
UDC 657.1

JEL Classification: M41

DOI: <https://doi.org/10.35774/visnyk2023.03.131>

Yuliya BILA,

PhD (Economics), Associate Professor,
Associate Professor of the Department of Accounting and Taxation,
West Ukrainian National University,
st. Lvivska, 11, Ternopil, 46020, Ukraine,
e-mail: yuliya.sudyn@gmail.com
ORCID ID: 0000-0002-0741-5597

BIOENERGY ASSETS IN THE GLOBAL CLIMATE SCENARIO: MULTILEVEL MODEL OF FUNCTIONS

Bila, Yu. (2023). Bioenergetychni aktyvy u globalnomu klimatychnomu stsenarii: multyryvneva model funktsii. [Bioenergy assets in the global climate scenario: multilevel model of functions]. *Visnyk ekonomiky – Herald of Economics*, 3, 131–143. DOI: <https://doi.org/10.35774/visnyk2023.03.131>

Біла Ю. Біоенергетичні активи у глобальному кліматичному сценарії: мультирівнева модель функцій. *Вісник економіки*. 2023. Вип. 3. С. 131-143. DOI: <https://doi.org/10.35774/visnyk2023.03.131>

Abstract

Introduction. *Dynamic European integration processes and Russia's military invasion of Ukraine dictate new conditions for the development of the national energy system. The use of renewable energy sources can be a key direction in the implementation of energy independence and the decarbonization strategy. However, the lack of a standardized accounting system for bioenergy assets, as one of the renewable energy sources, makes it impossible to develop Ukraine's energy policy in this direction.*

The aim of the study. *The purpose of the article is to justify the importance of recognizing bioenergy assets as an object of accounting due to its positive impact on the global climate scenario and creating a multi-level model of functions of their use.*

Methods. *The methodological basis of the study is the dialectical method of cognition using a systemic approach. Induction and analysis contributed to the identification of a significant impact of the lack of accounting methodology of bioenergy assets on the global ecological system in general, which strengthened the need for research in this direction. Economic and mathematical, graphic and historical methods were used to develop and illustrate the growth of CO₂ emissions into the atmosphere over the past 120 years. To create a multi-level model of the functions of bioenergy assets, graphic and factor analysis of the impact on different levels of the economy was used.*

© Yuliya Bila, 2023.

The results. *The article substantiates that bioenergy assets are a factor of positive changes in the global climate scenario in terms of decarbonization of the atmosphere. The functions of bioenergy assets were studied through the prism of the levels of the economy, and a multilevel model of the functions of bioenergy assets was created in order to assess their significance for the global economic and ecological space. The advantages of displaying information about bioenergy assets in the company's accounting and integrated reporting are determined and the risks of not displaying it are highlighted for the assessment of the consequences of the introduction of an innovative accounting object.*

Prospects for further research. *Further research is needed in identifying the criteria for recognition of bioenergy assets as an object of accounting and to form a methodology for their display in the accounting and analytical system of agrarian enterprises.*

Keywords: *accounting, bioenergy, climate, ecology, biomass, innovations.*

Formulas: 0, fig.: 4, tabl.: 0, bibl.: 17.

JEL classification: M41.

Introduction. Dynamic European integration processes and military invasion in Ukraine dictate new conditions for the development of the national energy system. In particular, in May 2022, the European Commission approved the REPowerEU Plan and adopted it. The "EU external energy engagement in a changing world" EU external energy cooperation strategy [1], which are aimed at applying measures with abandoning Russian gas by 2027 by switching to alternative gas sources of energy production. Current energy goals of Ukraine are being implemented through the National Renewable Energy Action Plan for the period up to 2030 [2], promising ones indicated in the Energy Strategy of Ukraine for the period up to 2050 [3]. The result of the implementation of the mentioned measures should be not only the saving of financial resources and independence from fossil imports fuel. The main advantage of using renewable energy sources is the embodiment of the ideology of the 21st century and even the third millennium – the Concept of sustainable development. According to which you need to maintain a balance between satisfying the needs of current generations and preservation of future interests. In the main extent, it concerns the ecological aspect: preservation of natural capital and mitigation of climatic conditions. The use of bioenergy assets (energy plants and biomass) as an innovative object of accounting and management in agricultural enterprises makes it possible to achieve a negative emission of carbon into the atmosphere. According to calculations of the International Energy Agency (IEA) regarding softening the effects of climate change requires recycling more than 2 giga tons of negative emissions by 2050 [4]. Since Ukraine and the IEA signed the Joint Declaration on association in 2022, implementation of energy and environmental goals should be combined and implemented taking into account the existing potential and opportunities.

