Nina Petrukha[1], Serhiy Petrukha[2], Oleksandr Gubanov[3], Ilya Demidyonok[4]

BIOECONOMICS AS A BASIS FOR COMPREHENSIVE DESIGN OF UKRAINE'S POST-WAR RECONSTRUCTION

The article is devoted to the analysis of the processes of formation and support of the development of the bioeconomy in Ukraine in the conditions of war and post-war times, with a focus on its potential as a tool for economic restoration. The study proposes nationwide measures for the integration of the bioeconomy into post-war reconstruction programs, taking into account inter-sectoral interaction and biotechnological innovations. The issue of bioeconomy development is gaining particular relevance in the context of the post-war reconstruction of Ukraine, where it is necessary to combine economic growth, energy security, and environmental sustainability. In modern conditions, the bioeconomy can become a catalyst for the modernization of the economy, reducing dependence on fossil fuels and integrating the country into global economic processes. The aim is to study the current state of the bioeconomy in Ukraine, assess its resource potential, and develop a conceptual model for managing the innovative development of the bioeconomic sector for post-war reconstruction. The study aims to create a system of indicators for monitoring the effectiveness of bioeconomy management at the national and regional levels. The work uses the analysis of statistical data from BioUkraine, UABIO, and other sources, as well as systems approaches for assessing biomass resources and the biotechnology sector. Comparative analysis, modeling, and expert assessments were used to develop a conceptual management model and performance indicators. It was found that the bioeconomy in Ukraine has not yet been identified as a separate sector due to the lack of statistical classification. Still, its elements can be integrated into all sectors of the economy, in particular bioenergy and agrobiotechnology. A management model and a system of indicators were developed to assess the development of the bioeconomy, contributing to post-war renovation. Further research may focus on refining statistical methods for accounting for bioeconomic activity, developing regional strategies for biomass use, and assessing the impact of biotechnology on socio-economic indicators. The analysis of the integration of the bioeconomy with EU programs, such as the "Ukraine Facility", for attracting investment and technology is promising.

Keywords: *bioeconomy, project management, post-war reconstruction, management technologies, Ukraine Facility, European Green Deal.*

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Ніна М. Петруха, Сергій В. Петруха,
Олександр В. Губанов, Ілля А. Демидьонок

БІОЕКОНОМІКА ЯК ОСНОВА ЦІЛІСНОГО ПРОЕКТУВАННЯ ПОВОЄННОЇ РЕКОНСТРУКЦІЇ УКРАЇНИ

Стаття присвячена аналізу процесів становлення та підтримки розвитку біоекономіки в Україні в умовах воєнного та повоєнного часу, з фокусом на її потенціал як інструменту економічної реставрації. Дослідження пропонує загальнодержавні заходи для інтеграції біоекономіки в програми повоєнної реконструкції, враховуючи міжгалузеву взаємодію та біотехнологічні інновації. Питання розвитку біоекономіки набуває особливої актуальності в контексті повоєнного відновлення України, де необхідно поєднати економічне зростання, енергетичну безпеку та екологічну сталість. У сучасних умовах

[1] Kyiv National University of Construction and Architecture. Ukraine.
[2] Kyiv National University of Construction and Architecture. Ukraine.
[3] Higher School of International Business. Slovakia.
[4] Higher School of International Business. Slovakia.

біоекономіка може стати каталізатором модернізації господарства, зменшення залежності від викопного палива та інтеграції країни в глобальні економічні процеси. Метою є дослідження сучасного стану біоекономіки в Україні, оцінка її ресурсного потенціалу та розробка концептуальної моделі управління інноваційним розвитком біоекономічного сектору для повоєнної реконструкції. Дослідження спрямоване на створення системи показників для моніторингу ефективності управління біоекономікою на національному та регіональному рівнях. У роботі використано аналіз статистичних даних від BioUkraine, UABIO, а також методи системного підходу для оцінки ресурсів біомаси та біотехнологічного сектору. Застосовано порівняльний аналіз, моделювання та експертні оцінки для розробки концептуальної моделі управління та показників ефективності. Встановлено, що біоекономіка в Україні ще не виділена як окремий сектор через брак статистичної класифікації, але її елементи можуть бути інтегровані в усі галузі економіки, зокрема біоенергетику та агробіотехнології. Розроблено модель управління та систему показників для оцінки розвитку біоекономіки, що сприяють повоєнній реновації. Подальші дослідження можуть зосередитися на уточненні статистичних методів обліку біоекономічної діяльності, розробці регіональних стратегій використання біомаси та оцінці впливу біотехнологій на соціально-економічні показники. Перспективним є аналіз інтеграції біоекономіки з програмами ЄС, такими як "Ukraine Facility", для залучення інвестицій та технологій.

Ключові слова: *біоекономіка, управління проєктами, повоєнна реконструкція, технології управління, Ukraine Facility, Європейський зелений курс.*

Problem statement. In the context of the post-war reconstruction of Ukraine, which involves a deep transformation of the socio-economic system and reconstruction according to the principles of sustainable development, the innovative progress of bioeconomy industries acquires special importance as an obligatory component of the transition from a traditional, resource-dependent economy to an innovative, knowledge-based business model based on ecological balance, efficiency, and technological renewal. This type of transformation is due to the rapid development of scientific and technological progress, the desire to increase productivity, as well as the reduction of periods necessary for the commercialization of scientific and technological innovations. The formation and development of bioeconomic industries are made possible by the increasing use of renewable energy sources, the introduction of new methods and technologies for the deep processing of biological resources, as well as the active penetration of biotechnology into all spheres of society, including agriculture, medicine, energy, the food industry, and municipal infrastructure. The particularly dynamic growth of biotechnology is explained not only by progress in biochemistry, molecular biology, and genetics but also by the increase in crisis phenomena in traditional industries, which are no longer able to ensure the proper level of environmental safety and energy stability, which are critically important conditions in the post-war reconstruction of the country.

In addition, the relevance of the bioeconomy is enhanced by global challenges related to the need to ensure food security, preserve natural resource potential, extend the duration and quality of life of citizens, form a healthy gene pool of the nation, and restore ecological balance within the country. The development of an effective method for assessing the level of development of the bioeconomy is of strategic importance, as it allows for rational allocation of resources in the post-war period, optimizes the territorial distribution of bioeconomy industries, and creates prerequisites for the post-war development of Ukraine.

Analysis of recent research and publications. In the scientific literature of recent decades, namely in the works +++, the phenomenon of bioeconomy as a new economic system, formed at the intersection of the achievements of biotechnology, ecological thinking, and innovative production, is increasingly highlighted, especially in the context of the challenges of the 21st century related to sustainable development and the need to restore post-war territories, such as Ukraine. Thus, Vostryakova V. [5], Faulkner J. P., Murphy E., Scott M. [19], Tomczyk E., Jacobson M., Ruamsuk K. [27], in their works, propose to consider bioeconomy in several dimensions: firstly, as an interdisciplinary field that combines the achievements of biology and economics to create a new explanatory paradigm of economic processes. Secondly, as a process of sustainable production and transformation of biomass into food products, medicines, fibers, industrial raw materials, and energy; thirdly, as a knowledge-based economy bioeconomy), or an economy focused on bioresources (bio-based economy), in which materials, chemical compounds, and energy come from renewable biological sources of plant and animal origin.

In a broader ideological context, researchers Vostryakov V. [6], Bianchi M., Cascavilla A., and Clavell Diaz J. [16] propose to interpret bioeconomy as a new model of social order, in which biotechnology plays a key role in ensuring material production and forming the basis for technological rethinking of the structure of the economy. In turn, Budyakova O., Prygarska D. [2], Rojas-Serrano F., Garcia-Garcia G., Parra -Lopez K., Sayadi-Gmada S. [25] emphasize the applied aspect, defining bioeconomy as an economic sector based on the use of renewable biological resources to create innovative products with higher added value. Thus, the analysis shows that bioeconomy, as a concept characterized by complexity, multifacetedness, and not yet fully formed theoretical foundations, requires deeper scientific clarification and methodological understanding, which forms a key importance for the development of strategic directions for the restoration of Ukraine after the war on the principles of environmental sustainability, technological progress, and social strength.

