduce CO2 in the atmosphere, as well as improve soil fertility and increase resilience to floods and droughts. These methods include year-round planting of fields and agroforestry, which combines crops, trees and livestock. For Europe, it is vital not only to store CO2 in the soil, but also to improve soil fertility, reduce the impact of droughts and increase resilience to erosion. State stimulation is one of the most important factors in the dynamic development of the bioeconomy. The main reason for supporting the bioeconomy at the government level is the desire to increase the efficiency of national production and, based on innovative technologies, to provide domestic companies with leading positions in the rapidly developing international biotechnological market.

In the 2000s, the need to promote new concepts in EU politics was strengthened by the need to increase the productivity of the agricultural state to satisfy the growing demand for food products and biomass. At the time of the formation of the concept of bioeconomy in the EU, the term "knowledge-based" was used to indicate a direct development that was harmonized with the overall strategy of the European Union for the creation of "economy, based on knowledge". This approach was formally endorsed at the Lisbon European Council in 2000, which declared the EU's ambition to become the most competitive and dynamic knowledge-based economy in the world. These efforts have since borne fruit. In 2005, the European Commission organized a conference on "*New perspectives for the knowledge-based economy"*, at which the European Commissioner for Science and Research, J. Potočnik, delivered a speech on "*Transforming life sciences knowledge into new sustainable eco-efficient and competitive products"*. [26]. In 2007, a seminar on this topic was held in Cologne during the German Presidency of the Council of the EU. It resulted in a document that formulated a vision of the bioeconomy as an interdisciplinary approach covering manufacturing, biotechnology, bioenergy and biomedicine [18].

The Cologne document defined two main dimensions of the bioeconomy concept. On the one hand, it outlined the role of biotechnology as one of the key pillars of the

European economy by 2030, noting its importance for ensuring economic growth, employment, energy security and maintaining living standards. This approach can be defined as the "biotechnological innovation perspective" within the bioeconomy. On the other hand, the document emphasized the importance of using agricultural crops as renewable resources for the production of biofuels, biopolymers and chemicals – accordingly, the resource-oriented perspective of the bioeconomy was absolutized. The evolution of the bioeconomy concept was accompanied by a change of emphasis between these two directions.

The review of the literature. The imperative greening of development as a global trend accompanying the processes of reformatting market principles of management has found itself in the research perspective of Ukrainian [11; 12; 13; 23] and foreign scientists [3; 5; 16]. Economic instruments for greening international production are highlighted in the works of Yu. Orlovska and V. Chala [6; 14; 15], M. Grod and N. Reznikova [1; 2; 9], R. Zablotska and D. Rusak [4], V. Panchenko, V. Karp, S. Stakhurska [25], O. Ptashchenko, D. Arkhipova, N. Farenyuk [10]. The green economy acts as a kind of "umbrella concept" in relation to the circular economy, sustainable bioeconomy, biological economy, circular carbon economy based on biotechnology, bioeconomy, industrial ecology and determines their interdependence [14; 15]. Understanding the substantive characteristics of the concept of the green economy is the key to achieving consensus on the essence of the bioeconomy. The scientific works of Ukrainian researchers propose a broad approach to defining the bioeconomy [14; 29; 31] as a high-tech sphere of economic activity, which makes it possible to increase energy efficiency, effectively use waste, develop renewable energy based on biomass, ensure the greening of the industrial sector, the sustainability of agriculture, the production of new food products and the development of medical technologies. A sustainable bioeconomy goes beyond the imperative of simply replacing fossil resources with renewable biological resources and requires low-carbon energy sources, sustainable supply chains, and promising breakthrough technologies for transforming renewable bioresources into valuable products, materials, and bio-based fuels.

Despite the existing body of work by authors who reveal the essence of the right to development as a basic right in the context of sustainable development, we propose to make such a distinction with a focus on the regulatory regulation of the right to development, with a focus on the economic aspects of its provision in the context of the imperative of greening and sustainability.

The purpose of the article. The purpose of the study is to determine the substantive features of the bioeconomy as an environment for implementing international economic cooperation in the context of the institutionalization of the green agenda.

The main material of the article. According to the EU approach [17], the bioeconomy encompasses the production of renewable biological resources and the transformation of these resources and waste streams into value-added products such as food, feed, bio-based products and bioenergy, and includes: agriculture, forestry, fisheries, food and pulp and paper, as well as parts of the chemical, biotechnology and energy industries. The bioeconomy, as a sector with certain specific characteristics, is linked to the «biologisation» of industrial value creation: it provides industry with renewable carbon and can directly replace fossil carbon in almost all applications, unlike minerals and metals. While the circular economy is dominated by the metallurgical and mining industries, and biomass is considered secondary to other materials, the bioeconomy adds an additional organic recycling pathway, which extends the circular economy. However, the bioeconomy and the circular economy share a common goal – a more sustainable and resource-efficient world with low carbon emissions.

There are different approaches to the bioeconomy in academia that consider resources, processes, and implications for economic and biophysical systems. One approach classifies the bioeconomy into the following categories: bioresources, which include products created from biomass; biotechnology, which concerns innovations in the life sciences; and bioecology, which is based on sustainable processes and sustainable products. Other classifications divide the bioeconomy into an ecological economy that is compatible with the limits of the biosphere, an economy based on science and industrial biotechnology, and a biomass-based economy. Additional approaches (Fig.1) offer a vision of the bioeconomy through socio-technical regimes, including a biotechnological bioeconomy that focuses on health, food, and the industrialization of living systems, and a biomass-based bioeconomy that aims to replace oil with biomass [32].