The IEA reports that in 2021, the energy sector contributed to a 6 per cent increase in CO₂ emissions to a record level of 36.3 billion tons [4]. The achievement of CO₂ emissions was the largest in history (Fig. 1).

Demand was growing due to a sharp increase in natural gas prices and unfavorable weather conditions. The use of gas more than coal led to the growth of global CO₂ emissions from electricity production more than by 100 million tons, especially in Europe

and the USA, where there has always been competition between gas and coal-fired power plants. That is why it caused reaching the highest level of greenhouse gas emissions, because burning of more coal happened.

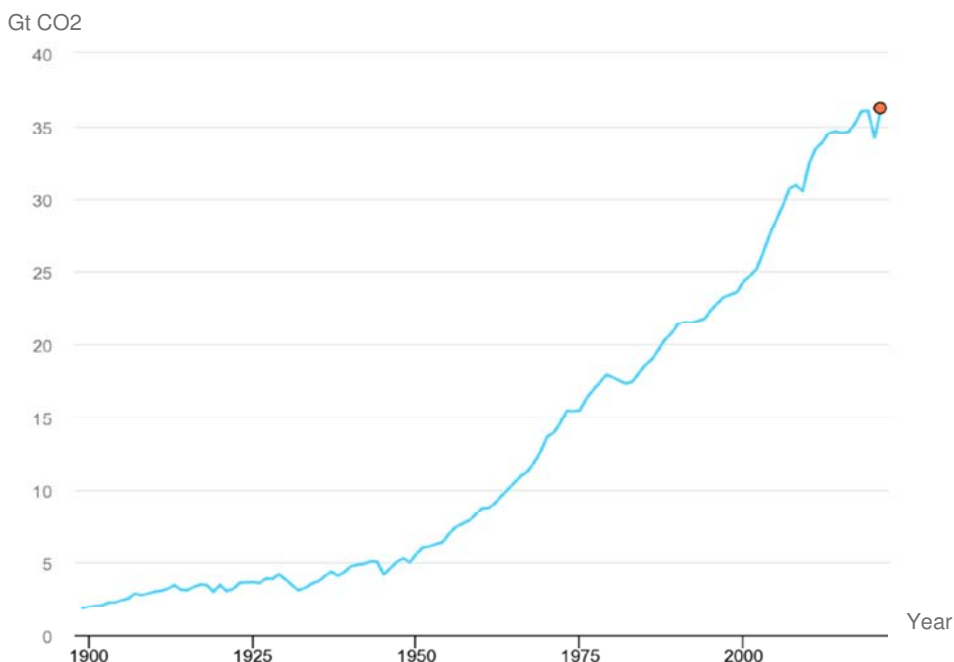


Fig. 1. CO2 emissions from energy combustion and industrial processes, 1900-2022
Source: official website of International Energy Agency [4].

The recovery of global CO₂ emissions above pre-pandemic levels has been largely caused by China, where they increased by 750 million tons between 2019 to 2021. It is the only major economy that experienced growth in both 2020 and 2021. In 2021, China's carbon dioxide emissions, which to a large extent relied on coal, exceeded 11.9 billion tons, which comprises 33 per cent of worldwide volume. India's CO₂ emissions recovered sharply in 2021 and exceeded the level of 2019 due to the increased use of coal for electricity production. Coal production reached a record level in India, exceeding the 2020 level by 13 per cent. This partly happened because renewable energy sources growth slowed down to one-third of the average rate for the previous five years. In 2021, the world economic production in countries with developed economies has recovered to the level of pandemic, but CO₂ emissions recovered less sharply, that testifies about more constant trajectory of structural decline. CO₂ emissions in the United States in 2021 were 4 per cent below the 2019 level. In the European Union they were 2.4 per cent lower (Fig. 2).

