UDC 351.777:504.06

https://doi.org/10.33271/nvngu/2021-5/165

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BIOECONOMY EDUCATION: IMPLEMENTATION OF THE EU BIOECONOMY STRATEGY IN UKRAINIAN HIGHER EDUCATION

Purpose. Studying the features of implementing the EU bioeconomy strategy in higher education in Ukraine.

Methodology. As the main research method, the authors used the comparative approach and the method of expert assessment. The authors used the methods of functional analysis, the methods of content analysis and systems analysis as additional ones.

Findings. According to the recommendations of the European Union, the implementation of the EU bioeconomy strategy in the higher education system is based on ten key principles. The authors considered the features of implementing the EU bioeconomy strategy in Ukrainian higher education, the key features of the recommended principles and the degree of their use in the modern system of higher education in Ukraine.

Originality. The possibilities of the key principles recommended by the European Union for the effective implementation of the EU bioeconomy strategy in higher education in Ukraine were evaluated.

Practical value. The research results contribute to the effective implementation of the EU bioeconomy strategy in the higher education system of Ukraine; the introduction of European standards in the educational, scientific and innovative activities of universities and enterprises in Ukraine in terms of the development of resource and energy-saving economy and environmental protection.

Keywords: *bioeconomy education, bioeconomy, EU bioeconomy strategy, bioeconomic cluster*

Introduction. The trend in the development of bioeconomy in Ukraine has positive dynamics. Following the European countries, bioeconomy in Ukraine is becoming the leading area of socio-economic development of the state [1]. Ukrainian researchers consider bioeconomy as a promising model of resource and energy-saving economy, which is based on the use of renewable biomass to increase the value and quality of human life and preserve the environment [1]. Ukrainian researchers study the European experience in the development of bioeconomy and approve it as an important part of the state's intellectual capital [2].

However, despite the diversity of approaches in the study on bioeconomy and its institutionalization in Ukraine, the field of "bioeconomy education" remains insufficiently researched. Therefore, the article aims to study the features of implementing the EU bioeconomy strategy in higher education in Ukraine, taking into account the European experience and Ukrainian realities.

Results. We designate the bioeconomy strategy of the European Union. The EU Bioeconomy Strategy aims to promote a sustainable economy in Europe and contributes to the European Green Deal, European strategies for industrial innovation, circular economy and clean energy. The EU Bioeconomy Strategy has five objectives [3]:

1. Ensuring food and nutritional security in Europe.
2. Rational management of natural resources.
3. Reducing dependence on non-renewable and unsustainable resources.
4. Limiting and adapting to climate change.
5. Strengthening European competitiveness and creating jobs.

The Action Plan for implementing the EU Bioeconomy Strategy provides for "promoting education, training and skills in bioeconomy" as a separate point [3].

Pay attention to the study by G. Sakellaris "Bioeconomy education," published by Springer in 2021 [4]. At the moment, this is the latest work out of a small number of publications in the field of bioeconomy education. Sakellaris starts his research by arguing two reasons for the development of bioeconomy education [4]:

1. Bioeconomy is the key technology driving the economic growth of European countries.
2. A new concept of sustainable increase in the value of natural and human resources, which underlies bioeconomy, needs to be promoted and confirmed in European culture and mass consciousness.

Sakellaris believes that the interdisciplinary and cross-sectorial characteristics of the structure of bioeconomy cause research across a wide range of scientific disciplines and lead to the acquisition of specific knowledge and skills [4]. The European society needs to train a new generation of experts who are adapted to the changing dynamics of the current business and the market needs. Sakellaris proposes to develop and implement special education in the field of bioeconomy in the European higher education system. This education should take into account a large number of additional parameters, such as [4]:

a) regional and industry characteristics;
b) clear determination of the target groups to be trained;
c) combination of educational programs with socio-economic priorities;
d) expected effects of the influence;
e) potential technical problems, and others.

Analysis of modern literature on "bioeconomy education" indicates that, on the one hand, this issue is relevant and is actively promoted not only by the programs of the European Union and the European Federation of Biotechnology (EFB). Bioeconomy education is promoted by the Organization for Economic Co-operation and development (OECD) along with the International Council of Biotechnology Associations (ICBA). However, on the other hand, the history of the development of bioeconomy education is only a few years old. Key European programs aimed at boosting bioeconomy education were adopted by the European Parliament in the second half of 2020. The number of publications on bioeconomy education in reputable scientific journals barely exceeds a dozen. Therefore, analysis of the experience in the development of bioeconomy education and the recommended principles of its implementation in national higher education systems need to

be comprehended taking into account the specifics of the existing cultural and educational practices [5].