This allows us to identify three main directions for defining the bioeconomy: the biotechnological approach (a concept that emphasizes the importance of scientific research in the field of biotechnology, its implementation and commercialization in various industries); the bioresource approach (focuses on research related to the use of biological raw materials, including biomass, in such industries as agriculture, marine, forestry and bioenergy production, and the creation of added value on their basis); the bioecological approach (this is a kind of vision of bioecology that emphasizes the importance of ecological processes that optimize the use of bioenergy and nutrients, contribute to the preservation of biodiversity and prevent soil degradation). Scientists propose the concept of a holistic bioeconomy, which combines three main approaches available in modern scientific discourse. These approaches are not mutually exclusive, and it is advisable to consider them in combination when assessing the bioeconomy. Therefore, a holistic bioeconomy is based on the primary source – biomass or bioresources. Biomass should be considered as all organic matter produced by photosynthesis, either as primary raw materials or as secondary organic residues (wastes) obtained from plants, animals or microorganisms.

It is advisable to start assessing the biomass-based bioeconomy by identifying the primary sectors that produce it. Typically, such sectors include agriculture, livestock and forestry. At the same time, assessment methods can differ significantly depending on the approaches, data and indicators. It is worth considering that although biomass is produced in a relatively narrow range of sectors, it circulates

through most elements of the economic system, being consumed or transformed with added value. Assessing the biomass-based bioeconomy allows you to analyze physical or monetary flows that indicate the volumes of this segment of the bioeconomy, for example, as a share of gross domestic product. This approach allows you to get closer to understanding the functioning of the economic system in which bioproducts are created and distributed through the relevant value chains and market structures. The second approach to measuring the bioeconomy is to consider the biotechnological bioeconomy. Alternatively, the term *"biotechonomy"* or *"knowledge-based bioeconomy"* can be used to refer to this approach. Conceptually, this approach is identified with the understanding of bioeconomy as a synonym for biotechnology, or as a second type of bioeconomy. Biotechnological bioeconomy is based on the application of biotechnology or bioengineering solutions developed using biological resources (in particular biodiversity) to solve socially significant problems in various areas: health (red bioeconomy), agriculture (green bioeconomy), marine biosphere (blue bioeconomy), industry (white bioeconomy), food (yellow bioeconomy), drylands (brown bioeconomy), biothreats (black bioeconomy), intellectual property (purple bioeconomy), nanobiotechnology (gold bioeconomy) and environmental protection (grey bioeconomy). This approach has gained widespread acceptance due to advances in genomics, synthetic biology, genetic engineering, and other modern biotechnology platforms. While the biomass-based bioeconomy is based on the use of biomass as a raw material, the biotechnological bioeconomy focuses on knowledge, innovation, and processes of adding value to biodiversity, including biomass as one of the resources.