Research purpose. The purpose of the article is to investigate the processes of formation and support for the development of the bioeconomy and to form nationwide measures to support the use of the bioeconomy for designing post-war programs for the reconstruction of the economy of Ukraine.

Research objectives:

– to investigate the current state and position of the bioeconomy in Ukraine in wartime conditions and assess its potential as a factor in economic restoration after the end of the war;

– assess Ukraine's available resources for the creation and development of the bioeconomic sector;

– to create a conceptual model for managing the innovative potential of the bioeconomy in Ukraine, which will ensure inter-sectoral interaction, optimal investment management, and integration of modern biotechnological developments;

– develop a comprehensive system of indicators to monitor and assess the effectiveness of bioeconomic development management at the national and regional levels in the context of post-war recovery.

Main results of the study. Within the framework of the modern scientific discourse devoted to the prospects of the restoration and transformation of the

Ukrainian economy after the full-scale war, the bioeconomy cannot always be unambiguously identified as a separate, independent sector of the economy, if we proceed from traditional sectoral approaches to statistical accounting. In particular, the existing system of statistical data collection currently used in Ukraine does not yet allow us to separate the volumes of production and use of biotechnological products within specific sectors of economic activity.

At the same time, despite the lack of an official classification of the bioeconomy as a full-fledged industry, its elements can be integrated into almost all areas of the national economy, which opens up wide opportunities for its development for the design of post-war renovation.

Table 1. **Classification of biotechnology industries in context bioeconomic development of Ukraine,** *compiled by the authors based on [4; 15; 18; 22]*

Industry/sphere of economic activity	Main areas of development
Biopharmaceuticals	Development of innovative medicines, new generation vaccines, antimicrobials, and bioactive compounds, with a special emphasis on import substitution and strengthening national pharmaceutical independence
Biomedicine	Development of precision and personalized medicine tools, including technologies in vitro diagnostics, cell therapy, creation of biocompatible materials, biobanks, as well as bioinformatics to support medical decisions in the post-war period
Industrial biotechnology	Biotechnological production of amino acids, enzymes, polysaccharides, bioactive substances, and biopolymers; creation of bio-industrial complexes for deep processing of biomass to reduce dependence on fossil fuels
Bioenergy	Generation of heat and electricity based on renewable biomass, implementation of bioconversion technologies to reduce greenhouse gas emissions, and elimination of the consequences of the energy and environmental crisis caused by the war
Agrobiotechnologies	Creation of highly productive and climate-resistant varieties of crops, development of biological plant protection products, production of biofertilizers, development of molecular breeding in livestock, production of bioprotein and additives, utilization of agricultural waste
Food Biotechnology	Production of functional food products - therapeutic, preventive, and baby food, bioprotein, enzyme preparations, probiotics, and prebiotics, as well as the introduction of deep processing technologies for raw materials to improve food security
Forest biotechnology	Bioengineering management of forest resources, preservation and reproduction of the forest gene pool, creation of highly productive tree forms with specified properties, application of biological methods of forest protection
Ecological (environmental) biotechnology	Using bioremediation technologies to purify water, soil, and air, create environmentally safe housing, and form biological collections and bioresource centers to protect biodiversity
Marine Biotechnology	Development of aquaculture and biotechnology centers in the coastal regions of Ukraine, deep processing of marine bioresources, and production of specialized feeds for aquaculture as part of food and environmental policy

In particular, traditional industries, such as the extractive industry, must undergo serious restructuring, since the further course towards decarbonization and abandonment of excessive dependence on fossil fuels implies a significant reduction in the volume of hydrocarbon production, and instead - the development of alternatives, in particular renewable bioenergy.

In the field of electricity, gas, and water production and supply, it is advisable to focus efforts on expanding the potential of bioenergy technologies, which can ensure not only the energy independence of individual regions but also contribute to environmental safety in the context of sustainable development. In the housing and communal services sector, it is important to intensify the implementation of environmentally friendly biotechnologies, in particular those related to household and industrial waste management, the introduction of resource-saving technologies in the lives of citizens, wastewater treatment, and modernization of recycling systems (Table 1).

Another promising direction is the introduction of biotechnological solutions in the manufacturing industry, where it is necessary to develop food, forestry, textile, chemical, and other types of applied biotechnologies aimed at increasing environmental efficiency, reducing dependence on imported raw materials, and forming new value chains. In the context of post-war reconstruction for Ukraine, bioeconomy is increasingly viewed as a complex system of knowledge-oriented use of biological resources, processes, and patterns, which ensures sustainable production of goods and services in a wide range of sectors of the national economy from agriculture and energy to pharmaceutical, chemical, textile, and food [8].

The approach itself is based on a high level of innovation and interdisciplinarity, which allows combining the achievements of natural, technical, economic, and social sciences to form effective mechanisms of economic activity aimed at restoring resource potential, ecological balance, and technological modernization of the territory of Ukraine after the war (Table 2).

Table 2. **Directions for implementing biotechnology in key areas for the post-war reconstruction of Ukraine,** *compiled by the authors based on [3; 15; 21-22]*

Field of activity	The role of biotechnology in shaping the bioeconomy of post-war Ukraine
Healthcare	1. Development of innovative medicines, vaccines, diagnostic tools, and genetic tests for the timely detection of hereditary diseases and chronic pathologies, in particular, vulnerable categories of the population in conditions of post-war stress. 2. Biotechnological support of reproductive health, including methods of artificial insemination and early diagnosis of genetic defects. 3. Implementation of modern approaches to cell and gene therapy for the treatment of severe and rare diseases. 4. Development of biocompatible materials and technologies for point-of-care drug delivery, especially relevant in the rehabilitation of the wounded.
Agriculture	1. Creation of new highly productive plant varieties and animal breeds that have increased resistance to diseases, drought, and other consequences of climate change. 2. Biotechnological preparations for the protection of crops and animals, including biological fertilizers and growth stimulants. 3. Production of balanced feeds and biological feed additives. 4. Reproductive technologies – artificial insemination, biotechnical reproduction, embryo manipulation. 5. Mass production of healthy, virus-free seed material to accelerate agricultural recovery.

End of Table 2.

Field of activity	The role of biotechnology in shaping the bioeconomy of post-war Ukraine
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The basis of the bioeconomic approach is the principle of colonization, which involves the widest possible use of biological resources - from plants and animals to enzymes and molecules in industrial production, which can become a driving force for the revival of Ukraine's agricultural sector and its integration into global value chains.

According to Nifatov O. M., and Petrychuk S. I. [13], countries, depending on their natural resource and industrial potential, have different development opportunities, which significantly affects the formation of the goals of the bioeconomy strategy, and also determines the criteria for assessing its successful implementation in the context of a holistic approach to the post-war reconstruction of Ukraine. The concept of biological processing, which is key within the bioeconomy, involves creating value by using biomass as the main resource, similar to how oil refineries obtain a wide range of products, such as various types of fuels and chemicals, from oil, while the bioeconomy focuses on the production of energy, biofuels and chemical products from biological materials, which can become the basis for restoring Ukraine's economic potential after the war. The goals and priorities of the bioeconomy in the context of post-war reconstruction measures in Ukraine include not only stimulating economic growth and creating new jobs but also ensuring energy and food security, as well as reducing the nature-intensiveness of industrial sectors and the level of environmental pollution, which contributes to the formation of a sustainable infrastructure for the country's development (Table 3).