As the main research method, the authors used the comparative approach and the method of expert assessment. In addition, the authors relied on the experience gained during the implementation of innovative approaches in organizing the work of the Philosophical Faculty of Taras Shevchenko National University of Kyiv [6, 7] and the Preparatory Department of this University [8].

We study the features of implementing the EU bioeconomy strategy in higher education in Ukraine. Initially, the authors briefly examine the current state of bioeconomy education in Ukraine. Then, we consider in more detail the key features of the implementation principles recommended by the European Union and the degree of their use in the modern system of higher education in Ukraine.

The level of the development of bioeconomy education in Ukraine is disclosed in the monograph *Formation of the Components of the National Bioeconomy of Ukraine under Conditions of Accelerated Scientific and Technological Progress* [9]. This is the latest work, published in Ukrainian, which substantiates the principles of forming the components of the national bioeconomy in Ukraine and determines the conditions for increasing its competitiveness. However, despite the fundamental and all-encompassing nature of the study, the authors did not reveal the features of the implementation of the results obtained in bioeconomy education. The authors did not take into account the recommendations of the European Union and the need to harmonize the development of the national bioeconomy with the EU bioeconomy strategy, as required by the Constitution of Ukraine and EU-Ukraine Association Agreement [10].

In accordance with the developed action plan for the implementation of the EU bioeconomy strategy in education, the European Union financed two projects:

1. Creation of the European Bioeconomy Library [11].

2. Development of the "UrBIOfuture – Boosting future careers, education and research activities in the European biobased industry" [12].

Both projects contribute to the implementation of the EU bioeconomy strategy in higher education and are advisory in nature for the Ministries of Education and Science of the European Union countries and its associated countries. Take a quick look at the first project.

1. Creation of the European Library of Bioeconomy was completed in 2020 [11]. The idea of the Library is to accumulate knowledge about biodiversity, ecosystems and sustainable development of bioeconomy, and to promote best practices in the implementation of the EU bioeconomy strategy in education and science of European countries.

The first highlighted category in the European Library of Bioeconomy is "bioeconomy education." The category "bioeconomy education" represents [11]:

a) recommendations for improving cooperation between universities and industry in the field of bioeconomy;

b) the results of webinars such as "Education gaps and skills mismatches in the European bioeconomy";

c) a list of problems arising in the field of bioeconomy education and requiring solution;

d) the results of projects aimed at improving bioeconomy education;

e) free online bioeconomy education courses in schools and universities.

2. Consider the second project of the European Union in detail, as it defines the principles for the implementation of the EU bioeconomy strategy in education.

The project "UrBIOfuture – Boosting future careers, education and research activities in the European biobased industry" offers practical solutions related to education reform and the implementation of the EU bioeconomy strategy in education [12].

Within the "UrBIOfuture" project framework, there were selected and recommended ten best practices for collaboration between universities and industry to develop educational programs in a circular economy based on biotechnology. They are called "the key principles for the implementation of the EU bioeconomy strategy in higher education" [13]. The UrBIOfuture project is built on an earlier study by the Corporación Tecnológica de Andalucía (CTA), which provided more than 60 recommendations to the European Union states for successful international University-Business cooperation.

Consider ten key principles recommended by the European Union for the implementation of the EU bioeconomy strategy in higher education [13] and the degree of their use in the higher education system of Ukraine.

Combining forces in the same direction: collaboration strategy. The first principle recommended by the European Union is based on the practice of Nord-Pas de Calais, the fourth most populous region in France. The main feature of this practice is that: 1) the universities and institutes located in this region have been merged into one of the largest federations of universities in France, The Community of Universities and Institutions (COMUE) Lille Nord de France, which has over a hundred thousand students; 2) senior management, faculty and staff of the Federation of Universities are concurrently managers and employees of the companies operating in the region.