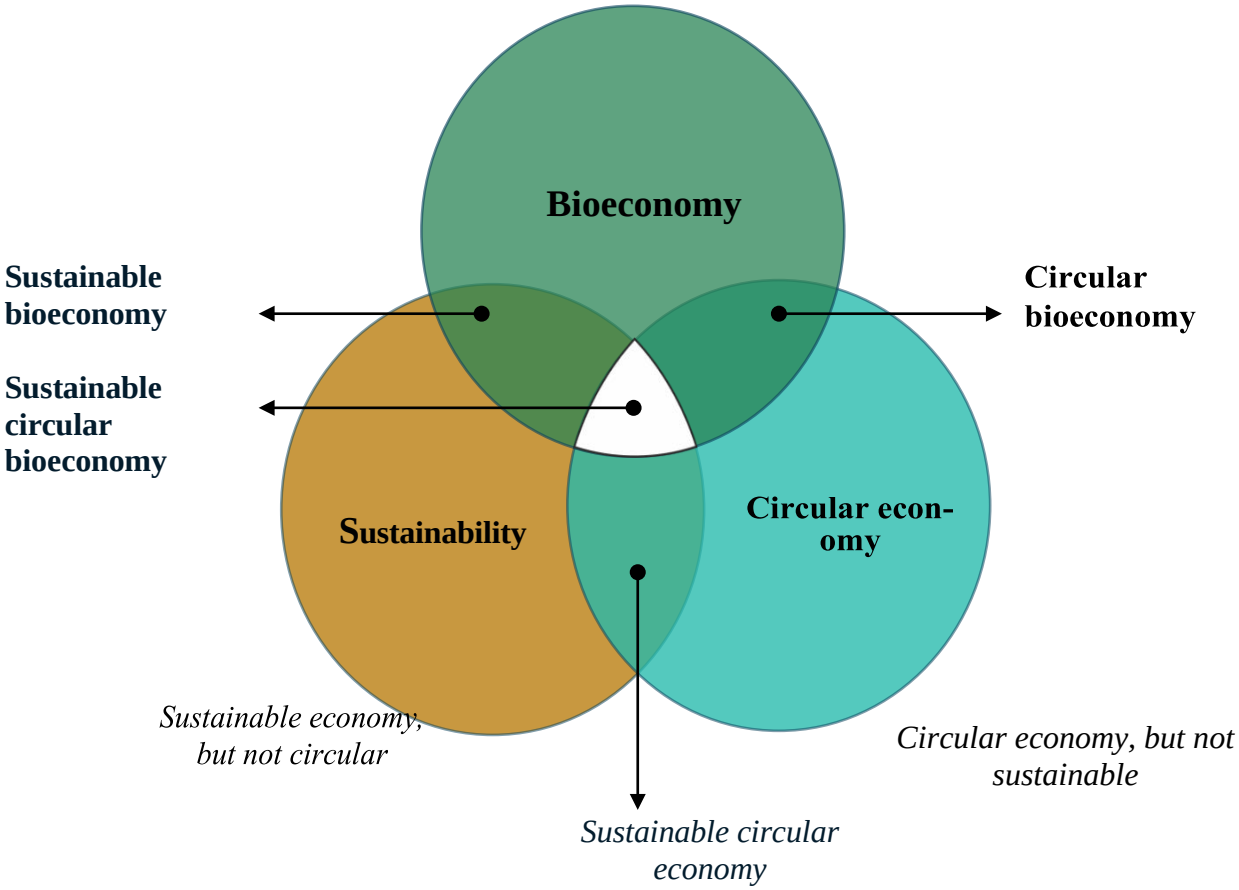

Fig. 1. Bioeconomy in the circularity-sustainability system
Source: [32]

The assessment of the biotechnological bioeconomy involves identifying relevant activities, sectors, and the economic value of biotechnology and its applications – both for society and for the biosphere. Resources, processes, and products in this case are integrated into the economic system, creating added value and increasing the overall contribution of the biotechnological bioeconomy to the national economy. Examples of indicators of the biotechnological bioeconomy include the volume of investment in scientific research and development (R&D) and the number of patents in the field of biotechnology. In this context, the strategic planning of the bioeconomy in the United States is considered as an example of a national policy that most closely corresponds to the concept of the biotechnological bioeconomy. The third conceptual approach to the analysis of the bioeconomy is to consider the bioeconomy based on the biosphere. The term "biosphere" is used to refer to the part of the Earth's environment where living organisms exist and interact with each other, forming sustainable systems. Various environments and ecosystems function within the biosphere. The environment includes the physical (soil, water, air) and biological conditions of

existence of organisms, as well as social, cultural, economic and political factors. The ecosystem covers the interaction of living and non-living components within the biosphere, where the key concepts are the flows of energy and matter. Thus, the entire system of life, together with the trophic hierarchy, can be interpreted as a natural market, which, in turn, forms the basis of the bioeconomy. Thus, the biosphere is a broader concept that covers both systemic prerequisites and life itself - the basic element of the bioeconomy.

In contrast to the approaches of the biomass-based bioeconomy and the biotechnological bioeconomy, which focus respectively on raw materials and technological innovation, the biosphere-based bioeconomy is considered the most integrative and broad approach. It is consistent with the bioecological and agroecological vision of the bioeconomy, as well as with the concept of a type I bioeconomy, which assumes the limits of the biosphere and the principles of non-equilibrium thermodynamics. At the level of public policy, the concept of a biosphere-based bioeconomy appears close to the bioeconomy strategy implemented in Brazil, focusing on social biodiversity, innovation and technology as the basis of the economic system. These different classifications indicate that a widely accepted concept of the bioeconomy does not yet exist. However, national concepts can be linked to different approaches to the bioeconomy: the European Union is approaching a bioresources or bioeconomy type, the United States is approaching biotechnology, and Brazil is approaching bioecology. A number of European countries have actively participated in the formation of national strategies in the field of bioeconomy. For example, in 2010, Germany established the Federal Council for the Bioeconomy under the leadership of the Federal Ministry of Education and Science. In the same year, the *«National Research Strategy BioEconomy 2030. Our Route towards a biobased economy»* was published with the aim of creating added value, jobs and sustainable income in an environmentally responsible way [20]. *«National Policy Strategy on Bioeconomy. Renewable resources and biotechnological processes as a basis for food, industry and energy»* [19] envisaged the use of renewable resources and biotechnological processes as a basis for food, industry and energy – combining both of the aforementioned perspectives of the bioeconomy. Other European countries have also started to develop their own strategies. For example, by 2015, France, the United Kingdom and Italy did not yet have separate bioeconomy strategies. At the same time, Finland published a national bioeconomy strategy back in 2014, and Austria and Norway were in the process of preparing one at that time. In the European Union, the concept of the bioeconomy was updated in 2018 to include not only the primary sectors of bioresource production, but also related systems that rely on biological resources.

The EU bioeconomy strategy is based on three clearly defined blocks: (1) the bioeconomy requires investment in research, innovation and professional development; (2) the bioeconomy can only be built with enhanced political interaction and stakeholder participation; (3) the creation of a bioeconomy requires strengthening markets and increasing competitiveness.