To realize this potential in the post-war reconstruction, it is necessary to develop a comprehensive strategy for the development of the bioeconomy, which would take into account the goal, driving forces, and influencing factors that form its basis, ensuring a holistic approach to designing economic and environmental reconstruction. The key condition for the successful implementation of the bioeconomic model within the framework of post-war reconstruction is the implementation of a holistic innovation policy, within which a national innovation system should be built (Fig. 1.).

Table 3. **Key drivers and constraints of bioeconomy development in the context of post-war reconstruction processes in Ukraine,** *compiled by the authors based on data from [7; 9; 15; 22]*

Drivers of bioeconomy development	Factors constraining development
Increasing government spending on the purchase of innovative medical products and vaccines stimulates the development of the domestic biopharmaceutical sector.	The unstable macroeconomic situation, security risks, and political turbulence due to martial law
Government programs to stimulate the production of domestic biotechnological solutions as a tool for import substitution	Outdated technological base of biotechnology enterprises and limited access to modern equipment
Active cluster policy in the bioeconomy sector, creating conditions for attracting international investments	High dependence on imported components, particularly in biopharmaceutical production and agrobiotechnologies
State support for startups through development investment funds focused on innovative enterprises.	The chronic shortage of specialists in the field of biotechnology, as well as the lack of a modern interdisciplinary education system
Expanding national vaccination programs, contributing to the growth of the domestic market for biologics	Unregulated localization conditions for international biotech companies and unpredictability of regulatory policy
Focus on preventive medicine driving demand for diagnostic biotechnologies, new biomarkers, and laboratory systems.	Disproportionate distribution of venture capital investments: the advantage of the IT sector while biotechnology is underfunded
The increasing number of surgical medical interventions due to war increases the demand for biocompatible materials for prosthetics, rehabilitation, and transplantation.	High logistics costs, limited infrastructure, and inefficient customs regulations make it difficult to import biomaterials.
The potential of Ukraine's IT industry for the development of bioinformatics, medical computing, and data analysis in healthcare and agro bio	Lack of harmonized modern legislation, environmental standards, and technical regulations for the bioeconomy sector
Dynamic development of the agricultural sector, growing demand for biostimulants, biofertilizers, and resistant crop varieties	Low level of state stimulation of the use of biotechnology in agriculture and energy
Significant potential for import substitution in agro-, pharma- and industrial biotechnology	Opaque public procurement procedures, and lack a guaranteed sales market, which discourages private investment.

The main function of such a management system should be the transformation and renewal of existing production capacities through technological adaptation, modernization of infrastructure, and replacement of outdated business models with bio-oriented practices based on the principles of sustainable development, environmental safety, and economic efficiency. When determining strategic approaches to managing the bioeconomy sector in the post-war period, it is worth giving preference to a flexible, adaptive, i.e. mixed strategy that can take into account regional specifics, technological multi-levelness, socio-economic unevenness of the country's development, as well as differences in their innovative potential [14, p . 39].

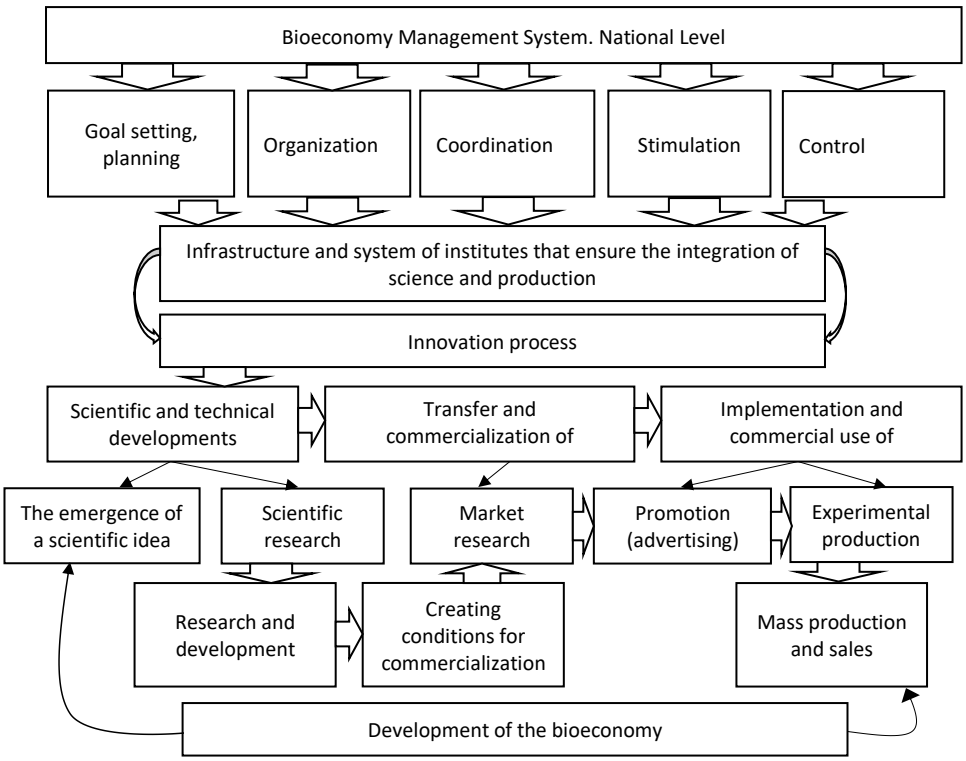

Fig. 1. **Model of the management system for innovative development of bioeconomy in the conditions of post-war reconstruction of Ukraine,** *developed by authors'*

In the context of the reconstruction of Ukraine after the end of the war, which requires fundamentally new approaches to economic recovery, the bioeconomy management system is appropriately considered as a key structural element of the national innovation system, capable not only of promoting its development, but also of acting as a catalyst for the deep modernization of the national economy through the introduction of biotechnological solutions, advanced production methods, and innovative products based on the use of renewable biological resources. Exactly Biomass can form a new role in the development of Ukraine's bioeconomy, especially in the context of post-war reconstruction, where the use of renewable resources can contribute to energy independence and sustainable development [1, p . 225]. The following is an estimate of the potential of different types of biomass in Ukraine, expressed in million tons of oil equivalent (toe) per year. The study shows that the biomass potential in Ukraine is approximately 23 million tons of oil equivalent (toe) per year, with the main contribution from straw and other agricultural waste (Fig. 2.).

The potential for biogas in Ukraine is significant, especially from agricultural wastes such as manure, poultry manure, and silage. It is estimated that biogas could replace 2.6 billion mi of natural gas per year, equivalent to approximately 2.5 million

tons, taking into account the energy content of natural gas (39.7 MJ/mi) and the conversion to toe (42 GJ/toe). This includes biogas from livestock farms, landfills, and sewage treatment plants, making it an important resource for energy security. The data themselves indicate a significant biomass potential in Ukraine that can be used for energy, biofuels, and biogas production, which is critical for post-war reconstruction [26].