According to the recommendations of the European Union, the value of the first principle is to combine the experience of working in the higher education system and in production simultaneously (as a manager or employee) [13]. This experience helps to develop a more coherent strategy that identifies the needs and development potentials of universities and industry, and to ensure the creation of successful and competitive R&D clusters on regional and national scales.

The first principle ensures the development and implementation of an effective strategy for cooperation between universities and industry (including large enterprises and small joint ventures), which takes into account the needs of various fields of knowledge and industrial sectors. The principle stipulates:

1. Development of a well-defined roadmap that is accepted by all participating agents and helps to create strong long-term relationships, the backbone of the bioeconomy cluster.

2. Determination of expectations and interests of both parties: objectives and channels of communication, as well as strategies for the transfer of knowledge and technology, are indicated.

3. Analysis of the peculiarities of cooperation, communication processes and cultural styles that provide the formation of joint thinking and teamwork.

4. Transparency of the strategy, action and implementation plan, the skills required to reach appropriate agreements, and so on.

5. Clarification of the role of persons in charge, responsibilities and functions of project managers, research and production cluster. Group seminars, round tables, etc., are held.

Despite the obvious and proven efficiency of the principle of cooperation strategy, its use in the higher education system of Ukraine is not possible. Key ideas of the principle are prohibited by the current Ukrainian legislation. On the one hand, there is no legal basis for the amalgamation of regional universities into a federation or a similar kind of association (except in cases of university mergers). On the other hand, the legislation of Ukraine prohibits the heads of state universities and their deputies to split appointments, with the exception of scientific, teaching, medical, and creative activities.

Designing a collaborative guide or manual. There are contradictions between the organizational structure of higher education and business, caused by cultural differences, management and organizational history, etc. The second principle recommended by the EU is aimed at overcoming these contradictions and gaining benefits from cooperation and mutual understanding. The principle is a recommendation to create an informational guide, in which the basic principles of coexistence are collected in plain language to raise awareness and mutual understanding between all agents of the bioeconomy cluster [13].

The second principle has been proven to be effective in the previously accepted guidelines. For example, *Guiding Principles for University-Industry Endeavours*. The document was published in 2006 and contained guidelines governing the relationship between universities and business. Also, in 2006, *Responsible Partnering – Joining Forces in a world of Open Innovation. Guideline for Collaborative Research and Knowledge Transfer between Science and Industry* was published. This handbook promotes better strategic collaboration and knowledge sharing between companies and research centers.

The main purpose of developing a collaborative guide or manual for the bioeconomy cluster is to collect information on experiences and various activities undertaken by universities in the field of bioeconomy and relevant industries. A collaborative guide or manual should suggest:

1. Comprehensive information on various forms of cooperation and best practices of cooperation between universities and business.

2. Guidelines for identifying potential partners and successful approaches.

3. Examples of jointly developed educational programs that have proven their effectiveness in training highly qualified managers and specialists.

The collaborative guide helps various agents: a) recover valuable information; b) improve their professional and personal relationships; c) develop guidelines for cooperation approved by both parties.

According to the recommendations of the European Union, a collaborative guide or manual should include the following chapters (topics) [13]: "Reciprocity of interests"; "How to build stable and lasting relationships"; "Cooperation strategies"; "Institutional assistance in supporting cooperation"; "Requirements for personnel and training"; and others. Management should make use of the following key terms: "circular bioeconomy," "sustainability," "responsible cooperation," "specific technical skills based on biological resources," "basic elements required for an economy based on biotechnology," "competencies and skills of encouragement," "markets, business and legal competencies," "demand for educational profiles in the field of bioeconomy," etc.

Analysis of the literature on the research topic proves that the second principle recommended by the EU is not used by Ukrainian researchers. There are no formal barriers to its use. The authors admit that the development of a guide or manual for collaboration between higher education institutions of Ukraine and businesses in the field of bioeconomy may be at the final stage of implementation. It can be emphasized that the above recommendations were published only in the second half of 2020. In any case, the senior management of Taras Shevchenko National University of Kyiv is working in this direction. An intermediate result of the development of a recommended collaborative guide or manual is the monograph *Creative Thinking* published in 2021 [14].