The bioeconomy in the EU can act both as a tool for achieving sustainable development goals and as a state-political concept that helps solve problems of interstate integration. The bioeconomy is an important part of the image of the economy of the future of the EU. One of the priorities of the current European strategy is to strengthen the bioeconomy sectors, including attracting additional investment and creating markets. The bioeconomy is considered in the EU as an effective tool for solving environmental problems, as it makes it possible to reduce the negative impact on the environment and use available resources more efficiently. It is important that the implementation of bioeconomy policies leads to significant synergies with other environmental policies. The bioeconomy corresponds to the low-carbon development paradigm. The bioeconomy for the EU is an important element of contribution to energy security and self-sufficiency in resources, including agricultural ones. The role of the bioeconomy in the EU will increase. It will contribute to achieving social, environmental and economic goals by creating new products and technologies with high added value.

However, the concept of bioeconomy is actively developing not only in the EU. In the USA, the national strategy is focused on three key elements: knowledge, technology and innovation. The bioeconomy is an economic activity based on research and technological progress in biotechnology, engineering, computing and information sciences. Leading technologies include genetic engineering, molecular biology, bioinformatics and synthetic biology. In 2012, the administration of President Barack Obama presented an official strategy for the development of the bioeconomy called *"National Bioeconomy Blueprint"* [33]. This document defines the bioeconomy as an economy based on the use of research and innovation in the life sciences to generate economic activity and social welfare. In particular, the bioeconomy includes the development of new medicines and diagnostics to improve health, high-yielding crops, new biofuels to reduce dependence on oil, and bio-based chemicals.

This definition, as in the European context, encompasses two key approaches to the bioeconomy: innovative biotechnological and resource-substitutable. In the first decades of the 21st century, other countries – both developed and developing – have also begun to develop relevant policies. In particular, in 2012, Malaysia published the *"Bioeconomy Transformation Agenda"* and in 2013, South Africa presented its own bioeconomy strategy [21]. For example, in Brazil, the bioeconomy development strategy focuses on using renewable resources and biodiversity as tools for sustainable development for local and indigenous communities [22]. This strategy has recently been expanded by adding an innovation component. However, the number of countries with formal bioeconomy policies at that time remained relatively limited, although many countries were involved in biotechnology or bioresource management. An important milestone in the global adoption of the bioeconomy was the first Global Bioeconomy Summit, held in Berlin in December 2015. The summit was organized by the German Bioeconomy Council in cooperation

with the International Advisory Committee. Over 700 experts from over 80 countries participated, demonstrating the growing importance of *the bioeconomy as a global political and scientific priority.*

In all strategies, the development of the bioeconomy of the country is linked to the Sustainable Development Goals (SDGs) of the Agenda for Sustainable Development until 2030 (adopted in 2015), emphasizing the impossibility of achieving the sustainability of society without the development of the bioeconomy. Therefore, it can be stated that in all strategies, the development of the bioeconomy is emphasized as one of the most important elements of the transformation of both the economy and society. Thus, the EU Member States have set as their goal the transformation of society based on the reorientation of the economy and society to environmentally sustainable production and consumption, a comprehensive change in approaches to the extraction and consumption of natural resources *("green transformation").* Another major goal of bioeconomy strategies in many countries is the development of scientific and technical work, research and innovation in biotechnology. All updated strategies set the task of correlating research in the field of biotechnology with the development of other sectors of the economy and overall economic growth in countries through the introduction of new methods of processing bio-raw materials.

The concept of the bioeconomy has developed within the framework of two main approaches: the perspective of resource substitution and the perspective of biotechnological innovation. Although biotechnological innovations were initially recognized as an opportunity for the development of the bioeconomy, in the first decade of the 21st century the resource substitution approach was more pronounced [24]. One of the key factors that contributed to the popularity of this perspective was the concept of «peak oil», which assumes that oil production will peak and then begin to decline, while prices will continue to rise. Rising oil prices have increased the attractiveness of using biomass as a source of energy and raw materials, thereby promoting the development of the bioeconomy as a substitute for fossil fuels.

The oil price crisis of 2007–2008 has further reinforced the perception of the reality of peak oil. The increased use of crops for biofuel production has been a factor in the increase in food prices that has been observed since the oil crisis. Policies that support biofuels (such as subsidies or gasoline additive mandates) have come under criticism after studies have shown their impact on global food prices. These processes have had two important consequences for the development of the bioeconomy. First, there is a potential conflict between ensuring food security and using biomass for energy purposes, a topic that has gained importance in the policy debate on the bioeconomy. Second, there is increased attention to the need to increase the productivity of biomass production and to develop technological solutions that do not compete with the food sector. Such solutions include, in particular, second-generation technologies based on the use of residual biomass and waste. The current policy of most developed and rapidly developing countries to support the biotechnology sector is aimed at further progressive commercialization of scientific achievements.