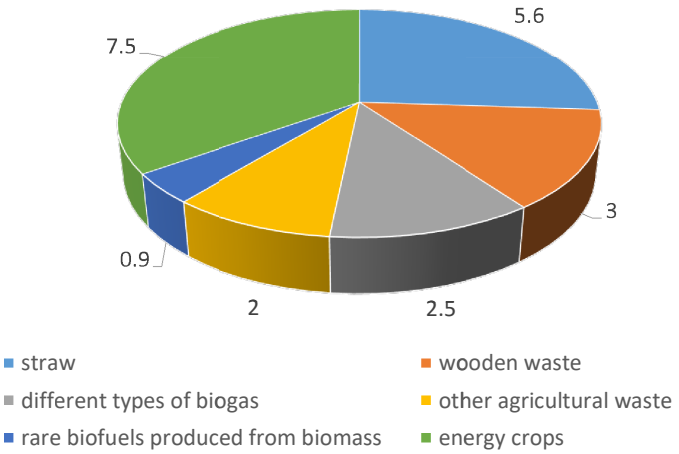

Fig. 2. **Estimated biomass potential in Ukraine by type of origin in million tons (oil equivalent),** *compiled by the authors based on [26]*

According to the analytical report BioUkraine, 75 companies operating in the field of life sciences, biotechnology, and bioeconomic projects were studied in Ukraine. The selection of companies was carried out according to such criteria as high technological intensity, the presence of a component of scientific research and development (R&D), the size of the enterprise, its media activity, and the potential for attracting investments. Thus, as of December 20, 2024, there were 34 biotechnology companies in Ukraine, of which 32 operate as independent business entities, and 2 are part of large corporate structures. The highest concentration of such companies is observed in Kyiv (10 companies), Lviv region (4 companies), and Cherkasy region (3 companies). The average age of these businesses is approximately 3 years and 5 months, which indicates the young and dynamic nature of the biotechnology sector [17] (Table 4).

In the context of the holistic design of Ukraine's post-war reconstruction, which involves not only the physical restoration of infrastructure but also the creation of an innovation-oriented, sustainably balanced economy, state programs to stimulate the development of the biotechnology sector and attract investments in key areas of the bioeconomy are gaining strategic importance. Such programs should be aimed at the long-term transformation of the country's economic model, acting as a powerful driver of its competitiveness in the global market and providing an impetus for the structural modernization of national production.

The development of a comprehensive state policy, which should include not only a national but also a regional level of implementation, is of particular relevance to

ensure a balanced spread of biotechnological innovations throughout Ukraine, including the regions affected by the war.

Table 4. **Distribution of biotechnology companies by regions of Ukraine (as of 2024), in %,** *compiled by the authors based on [17]*

Region	Number of companies, units	Interest from total (%)
Vinnytsia	1	4.17
Volynska	0	0.00
Dnipropetrovsk	1	4.17
Zhytomyrska	2	8.33
Transcarpathian	0	0.00
Zaporizhzhia	0	0.00
Ivano-Frankivsk	1	4.17
Kyivska	0	0.00
Kirovohradska	1	4.17
Lvivska	4	16.67
Mykolaivska	1	4.17
Odesa	1	4.17
Poltava	2	8.33
Rivne	0	0.00
Sumy	0	0.00
Ternopil	0	0.00
Kharkiv	7	29.17
Kherson	0	0.00
Khmelnytskyi	0	0.00
Cherkasy	3	12.50
Chernihiv	0	0.00
Chernivtsi	1	4.17

The integration of sectoral ministries, research institutions, businesses, local governments, and educational clusters into a single strategic management system will allow for effective coordination of the efforts of all participants and ensure sustainable dynamics of the implementation of bioeconomic solutions in key sectors [1].

A separate role in the implementation of investment policy in the field of biotechnology is played by subsidiary projects, which can become effective tools for supporting innovative enterprises, in particular young science-oriented companies, startups, technology parks, and bioengineering laboratories. State support in the form of public-private partnerships should become the basic model of interaction between investors, science, and the state, contributing to the implementation of high-tech platforms that accumulate resources, intellectual capital, and infrastructure capabilities for the creation, testing, and implementation of innovative biotechnologies [23]. Changes in the legal framework relating to scientific and technological activities and innovation policy should become a catalyst for deeper integration of science and production (Table 5).

Even though Ukraine has significant scientific and educational potential in the field of biotechnology, the current level of development of the bioeconomy remains insufficient due to the limited domestic demand for innovations from industrial

enterprises, as well as the low level of commercialization of research results. These problems are similar to those recorded in foreign reports, where more than 60% of biotechnology market participants indicated weak integration of science with business as the main barrier.

Table 5. **A comprehensive program for the development of biotechnology in Ukraine within the framework of reconstruction and sustainable economic growth,** *compiled by the authors*

Program indicators	Characteristics and targets
Strategic objectives of the program	1) Ensuring an increase in domestic consumption of biotechnological products by at least 8 times; 2) Increasing the production of biotechnological products by more than 30 times to meet national needs and strengthen export potential; 3) Reducing dependence on imports of biotechnological goods by 50%; 4) Increase the share of exports in the structure of biotechnological production by 25 times or more; bio-based production at a level of at least 1% of GDP by 2030 and further growth to 3% in subsequent years.
Stages of program implementation	1. The first stage (2027–2029) – formation of domestic demand for biotechnological products and support for exports through state incentives, in particular in the agricultural sector and medicine; 2. The second stage (2029–2035) is the creation of a stable institutional environment for the large-scale introduction of biotechnology into industry, with an emphasis on deep modernization of production processes.
Priority areas of development	1) Biomedicine and biopharmaceuticals (rebuilding the healthcare system); 2) Industrial biotechnology (sustainable industrial development); 3) Bioenergy (biogas production, biofuels as energy independence of regions); 4) Agrobiotechnologies (increasing the productivity of the agricultural sector); 5) Food biotechnology (production of functional and healthy food); 6) Forest biotechnology (restoration of ecosystems and forest resources); 7) Ecobiotechnologies (water and soil purification, restoration of contaminated areas); 8) Marine biotechnology (rational use of aquatic bioresources in coastal regions).
Institutional support	1) Stimulating demand: government orders, development of national standards, technical regulation, support for the localization of production by domestic and foreign investors; 2) Increasing competitiveness: providing grants and soft loans to small and medium-sized enterprises for research and development (R&D), supporting exports, developing innovation infrastructure, and actively involving development institutions in promoting the bioeconomy; 3) Development of education: introduction of modern educational standards and interdisciplinary curricula in the field of bioeconomy; 4) Support for science: increasing funding for scientific research, and creating strategic programs for fundamental and applied research in priority areas of the bioeconomy.

According to expert forecasts, the consumption of biological products in livestock farming in Ukraine will grow by 30-40% annually, which creates additional

incentives for active investment attraction, development of research infrastructure, and realization of the potential of the bioeconomy as one of the basic elements of the post-war economic revival of Ukraine [20].

Thus, among the main elements of the region's resource potential that have a direct impact on the possibility of deploying bioeconomic initiatives, it is advisable to highlight: natural raw materials, infrastructure, logistics, and labor potential. At the same time, in the process of analyzing the challenges associated with the development of complex and combined forms of production in the war and post-war periods, taking into account the technical modernization of restoration projects, it is advisable to include indirect components of the potential: financial, informational, organizational and managerial, etc. (Fig. 3.).