Promoting personal and sectorial interactions. The third principle, recommended by the European Union, aims to bring customers, suppliers, entrepreneurs, potential investors and academics together and transform them from disparate agents into a bioeconomy cluster. The principle has its own history and has proven its efficiency in many practices. For example, in 2006, a bioeconomy cluster "Nutrition, health and longevity" was created in the French region Hauts-de-France [15]. NHL cluster brought together 320 participants of various profiles: start-ups, companies, care institutions, research and educational organizations, agents in agri-dietology, biotech pharmaceuticals, health and palliative care technology, e-health and healthy lifestyles, and others. It is currently one of the successful bioeconomy clusters competing at the intersection of nutrition and healthcare markets.

The principle of promoting personal and sectorial interactions helps:

1. Achieve the most effective results in the development of sectorial activities for specific thematic goals.

2. Determine the technological needs of the market while promoting and consolidating the necessary skills, and technological expertise in creating a bioeconomy cluster.

3. Ensure a holistic and mutually enriching operation of the entire industry chain: education–production–sales.

4. Connect all potential partners with the academic world, embodying the idea that personal contacts are vital for achieving effective results.

The principle of promoting personal and sectorial interactions is used and promoted in Ukraine. It can be exemplified by the space industry [16]. Changes in the legislative framework have made it possible to create business clusters that compete at the national level and at the global level. The creation of such clusters in the bioeconomy of Ukraine is a matter of the near future. All the necessary conditions for this are available in Ukraine [2, 9].

Providing equipment as demonstrators. The exchange of equipment between companies and universities is an important step in the process of creating a bioeconomy cluster. The fourth principle is widely used in European and world practice. It is essential for collaboration to improve infrastructure, create pilot programs, improve active learning methodologies and instructor training schemes, etc.

Providing equipment as demonstrators is practiced at Taras Shevchenko National University of Kyiv, and in the work of the Preparatory Department [6, 8]. Thanks to the fourth principle, higher education institutions are provided with the resources they need, including, for example, free access to hardware, complete software packages, specialized courses, tools, books, etc. In return, industry and business get the opportunity to employ highly qualified personnel who know the specifics of production, technical characteristics of equipment, etc. Business and industry gain access to students who play a valuable role in internal organization excellence, generate new ideas, and focus on innovative development [2].

Consolidating long-term relationships with Universities. Innovation and research require a stable and solid foundation for achieving efficiency and productivity goals [7]. At the same time, joint research projects developed by universities and companies are of great benefit when a stable and lasting interaction process is established. An example of consolidation of long-term relationships with universities is "The Human Genome Project", officially launched in 1990 and completed on April 14, 2003 [17]. To this day, this project has remained the world's largest international research project in biology. It included the strategy of a long-term collaboration between dynamic teams of companies and universities [17].

The fifth principle for the implementation of the EU bioeconomy strategy in higher education is aimed at achieving a single goal – strengthening the relationships between university and industry in terms of timescale. Long-term relationships between university and industry can be established only when the needs, goals and concerns of the other party are recognized.

The principle provides two main ways to build a stable relationship [13]:

1. Signing a series of agreements on the development of various projects with the universities with which the companies have already had successful previous experience of cooperation.

2. Developing a strategy for long-term collaboration with interactive teams.

The principle of consolidating long-term relationships promotes:

1. Expanding informal contacts and dialogue in the development of cooperation strategies.

2. Maintaining direct contact among the participants and establishing open and transparent communication in the language of mutual understanding and trust.

3. Understanding collaboration as an interdisciplinary activity in which the skills of both parties can create useful synergies.

The principle of consolidating long-term relationships in the bioeconomy of Ukraine is just beginning to be used.

D. Gonta, et al. give various examples of using this principle [9]. However, the results of using this principle and the scale of its use remain insignificant due to the short period of time since Ukraine's joining the implementation of European programs.

Promoting good practices based on the impact of University–Business relationships. The relationships between higher education and industry are symbiotic. Companies need universities to grow, while universities need companies to transfer their knowledge. For this reason, it is important to develop a conceptual framework for mutual cooperation in which good practice becomes a driving force in education and economic reforms.

The goal of the sixth principle, recommended by the European Union, is to promote the idea that "it is not the direct result of research or collaboration that matters, but the impact that this information will have on the marketing of the company's products or services" [13]. This idea was formulated as a result of a research project developed at the MIT Sloan School of Management. Based on this idea, seven recommendations were developed and tested in more than 100 joint projects in Massachusetts Institute of Technology and 25 companies [13]:

1. Defining the strategic context of the project and company as part of the selection process. The company's research portfolio is used to create opportunities for collaboration, determine specific goals for collaboration, and identify individuals in the company who can benefit from the results.