Conclusions and prospects for further research. The bioeconomy paradigm rethinks the traditional economy based on fossil fuels and limited resources. With the emergence of new political and economic incentives, new enterprises in the bioeconomy sector began to actively form, which prompted many countries to develop specific programs, strategies and approaches to stimulate it. Institutionally, the concept of bioeconomy was first proposed in the form of the concept of a knowledge-based bioeconomy - as a vision for the development of the European bioeconomy by 2030. The aim of this concept was to combine economic competitiveness and environmental sustainability through the implementation of circular bioinnovations that take into account climate neutrality, environmental efficiency, safety and social acceptability within planetary boundaries. Subsequently, this approach was supported by international organizations, which also proposed official programs to promote the bioeconomy. Since 2012, the European Union has been implementing a strategy that combines the economy with natural resources for sustainable growth. Since then, a number of countries around the world have actively promoted the development of bioeconomy activities at the national level. These include the Netherlands, Sweden, the United States, Malaysia, South Africa, Germany, Finland, France, as well as Brazil and China, which have implemented their national programs or included the bioeconomy in state planning. The bioeconomy in the EU is a new type of economy that involves the production of new goods and services based on biotechnology and sustainable use of biomass. The bioeconomy in the EU is a tool for achieving the goals of sustainable and low-carbon development, and also contributes to the implementation of other areas - social, integration and regional policies.

Currently, dozens of countries have full or partial bioeconomy strategies. However, there are significant differences between these strategies – in particular, in how exactly they interpret the concept of bioeconomy and which areas are considered priority. The lack of unified criteria for identifying the substantive characteristics of the bioeconomy will create institutional obstacles to the implementation of international cooperation and will lead to artificial restrictions on international financial markets in terms of the impossibility of proving the sufficiency of greening the investment portfolios of companies involved in cooperation. The assessment of the economic contribution of the bioeconomy is mostly carried out within the framework of economic science, based on its theoretical and econometric approaches. At the same time, for a more complete understanding and measurement of this contribution, it is proposed to take into account the concept of a holistic bioeconomy. The use of traditional macroeconomic methods, data and indicators is accompanied by a number of limitations that do not allow us to adequately take into account the real scale of bioeconomic processes.

Current challenges include the need to develop new methodological approaches, access to relevant data and the construction of appropriate indicators. Despite some

progress in this area, it is emphasized that efforts should be intensified, in particular by recognizing the complexity and hierarchy of the bioeconomy as a system. For an effective analysis of the bioeconomy as an environment for international cooperation, it is necessary to use a comprehensive approach that combines economic, environmental and social aspects. The methodology for studying the bioeconomy includes a variety of tools: from traditional economic analysis to the assessment of sustainable development and the integration of biotechnology into economic cycles. Particular attention should be paid to the analysis of political, social and technological conditions that affect the expansion of international cooperation in the bioeconomy, as well as the formation of legal and institutional mechanisms to support joint projects. The acute problem remains the coordination of various bioeconomy participants with different interests and goals in implementing the strategy, which brings the problem of effective management to the forefront. Against this background, the development of the bioeconomy is stimulated by the increasingly active participation of interregional and international organizations, which will allow coordinating the desire of countries for regionalization and specialization to achieve the goals of bioeconomy strategies.

References:

1. Grod, M., & Reznikova, N. (2023). Rehuliatorni pastky tsyrkuliarnoi ekonomiky v polititsi perekhodiv YeS do stalosti: problemy identyfikatsii dzherel finansuvannia Novoho yevropeiskoho konsensusu z rozvytku ta Yevropeiskoho zelenoho kursu [Regulatory traps of the circular economy in the EU's sustainability transition policy: Problems of identifying financing sources for the New European Consensus on Development and the European Green Deal]. Investytsii: praktyka ta dosvid, 16, 49–57. https://doi.org/10.32702/2306-6814.2023.16.49
2. Grod, M., & Reznikova, N. (2023). Finansovi ta investytsiini instrumenty spryiannia tsyrkuliarnii ekonomitsi: stalyi rozvytok i klimtychna neutralnist yak tryhery ozelenennia mizhnarodnykh rynkiv kapitalu [Financial and investment instruments for promoting the circular economy: Sustainable development and climate neutrality as triggers for greening international capital markets]. Visnyk Khmelnytskoho natsionalnoho universytetu. Seriia: Ekonomichni nauky, 3(318), 249–259. https://doi.org/10.31891/2307-5740-2023-318-3-39.
3. Daly, H. (2002). Poza zrostanniam. Ekonomichna teoriia staloho rozvytku [Beyond growth: The economics of sustainable development]. Kyiv: Intelsfera
4. Zablotska, R. O., & Rusak, D. M. (2024). Suchasni trendy zelenoi ekonomiky: upravlinskyi ta finansovyi aspekty [Modern trends in the green economy: Managerial and financial aspects]. Svit finansiv, 3, 149–159. https://doi.org/10.35774/sf2024.03.149
5. Moren, E. (2014). Shliakh za maibutnie liudstva [The path for the future of humanity]. Kyiv: Nika-Tsentr
6. Orlovska, Yu. V., Chala, V. S., & Varlamova, O. A. (2016). Suchasni teorii mizhnarodnoi spetsializatsii: mozhlyvosti zastosuvannia na rehionalnomu rivni [Modern theories of international specialization: Application opportunities at the regional level]. Ekonomichnyi prostir, 116, 42–59. Available at: http://nbuv.gov.ua/UJRN/ecpros_2016_116_6 (Accessed 19 May 2025)
7. Ptashchenko, O. V., & Arkhipova, D. Ye. (2020). Hlobalni problemy liudstva: stan i perspektyvy vyrishennia [Global problems of humanity: Current state and prospects for solutions]. Biznes Inform, 10, 478–484. https://doi.org/10.32983/2222-4459-2020-10-478-484
8. Ptashchenko, O. (2024). Osoblyvosti finansovoho zabezpechennia silskykh terytorialnykh hromad v umovakh staloho rozvytku [Features of financial support for rural territorial communities in the context of sustainable development]. Herald of Khmelnytskyi National University. Economic Sciences, 334(5), 432–437. https://doi.org/10.31891/2307-5740-2024-334-65
9. Reznikova, N. V., & Grod, M. I. (2023). Formuvannia instytutsiinoi pidtrymky rozvytku tsyrkuliarnoi ekonomiky ta yii staloho finansuvannia v Yevropeiskomu Soiuzi [Institutional support for circular economy development and its sustainable financing in the European Union]. Ekonomika Ukrainy, 11(744), 52–75. https://doi.org/10.15407/economyukr.2023.11.052.
10. Farenyuk, N. V. (2024). Problemy zaluchennia zelenykh investytsii dlia finansuvannia rozvytku tsyrkuliarnoi ekonomiky i borotby zi zminamy klimatu v YeS [Problems of attracting green investments for financing the circular economy and combating climate change in the EU]. Investytsii: praktyka ta dosvid, 13, 154–160. https://doi.org/10.32702/2306-6814.2024.13.154
11. Tsybuliak, A. H. (2016). Henezys rushiinykh syl ekolohizatsii mizhnarodnykh torhovelnykh vidnosyn [Genesis of driving forces of the greening of international trade relations]. Skhidna Yevropa: Ekonomika, biznes ta upravlinnia, 3, 37–40.
12. Tsybuliak, A. H. (2015). Naukovi osnovy ekolohizatsii svitovoho vyrobnytstva [Scientific foundations of the greening of global production]. Stratehiia rozvytku Ukrainy (ekonomika, sotsiolohiia, pravo), 2, 124–127.
13. Tsybuliak, A. H. (2017). Teoretyko-metodolohichni aspekty analizu ekolohizatsii svitovoho hospodarstva [Theoretical and methodological aspects of analyzing the greening of the world economy]. In A. V. Rybchuk (Ed.), Internatsionalizatsiia osvity i nauky: natsionalni osoblyvosti ta svitovi tendentsii: kolektyvna monohrafiia [Internationalization of education and science: national characteristics and global trends: collective monograph] (pp. 484). Drohobych:

Vydavnychyi viddil Drohobytskoho derzhavnoho pedahohichnoho universytetu imeni Ivana Franka.

14. Chala, V. (2022). Kontseptsiia zviazku mizh resursamy ta maibutni natsionalni modeli zelenoi ekonomiky [The concept of the relationship between resources and future national models of the green economy]. In International scientific and practical conference «Mechanisms of economic development in the context of global changes: international experience» (pp. 19–23). Riga: Baltija Publishing. Available at: http://www.baltijapublishing.lv/omp/index.php/bp/catalog/book/312 (Accessed 20 May 2025).

15. Chala, V., & Orlovska, Yu. (2022). Green economy development: Methodological approach. Baltic Journal of Economic Studies, 7(3), 203–208. Available at: http://www.baltijapublishing.lv/index.php/issue/article/view/1203/1242 (Accessed 20 May 2025).

16. Dalal-Clayton, B., & Bass, S. (2009). The challenges of environmental mainstreaming: Experience of integrating environment into development institutions and decisions. London: International Institute for Environment and Development.

17. European Commission. (2012). Commission staff working document of COM. Innovation for sustainable growth: A bioeconomy for Europe. Available at: https://op.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51 (Accessed 19 May 2025).

18. European Union (EU). (2007). En route to the knowledge-based bio-economy ("Cologne Paper"). German Presidency of the Council of the European Union.

19. Federal Government of Germany. (2014). National policy strategy on bioeconomy: Renewable resources and biotechnological processes as a basis for food, industry and energy. Available at: https://science.desi.qld.gov.au/__data/assets/pdf_file/0019/306514/German-National-Policy-Strategy-on-Bioeconomy.pdf (Accessed 18 May 2025).

20. Federal Ministry of Education and Research. (2011). National Research Strategy BioEconomy 2030: Our route towards a biobased economy. Bonn, Berlin. Available at: https://www.pflanzenforschung.de/application/files/4415/7355/9025/German_bioeconomy_Strategy_2030.pdf (Accessed 20 May 2025).

21. Glatzel, K., Virchow, D., Musaazi S. Nakitto, A., Niyonsenga, S., Babu, S., Srivastava, N., & Kashandula, P. (2024). Bioeconomy pathways: Experience from Africa, Asia, and Latin America (Chapter 9). ReSAKSS. Available at: https://www.resakss.org/sites/default/files/2024_ator_individual_chapters/Chapter%209_ReSAKSS_AW_ATOR_2024.pdf (Accessed 18 May 2025).

22. Lopes, C. L., Corleto, A. F., & Chiavari, J. (2024). The bioeconomy in the Lula administration: Regulatory and institutional advances. Available at: https://www.climatepolicyinitiative.org/publication/the-bioeconomy-in-the-lula-administration-regulatory-and-institutional-advances/ (Accessed 18 May 2025).