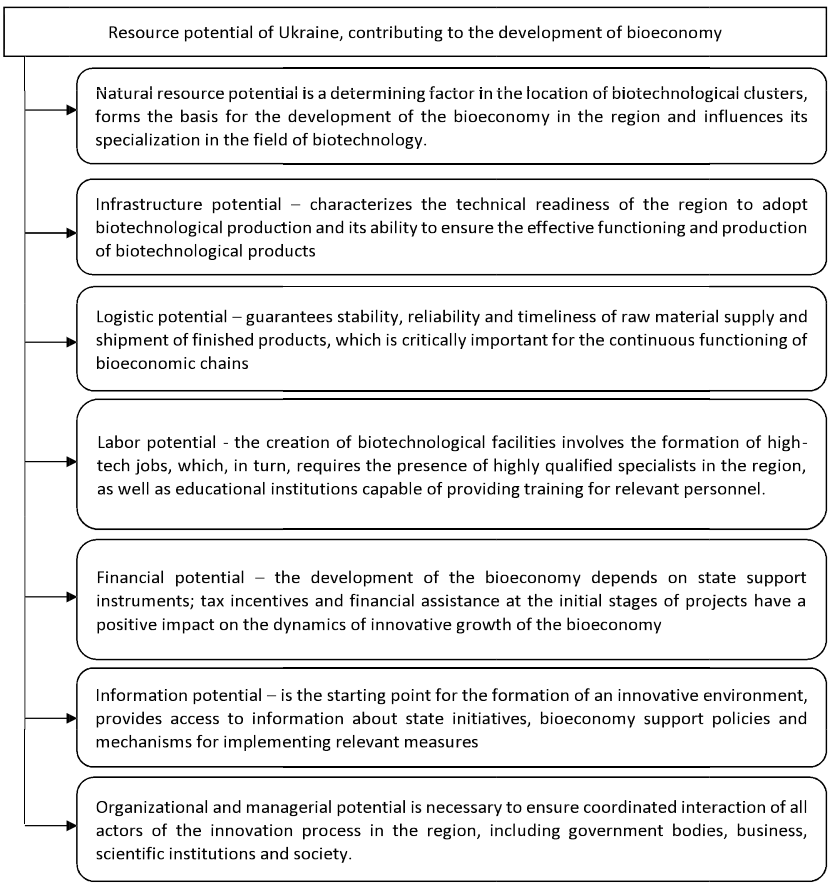

Fig. 3. **Components of Ukraine's resource potential, directed for sustainable development of the bioeconomy,** *built by the authors*

An equally important component is the labor potential, which reflects the availability and level of training of personnel capable of working in the field of biotechnology, as well as the degree of integration of regional educational and scientific insti-

tutions with biotechnology companies that form the human capital of the future. The financial potential of the region includes the level of availability of financing for innovative projects in the field of bioeconomy, as well as the general investment attractiveness, which is a necessary condition for the implementation of public-private initiatives.

Information potential assumes the availability of an accessible digital infrastructure that ensures the openness of data on innovative development, available opportunities, and state support for bioeconomic projects. Finally, organizational and managerial potential is formed through the effectiveness of managerial decisions, the level of regional policy in the field of biotechnology, the regulatory framework, and the readiness of institutions to implement innovative approaches. Each of the above resource elements requires the development of specific criteria and evaluation parameters, which can be determined based on an expert survey of specialists involved in the implementation of investment projects in the field of biotechnology [16]. These parameters allow for a more accurate identification of the potential of each region in the context of developing the bioeconomy within the framework of national reconstruction (Table 6).

At the same time, when assessing the effectiveness of the bioeconomy management system, it is necessary to take into account performance indicators that allow objectively tracking the dynamics of program implementation and their impact on the biotechnology sector. Such indicators may include: an increase in the production of biotechnological products, an increase in investment in research and development (R&D), a reduction in waste through bioprocessing, the introduction of new biotechnological solutions, etc. All this forms the basis for assessing structural changes and innovative breakthroughs in the national economy [7].

The methodology for assessing the effectiveness of bioeconomy management, which was developed to systematize indicators of various state programs, can be adapted to Ukrainian realities, where such programs could be implemented at the level of regional administrations to contribute to the reconstruction of the country after the war through the development of biotechnology and the use of renewable resources. This methodology takes into account the interest of local authorities in the effective implementation of such programs, since they have significant socio-economic potential, in particular for restoring employment, stimulating economic growth, and ensuring sustainable development in the regions of Ukraine that have suffered destruction, which makes their implementation especially relevant in the post-conflict period. Since the development of biotechnology is indirectly reflected in state strategies and programs, and the bioeconomy is capable not only of creating new jobs but also of providing revenue to the budget through taxes and generating a positive multiplier effect in related industries, the author proposes a comprehensive system of indicators that allows assessing the effectiveness of managing the development of the bioeconomy, which can become the basis for developing a holistic strategy for the post-war recovery of Ukraine with an emphasis on innovative and environmentally friendly approaches [21].

In response to Russian aggression, the European Union initiated the program " Ukraine Facility » (2024–2027), which provides for the allocation of up to 50 billion euros in the form of grants and loans to support financial stability, reforms, and the

Table 6. **Performance measurement system bioeconomy management in Ukraine,** *compiled by the authors*

Program direction	Indicator	Unit of measurement
Industrial, food, and biotechnologies		
Development of industry and increasing its competitiveness	The volume of production of products created thanks to industrial biotechnology	million UAH
	Volume of consumption in Ukraine of products manufactured based on industrial biotechnology	million UAH
	Share of imported products based on industrial biotechnology in total consumption	%
	Share of exports of products based on industrial biotechnology in total production	%
	Share of biodegradable materials in the total volume of polymer products consumed	%
Development of the pharmaceutical and medical industry	Growth in the share of high-tech and science-intensive products in the total production volume of the industry	%
	The volume of investments in scientific research, development, technological innovations, and modernization of pharmaceutical and medical product production	billion UAH
	The volume of production of domestic medicines, in particular, due to the introduction of advanced technologies	billion UAH
Agricultural biotechnology		
State Program for Agricultural Development and Market Regulation	Growth in crop production on agricultural lands (cumulative total)	%
	Preservation of existing and creation of new high-tech jobs for agricultural producers through increased productivity and introduction of new lands into circulation	thousand jobs
Environmental Biotechnology		
Restoration and use of natural resources	Area of restored water bodies (rolling total)	thousand hectares
	The volume of internal research and development expenditures within the framework of the program implementation	million UAH
	Share of polluted wastewater in the total volume of discharges into surface water bodies requiring treatment	%
	Number of projects for the construction or reconstruction of treatment plants and recycled water supply systems implemented with the support of subsidized interest rates on loans	units
Forest biotechnology		
Industrial development and its competitiveness	The volume of forest industrial biotechnology products production	thousand UAH
Forestry development	The volume of budget revenues from the use of forests on forest fund lands per 1 hectare	UAH
	Share of seeds with improved hereditary properties in the total volume of harvested seeds	%
	Share of funding for scientific research in the field of forests in the total amount of forestry funding	%
	Internal research and development costs	million UAH
Aquaculture		
Development of the fisheries complex	The volume of the estimated potential of the raw material base of aquatic biological resources (annual value)	thousand tons
	Growth in commercial aquaculture production, including planting material, compared to the base period	%
	Investments in fixed capital in the field of "Fishery and fish farming"	thousand UAH
Bioenergy		
Energy development	Share of installed capacity of generation facilities operating on renewable energy sources in the total capacity of the unified energy system of Ukraine	%

recovery of the Ukrainian economy. At the same time, the bioeconomy, based on the sustainable utilization of biological resources for the production of food, energy, and materials, is identified as a key area for ensuring economic sustainability and environmental security. The integration of this sector into the reconstruction program will allow the formation of a resilient economy capable of adapting to future post-war realities.

In the context of a holistic design of the post-war reconstruction of Ukraine, which is based on the principles of the European Green Deal and the implementation of the instrument " Ukraine Facility ", bioeconomy is considered a key vector of transformation of the agricultural sector, capable of ensuring not only sustainable development but also energy efficiency, innovation, and environmental safety. One of the conceptual approaches within this direction is convergence – synergistic interaction between different sub-sectors of agriculture, which allows the formation of highly efficient production systems based on complementary benefits between sectors, which is fully consistent with the ideology of bioeconomic development.

According to modern scientific research, the bioeconomy opens up several strategic opportunities that should be integrated into the reconstruction of Ukraine's agriculture. Among the main advantages, it is worth highlighting the potential for more efficient use of natural resources, which is realized through the gradual replacement of traditional production based on fossil energy sources with biotechnological systems that are characterized by less environmental damage and greater economic feasibility. In addition, the bioeconomy involves the creation of new interdisciplinary research structures that will facilitate the exchange of knowledge, technologies, and the direction of innovations in the practical sphere of agricultural production [12, p . 21–22].