2. Selecting project managers who are well aware of the technological needs of the research project, have good management and communication skills in various departments and functions of the participating organizations.

3. Developing together with the university team a common vision of how the research project can help the company.

4. Investing in long-term relationships through long-term cooperation projects. Personal interaction with leading researchers at universities is encouraged, even in cases where there are no planned projects.

5. Establishing a strong connection with the research group through meetings and interviews, as well as creating a communication mechanism as a form of maintaining contact and facilitating the personnel exchange.

6. Ensuring project priorities in the company in such a way that communications between researchers and company departments are successful.

7. Supporting collaborative activities during and after the contract period to ensure complete use of the research process results.

The principle of promoting advanced University–Business experience has been used in Ukraine [2]. Modern requirements for the educational and research process at Taras Shevchenko National University of Kyiv are based on this principle [6, 14]. University senior management uses this principle to create a bioeconomy cluster considering the EU bioeconomy strategy [14].

Promoting dialogue between Universities and Companies in the field of knowledge transfer. In the knowledge society, higher education institutions play a central role in three key areas: 1) they produce knowledge; 2) they impart knowledge through teaching and publication of results; 3) they receive and process knowledge from the outside. The most advanced economies are those that have built a stable relationship between scientific knowledge and its application in industrial goods and services.

An example of the implementation of the seventh principle is the work of German universities. For example, in Karlsruhe (Germany), higher education institutions facilitate access to and contact with companies. Cooperation is developing on the idea of joint use of the laboratory in exchange for income received from the intellectual property [18, 19]. Collaboration is facilitated by: 1) a focus on licensing and ancillary revenue generation; 2) an innovative collaboration model that is clearly focused on product commercialization.

The principle of promoting dialogue between universities and companies in the field of knowledge transfer is used by Ukrainian higher education institutions [8, 14]. However, unlike German universities, Ukrainian legislation restricts the involvement of business in the research activities of universities, as well as the participation of higher education institutions in commercial projects. Furthermore, Ukrainian laws prohibit using the experience of Karlsruhe universities in the higher education system of Ukraine.

Supporting the creation of technology-based spin-offs and start-ups. The eighth principle affirms innovation as an ongoing activity, not a periodic transaction of knowledge. An innovative mindset is a distinct entrepreneurial culture with knowledge-driven values coupled with an ongoing commitment to collaboration. For example, bioeconomy is the theme for the Year of Science 2020/21 in Germany. The Innovation Department of the Karlsruhe Institute of Technology (Germany) promotes this issue in two key directions [18]. Firstly, the university provides management support services for bioeconomy researchers covering such issues as obtaining patents and contracts for research, marketing and technological supervision, and so on. Secondly, it offers advice on business development, assists in organizing enterprises, opens access to technology business incubators. The university motivates employees to create new businesses and encourages professors to combine work in companies and universities. The university maintains Direct Labs – laboratories that operate exclusively for one or more companies, employ research personnel and create numerous spin-offs. The creation of these new companies is carried out either by the university itself or through parallel work with external staff [13, 18].

The creation of technology-based spin-offs and start-ups is encouraged and strengthened through a variety of tools. For example, the university provides consulting services that help educators, researchers, students and/or employers maximize the potential of bioeconomy knowledge through the creation, management and consolidation of spin-offs and start-ups.

The principle of supporting the creation of technology-based spin-offs and start-ups is actively used in the higher education system of Ukraine [2] and at Taras Shevchenko National University of Kyiv in particular [6, 14]. At this stage of bioeconomy development in Ukraine, the main one is creating bioeconomy clusters [9].

Generating Living Labs or Real-Time Laboratories. Promising technologies cannot often be implemented into production due to lack of promotion or due to the fact that technologies do not take into account the real needs of the market. To avoid this problem, Living Labs or Real-Time Laboratories were created to ensure that the technologies developed would meet market demands and be commercially successful. Living Labs is "an experimental environment that allows disparate agents with common interests to collaborate in a scientific or technological field to develop and use innovative ideas to solve current problems in an integrated manner" [13]. An example of such a laboratory is the FZI Research Center for Information Technology (Karlsruhe, Germany) [19]. The above-named Center is a non-profit organization engaged in applied research in the field of creation and promotion of information technology. The objectives of the Center are: [19]: a) providing enterprise and government agencies with the latest research results in the field of information technology; b) creating conditions for self-employment for young people; c) helping young people pursue careers in academia or business.