23. Medvedieva, M., Yedeliev, R., Reznikova, N., Nanavov, A., & Grydasova, G. (2024). European strategy for achieving climate neutrality and analysis of legal instruments for its implementation. Social & Legal Studios, 7(2), 64–74. https://doi.org/10.32518/sals2.2024.64.

24. OECD. (2009). Bioeconomy to 2030: Designing a policy agenda. OECD Publishing. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2009/04/the-bioeconomy-to-2030_g1gha07e/9789264056886-en.pdf (Accessed 18 May 2025).

25. Patermann, C., & Aguilar, A. (2018). The origins of the bioeconomy in the European Union. New Biotechnology, 40(Part A), 20–24. https://doi.org/10.1016/j.nbt.2017.04.002

26. Potočnik, J. (2005). Transforming life sciences knowledge into new sustainable eco-efficient and competitive products [Speech]. Conference on Knowledge-based Bio-economy, European Commission, Brussels.

27. Ptashchenko, O. V. (2018). Transformation of the global economic space in the present. Visnyk Skhidnoukrainskoho natsionalnoho universytetu im. V. Dalia, 4(245), 14–18.

28. Ptashchenko, O. V., & Shersheniuk, O. M. (2023). Methodological bases of management of business activity of enterprises in the conditions of globalization. Problemy i perspektyvy rozvytku pidpryiemnytstva: Zbirnyk naukovykh prats Kharkivskoho natsionalnoho avtomobilno-dorozhnoho universytetu, 1(30), 38–57

29. Reznikova, N., Ivashchenko, O., & Rubtsova, M. (2020). Global problems as a subject of interdisciplinary studies in the focus of international economic security and sustainable development. Ekonomika ta derzhava, 7, 24–31.

30. Reznikova, N., Panchenko, V., Karp, V., Grod, M., & Stakhurska, S. (2024). The relationship between the green and digital economy in the concept of sustainable development. Economic Affairs, 69(Special Issue), 389–399. https://doi.org/10.46852/0424-2513.1.2024.41.

31. Rist, G. (1997). The history of development: From Western origins to global faith. London & New York: Zed Books.

32. UNCTAD. (2024). Science, technology and innovation policy review: Global overview.

33. White House. (2012). National bioeconomy blueprint. Available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf (Accessed 18 May 2025).

Список використанихз джерел:

1. Грод М., Резнікова Н. Регуляторні пастки циркулярної економіки в політиці переходів ЄС до сталості: проблеми ідентифікації джерел фінансування Нового європейського консенсусу з розвитку та Європейського зеленого курсу. Інвестиції: практика та досвід. 2023. № 16. С. 49–57. DOI: https://doi.org/10.32702/2306-6814.2023.16.49.
2. Грод М., Резнікова Н. Фінансові та інвестиційні інструменти сприяння циркулярній економіці: сталий розвиток і кліматична нейтральність як тригери озеленення міжнародних ринків капіталу. Вісник Хмельницького національного університету. Серія: Економічні науки. 2023. № 3 (318). С. 249–259. DOI: https://doi.org/10.31891/2307-5740-2023-318-3-39.
3. Дейлі Г. Поза зростанням. Економічна теорія сталого розвитку. Київ: Інтелсфера, 2002.
4. Заблоцька Р. О., Русак Д. М. Сучасні тренди «зеленої» економіки: управлінський та фінансовий аспекти. Світ фінансів. 2024. № 3. С. 149–159. DOI: https://doi.org/10.35774/sf2024.03.149.
5. Морен Е. Шлях за майбутнє людства. Київ: Ніка-Центр, 2014.
6. Орловська Ю. В., Чала В. С., Варламова О. А. Сучасні теорії міжнародної спеціалізації: можливості застосування на регіональному рівні. Економічний простір. 2016. № 116. С. 42–59. Режим доступу: http://nbuv.gov.ua/UJRN/ecpros_2016_116_6 (дата звернення: 19.05.2025).
7. Пташенко О. В., Архіпова Д. Є. Глобальні проблеми людства: стан і перспективи вирішення. Бізнес Інформ. 2020. № 10. С. 478–484. DOI: https://doi.org/10.32983/2222-4459-2020-10-478-484.
8. Пташенко О. Особливості фінансового забезпечення сільських територіальних громад в умовах сталого розвитку. Вісник Хмельницького національного університету. Економічні науки. 2024. № 334(5). С. 432–437. DOI: https://doi.org/10.31891/2307-5740-2024-334-65.
9. Резнікова Н. В., Грод М. І. Формування інституційної підтримки розвитку циркулярної економіки та її сталого фінансування в Європейському Союзі. Економіка України. 2023. № 11(744). С. 52–75. DOI: https://doi.org/10.15407/economyukr.2023.11.052.
10. Фаренюк Н. В. Проблеми залучення «зелених» інвестицій для фінансування розвитку циркулярної економіки і боротьби зі змінами клімату в ЄС. Інвестиції: практика та досвід. 2024. № 13. С. 154–160. DOI: https://doi.org/10.32702/2306-6814.2024.13.154.
11. Цибуляк А. Г. Генезис рушійних сил екологізації міжнародних торговельних відносин. Східна Європа: Економіка, бізнес та управління. 2016. № 3. С. 37–40.
12. Цибуляк А. Г. Наукові основи екологізації світового виробництва. Стратегія розвитку України (економіка, соціологія, право). 2015. № 2. С. 124–127.
13. Цибуляк А. Г. Теоретико-методологічні аспекти аналізу екологізації світового господарства. У: Рибчук А. В. (ред.). Інтернаціоналізація освіти і науки: національні особливості та світові тенденції: колективна монографія. Дрогобич: Видавничий відділ Дрогобицького державного педагогічного університету імені Івана Франка, 2017. С. 484.
14. Чала В. Концепція зв'язку між ресурсами та майбутні національні моделі «зеленої» економіки. Міжнародна науково-практична конференція «Механізми економічного розвитку в умовах глобальних змін: міжнародний досвід», м. Рига, 2022. Рига: Baltija Publishing, 2022. С. 19–23. Режим доступу: http://www.baltija-publishing.lv/omp/index.php/bp/catalog/book/312 (дата звернення: 20.05.2025).
15. Chala V., Orlovska Yu. Green economy development: methodological approach. Baltic Journal of Economic Studies. 2022. Vol. 7, No. 3. P. 203–208. Available at: http://www.baltijapublishing.lv/index.php/issue/article/view/1203/1242 (Accessed 20.05.2025).
16. Dalal-Clayton B., Bass S. The challenges of environmental mainstreaming: experience of integrating environment into development institutions and decisions. London: International Institute for Environment and Development, 2009.
17. European Commission. Commission staff working document of COM. Innovation for sustainable growth: a bioeconomy for Europe. 2012. Available at: https://op.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51 (Accessed 19.05.2025).
18. European Union (EU). En route to the knowledge-based bio-economy ("Cologne Paper"). German Presidency of the Council of the European Union, 2007.
19. Federal Government of Germany. National policy strategy on bioeconomy: renewable resources and biotechnological processes as a basis for food, industry and energy. 2014. Available at: https://science.desi.qld.gov.au/__data/assets/pdf_file/0019/306514/German-National-Policy-Strategy-on-Bioeconomy.pdf (Accessed 18.05.2025).
20. Federal Ministry of Education and Research. National research strategy BioEconomy 2030: our route towards a biobased economy. Bonn, Berlin, 2011. Available at: https://www.pflanzenforschung.de/application/files/4415/7355/9025/German_bioeconomy_Strategy_2030.pdf (Accessed 20.05.2025).
21. Glatzel K., Virchow D., Musaazi S. Nakitto A., Niyonsenga S., Babu S., Srivastava N., Kashandula P. Bioeconomy pathways: experience from Africa, Asia, and Latin America (Chapter 9). ReSAKSS, 2024. Available at:

https://www.resakss.org/sites/default/files/2024_ator_individual_chapters/Chapter%209_ReSAKSS_AW_ATOR_2024.pdf (Accessed 18.05.2025).

22. Lopes C. L., Corleto A. F., Chiavari J. The bioeconomy in the Lula administration: regulatory and institutional advances. 2024. Available at: https://www.climatepolicyinitiative.org/publication/the-bioeconomy-in-the-lula-administration-regulatory-and-institutional-advances/ (Accessed 18.05.2025).

23. Medvedieva M., Yedeliev R., Reznikova N., Nanavov A., Grydasova G. European strategy for achieving climate neutrality and analysis of legal instruments for its implementation. Social & Legal Studios. 2024. Vol. 7, No. 2. P. 64–74. https://doi.org/10.32518/sals2.2024.64.

24. OECD. Bioeconomy to 2030: designing a policy agenda. OECD Publishing, 2009. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2009/04/the-bioeconomy-to-2030_g1gha07e/9789264056886-en.pdf (Accessed 18.05.2025).

25. Patermann C., Aguilar A. The origins of the bioeconomy in the European Union. New Biotechnology. 2018. Vol. 40, Part A. P. 20–24. https://doi.org/10.1016/j.nbt.2017.04.002.

26. Potočnik J. Transforming life sciences knowledge into new sustainable eco-efficient and competitive products [Speech]. Conference on Knowledge-based Bio-economy, European Commission, Brussels, 2005.

27. Ptashchenko O. V. Transformation of the global economic space in the present. Вісник Східноукраїнського національного університету ім. В. Даля. 2018. № 4(245). С. 14–18.

28. Ptashchenko O. V., Shersheniuk O. M. Methodological bases of management of business activity of enterprises in the conditions of globalization. Проблеми і перспективи розвитку підприємництва: Збірник наукових праць Харківського національного автомобільно-дорожнього університету. 2023. № 1(30). С. 38–57.

29. Reznikova N., Ivashchenko O., Rubtsova M. Global problems as a subject of interdisciplinary studies in the focus of international economic security and sustainable development. Економіка та держава. 2020. № 7. С. 24–31.

30. Reznikova N., Panchenko V., Karp V., Grod M., Stakhurska S. The relationship between the green and digital economy in the concept of sustainable development. Economic Affairs. 2024. Vol. 69, Special Issue. P. 389–399. https://doi.org/10.46852/0424-2513.1.2024.41.

31. Rist G. The history of development: from Western origins to global faith. London & New York: Zed Books, 1997.

32. UNCTAD. Science, technology and innovation policy review: global overview. 2024.

33. White House. National bioeconomy blueprint. 2012. Available at: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf (Accessed 18.05.2025).