Within the environmental imperative of the European Green Deal, the bioeconomy plays a leading role in reducing carbon dioxide (CO) emissions and in shaping new approaches to agricultural production, which involve the transition from non-renewable energy sources to renewable ones, including biofuels. At the same time, improving farming systems, in particular in the livestock sector, by improving housing conditions, feeding, and genetic selection, are becoming important areas.

The agricultural bioeconomy also encompasses the application of innovations to increase water efficiency (using crops that consume less moisture), optimize the use of fertilizers (especially nitrogen), introduce more disease-resistant crop varieties, and streamline crop rotations by introducing crops that increase soil fertility, such as perennial legumes. Among the technological solutions that can provide a breakthrough in the modernization of Ukraine's agricultural sector following the strategic goals of the Ukraine Facility, we can distinguish [1; 20]:

1) Breeding technologies aimed at increasing the adaptability of plants to climate change, increasing their resistance to pests and diseases, increasing yields and nutritional value while reducing the need for water and chemical protection agents;

2) Alternative agricultural practices, including integrated pest management systems, as well as the use of agricultural robotics to reduce herbicide use and increase the precision of field cultivation;

3) Precision farming technologies that encompass digital solutions: sensors, control platforms, drones, and mobile applications that provide real-time data analytics and optimize production processes;

4) Innovative systems for processing agricultural waste to produce energy or biofertilizers, which are an example of closed cycles and comply with the principles of a circular bioeconomy;

5) Sustainable soil management involves methods to preserve its quality and biological activity, without harming the environment.

The EU program can become a catalyst for the development of the bioeconomy sector by [19] :

1. Financing bioenergy infrastructure through the construction of biogas plants, biomass CHPs, and waste processing plants;

2. Support for research and development, investments in biotechnology (bioprinting, biorefining), increasing the efficiency of biofuel production;

3. Stimulating the cultivation of energy crops:

Subsidies for farmers who cultivate willow, poplar, or miscanthus and the use of agricultural waste for energy without harming the soil;

4. Harmonization of legislation with European standards and adaptation of norms regarding biofuels, simplification of procedures for investors.

The identified measures will facilitate the integration of bioenergy into the energy system, reducing dependence on gas and coal imports. To achieve long-term sustainability, the bioeconomy needs to be integrated with key sectors [20–21] :

1) Energy, replacement of 2.6 billion mi of natural gas per year with biogas.

2) In the agricultural sector, this is the processing of waste into additional sources of income for farmers.

3) The country's economy, through the creation of thousands of jobs in the bioenergy sector.

4) Ecology by reducing CO emissions by 68–83% by 2050 (by Ukraine's climate goals).

In today's conditions, it is advisable to consider the bioeconomy as a powerful megatrend that encompasses not only the creation of goods or the provision of services based on the use of biotechnology and renewable biological resources but also acts as a key tool for achieving sustainable development goals, which is especially relevant for a country that seeks to restore its economy and infrastructure after a devastating conflict. Such an approach to the bioeconomy involves its perception as a state-political concept that contributes not only to solving internal reconstruction tasks but also provides a platform for international integration, allowing Ukraine to harmonize its economic and environmental strategies with European standards, which can become the basis for its gradual return to global economic processes. In this broad sense, bioeconomy represents a new vision of economic development based on advanced biotechnologies of the future, such as fabrication and bioprinting, where bioprinting, for example, opens up opportunities for the creation of organs and tissues for medical transplantations, artificial meat for the needs of the food industry, or even natural leather for the production of consumer goods using cellular technologies, which can radically change approaches to healthcare, agriculture, and light industry in Ukraine [24, p . 9–10].

These innovative technologies, which underlie the bioeconomy, have the potential not only to revolutionize key industries, which is critical for restoring Ukraine's economic potential after the war but also require the formation of new value orienta-

tions in society and among decision-makers aimed at realizing the importance of rational use of natural resources and the widespread introduction of biotechnology to ensure the country's long-term prosperity. Moreover, in the context of post-war reconstruction, bioeconomy can be considered an interdisciplinary scientific field that unites the humanities and natural sciences, allowing the development of comprehensive strategies that take into account both economic social, and environmental aspects, which is necessary for creating a sustainable model of development of Ukraine, capable of confronting the challenges of the future and contributing to its integration into the global community on the principles of sustainability and innovation [28].

Therefore, in the context of the post-war reconstruction of Ukraine, which requires rethinking and updating the economic structure taking into account the principles of sustainable development, the issue of forming an effective bioeconomy management system based on the assessment of the resource potential of regions becomes of particular importance. According to the modern approach to regional development planning, it is advisable to single out several key components of resource potential, each of which is of critical importance for ensuring the innovative transformation of the economy based on biotechnology.

Conclusions and prospects for further research. The study revealed that the bioeconomy of Ukraine, despite the difficult conditions of wartime, demonstrates high adaptability and significant potential for structural changes in the national economy, which formed the basis for a detailed consideration of it as one of the fundamental factors in the restoration of the economy and infrastructure of Ukraine in the post-war period. Analysis of the current state of the bioeconomy showed that, despite the lack of a unified statistical classification, innovative enterprises in the fields of biopharmaceuticals, agrobiotechnologies, bioenergy, food, and environmental biotechnology are actively developing in Ukraine.

The country's resource potential has been studied, including raw material base, infrastructure, logistics, labor, financial and managerial resources. The outlined factors create the prerequisites for regional development of bioeconomy and can become the basis for rebuilding the economy taking into account the principles of the European Green Deal. Special attention is paid to the possibilities of bioenergy production from local biomass and biogas, which can reduce Ukraine's energy dependence and contribute to achieving climate goals, in particular by reducing greenhouse gas emissions and implementing a circular economy.

A system of indicators was developed to assess the effectiveness of bioeconomy management, covering the industrial, agricultural, energy, environmental and infrastructure sectors. The developed system is the basis for systematic monitoring of the integration of bioeconomy projects and programs into the post-war recovery economy of Ukraine, both at the national and regional levels.

1. Белова І. М., Ярощук О. В. Розвиток біоекономіки в Україні: адаптація європейського досвіду для інтеграції в європейський економічний простір. Інноваційна економіка. 2024. № 3. С. 221-230. DOI: 10.37332/2309-1533.2024.3.27.

2. Будякова О., Дервіш Д. Інвестиції в біоекономіку для повоєнного відновлення України. Трансформаційна економіка. 2023. № 4 (04). С. 9-13. DOI: https://doi.org/10.32782/2786-8141/2023-4-2.

3. Будякова О., Пригарська Д. Можливості впровадження біоекономіки у фармацевтичні підприємства. Економіка харчової промисловості. 2024. Том 16, № 2. С. 52-58. DOI: https://doi.org/10.15673/fie.v16i2.2941.

4. Василюк С. В., Франів І. А., Київ Д. І. Інтеграція біоекономіки в галузі національного господарства. Інфраструктура ринку. 2024. № 72. С. 20-27. DOI: https://doi.org/10.32782/infrastruct72-4.

5. Вострякова В. І. Біоекономіка як комплексна система забезпечення сталого розвитку країни. Економіка та держава. 2023. № 1. С. 167-177. DOI: https://doi.org/10.32983/2222-4459-2023-1-167-177.

6. Вострякова В. І. Локально-орієнтована модель управління біоекономічною трансформацією соціально-економічних систем на засадах сталого розвитку. Ефективна економіка. 2024. № 9. DOI: http://doi.org/10.32702/2307-2105.2024.9.37.

7. Зелена трансформація та стала біоекономіка: моногр.; за наук. ред. А.А. Олешко, О.Ю. Будякової. Київ: КНУТД, 2024. 496 с.