In most cases, the Living Lab's goal is to ensure that the end-user participates in prototype testing and builds an open innovation community to commercialize technology and add value to know-how [13]. The idea behind the Living Labs is to design a space in which the end-user takes an active role, explaining their needs, concerns and questions, while at the same time allowing university staff, companies, entrepreneurs, investors and society at large to contact and test newly created technologies, or technologies under development, to improve them or bring them in line with the real needs of the user [13, 19].

The creation of Living Labs in Ukraine is at the stage of discussion and primary development [9, 14]. These are promising projects, which, however, require significant funding and government support.

Organizing permanent interactive forums: LabTours and IdeasLab. There are two key issues that limit the scope of collaboration between companies and universities [13]:

1. Difficulty of finding a research group that meets the company's requirements in terms of skills and knowledge, and the infrastructure at their disposal.

2. Obstacles to building mutual trust to establish ongoing communication.

To solve these problems, the European Union proposes to organize stable interactive initiatives between business and higher education institutions, which involve long-term personal contact, the so-called LabTour and IdeasLab. LabTour specializes in companies that regularly attend university sites. Organizing such tours helps companies: a) check the laboratory's capabilities or the level of university resources; b) initiate discussions on potential projects with individual researchers. On the other hand, when a company has facilities that are of interest to the university, the research group gets the opportunity to evaluate the company's infrastructure for the implementation of its research and development.

Interactive forums such as LabTour and IdeasLab boost the effectiveness of collaboration between the university and industry. Taras Shevchenko National University of Kyiv has experience in organizing such forums [7, 14]. Currently, forums of this type are used to create a bioeconomy cluster and evaluate the possibilities of implementing the EU bioeconomy strategy in the higher education system of Ukraine.

Conclusions. Thus, the guidelines recommended by the European Union are an effective tool for the implementation of the EU bioeconomy strategy in the Ukrainian higher education system and the creation of competing bioeconomy clusters in Ukraine. However, the authors found a number of obstacles in their use that need to be overcome. Namely:

1. In Ukraine, cultural differences between organizing higher education and business have not been overcome yet. Universities generate and transmit knowledge gained from basic research, while industry focuses on using knowledge for profit.

2. The legislative and regulatory framework of Ukraine hinders effective University-Business cooperation.

3. Higher education institutions in Ukraine and businesses are still considering different terms of project development and implementation.

4. Until now, higher education institutions and businesses in Ukraine are on opposite sides of the open innovation model.

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Біоекономічна освіта: імплементація стратегії біоекономіки ЄС у вищу освіту України

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Мета. Дослідити особливості імплементації стратегії біоекономіки ЄС у вищу освіту України.

Методика. У якості основного методу дослідження автори використали порівняльний підхід і метод експертної оцінки. Методи функціонального аналізу, метод контент-аналізу й метод системного аналізу автори використали як додаткові методи.

Результати. Згідно з рекомендаціями Європейського Союзу, імплементація стратегії біоекономіки ЄС у систему вищої освіти відбувається на основі десяти ключових принципів. Автори розглянули особливості імплементації стратегії біоекономіки ЄС в українську вищу освіту, ключові особливості рекомендованих принципів і ступінь їх використання в сучасній системі вищої освіти України.

Наукова новизна. Були оцінені можливості ключових принципів, рекомендованих Європейським Союзом для ефективної імплементації стратегії біоекономіки ЄС у вищу освіту України.

Практична значимість. Результати дослідження сприяють: ефективній імплементації стратегії біоекономіки ЄС у систему вищої освіти України; впровадженню європейських стандартів в освітню, наукову та інноваційну діяльність університетів і підприємств України в частині розвитку ресурсо- та енергозберігаючої економіки й захисту навколишнього середовища.

Ключові слова: *біоекономічна освіта, біоекономіка, стратегія біоекономіки ЄС, біоекономічний кластер*

Recommended for publication by D. Svyrydenko, Doctor of Philosophical Sciences. The manuscript was submitted 12.02.21.