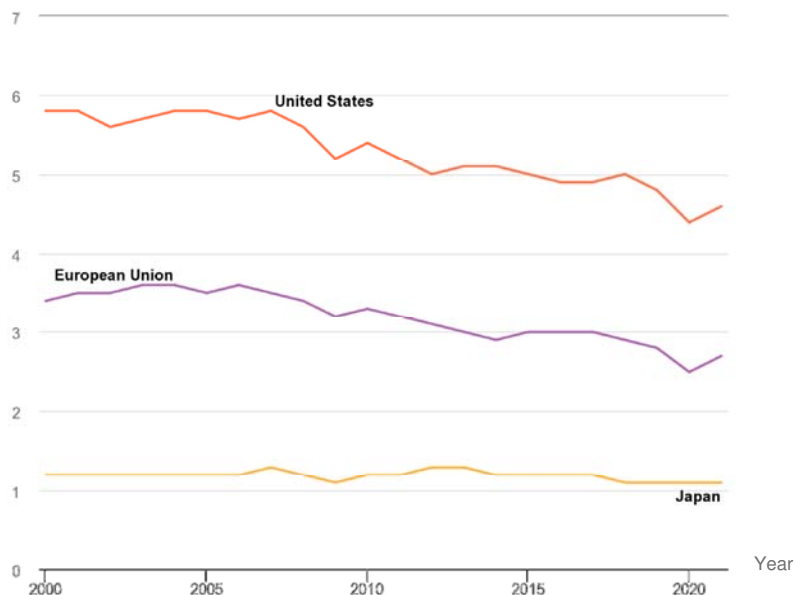


Fig. 2. CO2 emissions in selected advanced economies, 2000-2022

Source: official website of International Energy Agency [4].

Ukraine as an agricultural country (in 2021, the share of agriculture in GDP was the highest among all sectors of the economy and amounted to more than 10 per cent) [5] can become a platform for creating alternative biological sources of energy creating. The use of renewable bioenergy assets can be a key direction in the implementation of the decarbonization strategy.

The lack of a standardized system of bioenergy resources accounting makes it impossible to develop Ukraine's energy policy in this direction. The purpose of the study is to research bioenergy assets as an object of accounting, research of the prospects for their reflection in integrated reporting and allocation of functions at different levels of economic functioning.

Analysis of research and publications. The issue of energy policy, bioenergy and the application of their consistent implementation in the activities of agricultural enterprises is the subject of many modern studies. In particular, V. Walter et al. in their article defined bioenergy as an important component of the energy system, which will be very popular in the next century as a transitional element in the global energy mix [6]. P.V Femeena et al. considered multifunctional bioenergetic systems through the study of the value of bioenergetic resources and their impact on the environment [7]. A. B. Avagyan developed the theory of accumulation and transformation of bioenergy through the prism of energy, sustainable development, climate change, production, agriculture, military activity and the challenges of the pandemic [8]. R. Rather et al. and others. studied the advantages of bioenergy resources compared to fossil fuels and the impact of their use on ecology and climate in a global sense [9]. O. Borysiak et al. considered the prospects of climate-neutral energy security technologies after the consequences of the global COVID-19 pandemic [10].

Recently, research by scientists is aimed at studying the advantages and disadvantages of using bioenergy, its impact on ecology and climate. However, for effective production and use of bioenergy assets in agricultural enterprises, high-quality accounting and analytical support should be developed, which would provide management with information for making relevant decisions. V. M. Zhuk is working in this direction, and he singled out non-standard accounting objects of the «alive economy», to which he proposes to include biological assets and renewable energy assets [11]. I. V. Honcharuk, Y. P. Ishchenko, I. V. Strygun [12] considers energy resources as a whole and proposes a methodology and organization of their accounting. L. Gutsalenko and V. Fabianska study biofuel production [13], V. Derii specifies the nomenclature of cost items in biofuel production [14]. However, the issue of a comprehensive approach to the formation of accounting and analytical support for bioenergy assets at the enterprise level, the determination of their function and impact on ecology and climate in general remains unresolved.

The purpose of the article is to justify the importance of recognizing bioenergy assets as an object of accounting due to their positive impact on the global climate scenario and creating a multi-level model of their functions.

Results. We think that when researching the need for production and use bioenergetic assets, it is necessary to turn to the classical postulates of physical economy by F. Kehne, which were described by M. Rudenko [15]. According to his doctrine, two development options are possible of the society. The first is that natural resources produce additional value, as a result of which we get biological growth of the potential. The second option foresees the production of natural resources of negative value, which leads to the exhaustion of the potential of land and destruction of the economy. Production and use of bioenergy assets is one of the important areas of implementation of the first option of using natural resources and harmonization of economic strategy with the principles of stable development [16].