8. Колач С. М. Біоекономіка та її вплив на розвиток сільських територій. Наукові записки Львівського університету бізнесу та права. Серія економічна. Серія юридична. 2023. Вип. 37. С. 230-234. DOI: http://dx.doi.org/10.5281/zenodo.8047092.

9. Крамар І., Лисий В. Деякі аспекти розвитку біоекономіки в Україні. Матеріали Міжнародної науково-практичної конференції «Сучасні напрями розвитку економіки, менеджменту та фінансів в Україні та світі». 2023. С. 135-137. URL: https://elartu.tntu.edu.ua/bitstream/lib/40903/2/MNPK_2023_Kramar_I-Some_aspects_of_the_bioeconomy_135-137.pdf.

10. Кучер О. В. Формування маркетингового механізму управління розвитком біоекономіки. Подільський вісник: сільське господарство, техніка, економіка. 2024. № 42. С. 132-139. DOI: https://doi.org/10.37406/2706-9052-2024-1.18.

11. Македон В. В., Байлова О. О. Планування і організація впровадження цифрових технологій в діяльність промислових підприємств. Науковий вісник Херсонського державного університету. Серія «Економічні науки». 2023. Випуск 47. С. 16-26. DOI: 10.32999/ksu2307-8030/2023-47-3.

12. Македон В., Михайленко О., Красніков П. Управління розробкою та реалізацією національних і міжнародних проектів у сфері відновлювальної енергетики. Підприємництво та інновації. 2023. №(26). с. 5-13. https://doi.org/10.32782/2415-3583/26.1.

13. Ніфатова О. М., Петричук С. І. Емпірична верифікація впливу імплементації біоекономічних принципів на підвищення рівня екологічної відповідальності та сталого розвитку підприємств. Науковий вісник Міжнародного гуманітарного університету. 2024. № 60. С. 15-22. DOI: https://doi.org/10.32782/2413-2675/2024-60-3.

14. Петричук С. І. Методологічні підходи до оцінювання ступеня екологічної відповідальності та сталого розвитку підприємств в умовах імплементації біоекономічної парадигми. Економіка: державне управління та місцеве самоврядування. 2024. № 2. С. 35-42. DOI: https://doi.org/10.32782/1814-1161/2024-2-5.

15. Петруха Н. Повоєнне відновлення аграрного сектору економіки на засадах біоекономіки. Економічний аналіз. 2023. Том 33. № 4. С. 49–58. DOI: https://doi.org/10.35774/econa2023.04.049

16. Bianchi M., Cascavilla A., Clavell Diaz J., Ladu L., Palacino Blazquez B., Menger P., Staffieri E., Yilan G. Circular bioeconomy: A review of empirical practices across implementation scales. Journal of Cleaner Production. 2024. Vol. 477. P. 143816. DOI: 10.1016/j.jclepro.2024.143816.

17. Biotechnology in Ukraine. URL: https://bioukraine.org/biotechnology-in-ukraine/

18. Dietz T., Bogdanski A., Boldt C., Bцrner J., von Braun J., O Concubhair C., Nн Choncubhair У., Durham B., Ecuru J., Lang C., Li Y., Lund M., MacRae E., Maxon M., Chavarrna Miranda H., Mizunashi W., Mungeyi P., O'Hara I. M., Pittaluga Fonseca L., Popov V., Regъnaga M., Rodrнguez A., Teitelbaum L., Barcelos Vargas D., Virgin I., Werheim P. Bioeconomy globalization: Recent trends and drivers of national programs and policies. A report by the International Advisory Council on Global Bioeconomy (IACGB). April 2024. 43 p. DOI: https://doi.org/10.2139/ssrn.5023374.

19. Faulkner J. P., Murphy E., Scott M. Bioeconomy, Planning and Sustainable Development: A Theoretical Framework. Sustainability. 2024. Vol. 16, no. 19. P. 8303. https://doi.org/10.3390/su16198303.

20. Financing a Sustainable Global Bioeconomy. URL: https://wcbef.com/wp-content/uploads/2024/09/financing-a-sustainable-global-bioeconomy_report_092024.pdf

21. Global Bioeconomy Assessment Coordinated Efforts of Policy, Innovation, and Sustainability for a Greener Future. URL: http://www.unep-iemp.org/file/2024/04/24/1713940443921.pdf

22. Gorokhova T., Firstenko O., Chopyk Y., Voitsitska K., Petrukha N. Strategies for Ukraine's Post-War Economic Recovery within the Framework of Sustainable Development Goals. Journal of Lifestyle and SDGs Review. 2024. Volume 5, Issue 1, e03350. DOI: https://doi.org/10.47172/2965-730X.SDGsReview.v5.n01.pe03350

23. Makedon V., Myachin V., Plakhotnik O., Fisunenko N., Mykhailenko O. Construction of a model for evaluating the efficiency of technology transfer process based on a fuzzy logic approach. Eastern-European Journal of Enterprise Technologies. 2024. no 2(13(128)). p. 47-57. DOI: https://doi.org/10.15587/1729-4061.2024.300796.

24. Petrukha N., Demydonok I., Hubanov O. Ethical aspects of bioeconomy in post-war reconstruction projects in Ukraine. Economics, Finance and Management Review. 2024. No. 4(20). P. 4-17. DOI: https://doi.org/10.36690/2674-5208-2024-4-4-17.

25. Rojas-Serrano F., Garcia-Garcia G., Parra-Lypez C., Sayadi-Gmada S. Sustainability, circular economy and bioeconomy: A conceptual review and integration into the notion of sustainable circular bioeconomy. New Medit. 2024. vol. 23, no. 2, p. 3-22. DOI: https://doi.org/10.30682/nm2402a.

26. The Ukraine Facility. URL: https://commission.europa.eu/topics/eu-solidarity-ukraine/eu-assistance-ukraine/ukraine-facility_en

27. Thomchick E., Jacobson M., Ruamsook K. Bioeconomy bright spots, challenges, and key factors going forward: Perceptions of bioeconomy stakeholders. EFB Bioeconomy Journal. 2024. Vol. 4. P. 100068. DOI: https://doi.org/10.1016/j.bioeco.2024.100068.

28. Yuniati D., Nurrochmat D. R., Pribadi D. O., Djaenudin R. D., Kuncahyo B., Khotimah H. Unlocking economic growth: Circular bioeconomy implementation and the role of forestry industry. BIO Web of Conferences. 2024. Vol. 123. P. 03003. DOI: https://doi.org/10.1051/bioconf/202412303003.

---

1. Belova, I. M., Yaroschuk O. V. Rozvytok bioekonomiky v Ukraini: adaptatsiia yevropeiskoho dosvidu dlia intehratsii v yevropeiskyi ekonomichnyi prostir. Innovatsiina ekonomika. 2024. no 3. p. 221–230. https://doi.org/10.37332/2309-1533.2024.3.27

2. Budiakova, O., Pryharska, D. Mozhlyvosti vprovadzhennia bioekonomiky u farmatsevtychni pidpryiemstva. Ekonomika kharchovoi promyslovosti. 2024. vol. 16, no 2. p. 52–58. https://doi.org/10.15673/fie.v16i2.2941

3. Budiakova, O., Dervish, D. Investytsii v bioekonomiku dlia povojennoho vidnovlennia Ukrainy. Transformatsiina ekonomika. 2023. no 4(04). p. 9–13. https://doi.org/10.32782/2786-8141/2023-4-2

4. Vasiliuk, S. V., Franiv, I. A., Kiiv, D. I. Intehratsiia bioekonomiky v haluzi natsionalnoho hospodarstva. Infrastruktura rynku. 2024. no 72. p. 20–27. https://doi.org/10.32782/infrastruct72-4

5. Vostriakova, V. I. Bioekonomika yak kompleksna systema zabezpechennia staloho rozvytku krainy. Ekonomika ta derzhava. 2023. no 1. p. 167–177. https://doi.org/10.32983/2222-4459-2023-1-167-177

6. Vostriakova, V. I. Lokalno-orientovana model upravlinnia bioekonomichnoiu transformatsiieiu sotsialno-ekonomichnykh system na zasadakh staloho rozvytku. Efektyvna ekonomika. 2024. no 9. https://doi.org/10.32702/2307-2105.2024.9.37

7. Zelena transformatsiia ta stala bioekonomika: monohrafiia; za nauk. red. A. A. Oleshko, O. Yu. Budiakovoi. Kyiv: KNUTD, 2024. 496 p.