Bioenergy assets are a component of the planet's natural resources and are revealed through a wide range of functions at different levels of existence of the economy in general, as well as the impact on the environmental and energy sectors in particular.

Bioenergy assets as a component of natural resources on the one hand and energy potential, on the other hand, can perform the following functions:

1. Resource – it reflects the creation of a source of public goods for meeting the needs of humanity.
2. Restorative – it characterizes cyclical nature of bioenergetic assets capable of recovery.
3. Energetic – it means creating energy to meet social demands.
4. Ecological – it allows to preserve the ecosystem and moderate climatic conditions.
5. Environmental protection – it is aimed at preserving the integrity of natural capital.

The last of these functions is gaining global importance today, due to the use of fossil energy sources, there is a release of greenhouse gases into the atmosphere, which increases the greenhouse effect. This is the main cause of global warming and, as a result, climate change. It has been proved that if the average global temperature will increase by more than 1.5°C compared to in pre-industrial times, the planet's climate will change irreversibly, which will have devastating consequences [17].

Decarbonization is aimed at the fastest possible transition from the use of fossil fuel, such as coal, natural gas or oil, to carbon-free and renewable energy sources. The amount of CO₂ emitted from bioenergy assets can be completely absorbed in the process of photosynthesis (Fig. 3).

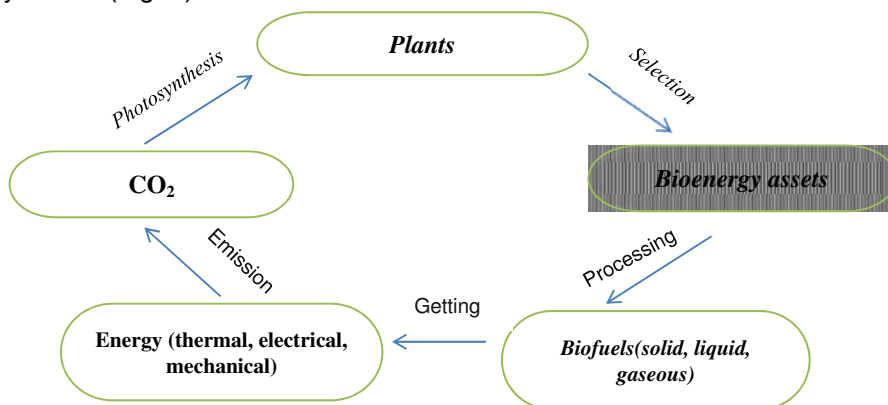


Fig. 3. The role of bioenergy assets in reducing CO₂ emissions

Source: developed by the author.

All these functions are considered at the macro level. In order to create accounting and analytical provision for bioenergy assets it is necessary to consider the meso-level and the micro-level.

At the meso-level, bioenergy assets can perform the following functions:

1. **Autonomy** – it is the provision of the region in which we grow bioenergy assets by renewable energy.

2. **Protective** – the use of the received benefits for preserving the region's natural capital.

3. **Energy-saving** – it is manifested in preservation of energy potential.

The micro-level of use of bioenergy assets is realized through a business entity. The main functions are the following:

1. **Ensuring continuous cyclical activity** – production and use of bioenergy assets at agricultural enterprises allows to achieve continuous activity.

2. **Controlling** – gives the possibility to establish efficiency of use of the investigated assets.

3. **Regulatory** – influences the uniformity of distribution of benefits obtained from the use of bioenergy assets.

4. **Innovative** – lies in realization of new commercial ideas and innovative solutions in the economic process.

We should not leave without attention the nano-level – the level of the individual, from which the attitude to the formation of the global energy and environmental system begins. The main functions are as follows:

1. **Energy responsibility** – formation of a self-awareness regarding the impact of personal activities and the environment as a whole.

2. **Environmental responsibility** – creating self-awareness regarding impact of personal activity and ecology as a whole.

3. **Moderate consumption** is control over using economic and natural resources.

Summarizing the selected functions, we will form a multi-level model of the functions of bioenergy assets in Fig. 4.