8. Kolach, S. M. Bioekonomika ta ii vplyv na rozvytok silskykh terytorii. Naukovi zapysky Lvivskoho universytetu biznesu ta prava. Seriia ekonomichna. Seriia yurydychna. 2023. issue 37. p. 230–234. https://doi.org/10.5281/zenodo.8047092

9. Kramar, I., Lysyi, V. Deiaki aspekty rozvytku bioekonomiky v Ukraini. Materialy Mizhnarodnoi naukovo-praktychnoi konferentsii «Suchasni napriamy rozvytku ekonomiky, menedzhmentu ta finansiv v Ukraini ta sviti». 2023. p. 135–137. https://elartu.tntu.edu.ua/bitstream/lib/40903/2/MNPK_2023_Kramar_I-Some_aspects_of_the_bioeconomy_135-137.pdf

10. Kucher, O. V. Formuvannia marketynhovoho mekhanizmu upravlinnia rozvytkom bioekonomiky. Podilskyi visnyk: silske hospodarstvo, tekhnika, ekonomika. 2024. no 42. p. 132–139. https://doi.org/10.37406/2706-9052-2024-1.18.

11. Makedon, V., Mykhailenko, O., Krasnikov, P. Upravlinnia rozrobkoiu ta realizatsiieiu natsionalnykh i mizhnarodnykh proektiv u sferi vidnovliuvalnoi enerhetyky. Pidpryiemnytstvo ta innovatsii. 2023. no 26. p. 5–13. https://doi.org/10.32782/2415-3583/26.1

12. Makedon, V. V., Bailova, O. O. Planuvannia i orhanizatsiia vprovadzhennia tsyfrovykh tekhnolohii v diialnist promyslovykh pidpryiemstv. Naukovyi visnyk Khersonskoho derzhavnoho univer-

sytetu. Seriia «Ekonomichni nauky». 2023. issue 47. p. 16–26. https://doi.org/10.32999/ksu2307-8030/2023-47-3

13. Nifatova, O. M., Petrychuk, S. I. Empirychna veryfikatsiia vplyvu implemetatsii bioekonomichnykh pryntsypiv na pidvyshchennia rivnia ekolohichnoi vidpovidalnosti ta staloho rozvytku pidpryiemstv. Naukovyi visnyk Mizhnarodnoho humanitarnoho universytetu. 2024. no 60. p. 15–22. https://doi.org/10.32782/2413-2675/2024-60-3

14. Petrychuk, S. I. Metodolohichni pidkhody do otsiniuvannia stupenia ekolohichnoi vidpovidalnosti ta staloho rozvytku pidpryiemstv v umovakh implemetatsii bioekonomichnoi paradyhmy. Ekonomika: derzhavne upravlinnia ta mistseve samovriaduvannia. 2024. no 2. p. 35–42. https://doi.org/10.32782/1814-1161/2024-2-5

15. Petrukha, N. Post-war restoration of the agricultural sector of the economy on the basis of the bioeconomy. Ekonomichnyy analiz. 2023. Vol. 33. no 4. p. 49–58. https://doi.org/10.35774/econa 2023.04.049

16. Bianchi, M., Cascavilla, A., Clavell Diaz, J., Ladu, L., Palacino Blazquez, B., Menger, P., Staffieri, E., & Yilan, G. (2024). Circular bioeconomy: A review of empirical practices across implementation scales. Journal of Cleaner Production, 477, 143816. https://doi.org/10.1016/j.jclepro.2024.143816

17. Biotechnology in Ukraine. (n.d.). Retrieved from https://bioukraine.org/biotechnology-in-ukraine/

18. Dietz, T., Bogdanski, A., Boldt, C., Bцrner, J., von Braun, J., O Concubhair, C., Nн Choncubhair, У., Durham, B., Ecuru, J., Lang, C., Li, Y., Lund, M., MacRae, E., Maxon, M., Chavarгна Miranda, H., Mizunashi, W., Mungeyi, P., O'Hara, I. M., Pittaluga Fonseca, L., Popov, V., Regъnaga, M., Rodrнguez, A., Teitelbaum, L., Barcelos Vargas, D., Virgin, I., & Werheim, P. (2024). Bioeconomy globalization: Recent trends and drivers of national programs and policies. A report by the International Advisory Council on Global Bioeconomy (IACGB) (April 2024). https://doi.org/10.2139/ssrn.5023374

19. Faulkner, J. P., Murphy, E., & Scott, M. (2024). Bioeconomy, planning and sustainable development: A theoretical framework. Sustainability, 16(19), 8303. https://doi.org/10.3390/su16198303

20. Financing a sustainable global bioeconomy. (2024). Retrieved from https://wcbef.com/wp-content/uploads/2024/09/financing-a-sustainable-global-bioeconomy_report_092024.pdf

21. Global Bioeconomy Assessment: Coordinated efforts of policy, innovation, and sustainability for a greener future. (2024). Retrieved from http://www.unep-iemp.org/file/2024/04/24/1713940443921.pdf

22. Gorokhova, T., Firstenko, O., Chopyk, Y., Voitsitska, K., & Petrukha, N. (2024). Strategies for Ukraine's Post-War Economic Recovery within the Framework of Sustainable Development Goals. Journal of Lifestyle and SDGs Review, 5(1), e03350. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n01.pe03350

23. Makedon, V., Myachin, V., Plakhotnik, O., Fisunenko, N., & Mykhailenko, O. (2024). Construction of a model for evaluating the efficiency of technology transfer process based on a fuzzy logic approach. Eastern-European Journal of Enterprise Technologies, 2(13(128)), 47–57. https://doi.org/10.15587/1729-4061.2024.300796

24. Petrukha, N., Demydonok, I., & Hubanov, O. (2024). Ethical aspects of bioeconomy in post-war reconstruction projects in Ukraine. Economics, Finance and Management Review, 4(20), 4–17. https://doi.org/10.36690/2674-5208-2024-4-4-17

25. Rojas-Serrano, F., Garcia-Garcia, G., Parra-Lypez, C., & Sayadi-Gmada, S. (2024). Sustainability, circular economy and bioeconomy: A conceptual review and integration into the notion of sustainable circular bioeconomy. New Medit, 23(2), 3–22. https://doi.org/10.30682/nm2402a

26. European Commission. (2024). The Ukraine Facility. Retrieved from https://commission.europa.eu/topics/eu-solidarity-ukraine/eu-assistance-ukraine/ukraine-facility_en

27. Thomchick, E., Jacobson, M., & Ruamsook, K. (2024). Bioeconomy bright spots, challenges, and key factors going forward: Perceptions of bioeconomy stakeholders. EFB Bioeconomy Journal, 4, 100068. https://doi.org/10.1016/j.bioeco.2024.100068

28. Yuniati, D., Nurrochmat, D. R., Pribadi, D. O., Djaenudin, R. D., Kuncahyo, B., & Khotimah, H. (2024). Unlocking economic growth: Circular bioeconomy implementation and the role of forestry industry. BIO Web of Conferences, 123, 03003. https://doi.org/10.1051/bioconf/202412303003