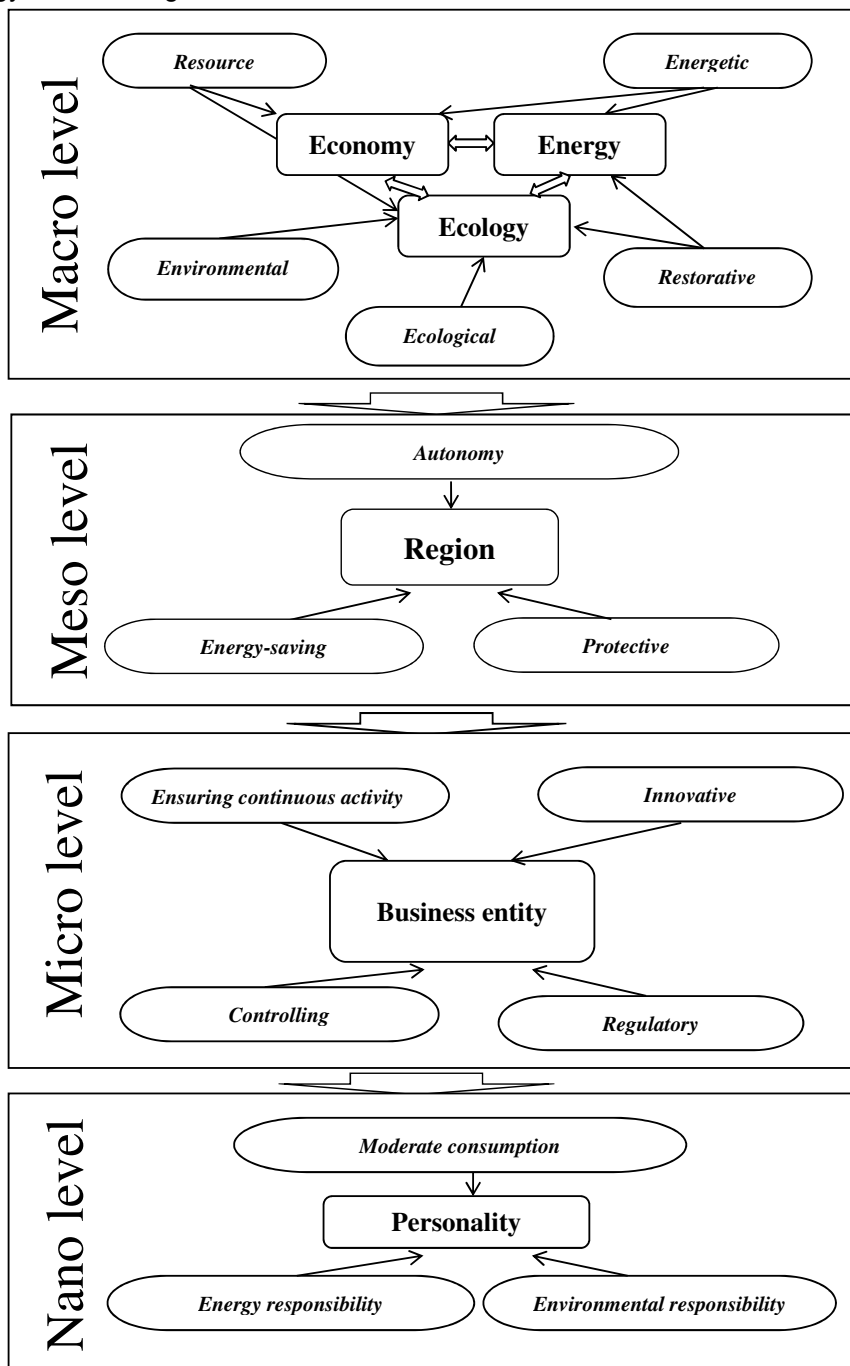


Fig. 4. Innovative multi-level model of functions of bioenergy assets.

Source: developed by the author.

The model shows that the use of bioenergy assets, as a renewable source of energy, forms environmental responsibility and smart consumption in the individual. At the macro level, this has a positive impact on the global climate scenario and humanity as a whole.

At the micro level, the use of bioenergy assets is carried out through a business entity. Let's consider the negative impact of the lack of information in accounting and integrated reporting on bioenergy assets on the economy of enterprises in the agrarian sector:

1. Growing shortage of natural capital and increase in the value of the use of bioenergy assets.

2. Penalties for non-compliance with legislation in the field of nature use and high environmental taxes.

3. Increase in the cost of products and services of an enterprise in connection with uncontrolled use of natural resources.

4. Increase of energy consumption and reduction of bioenergy potential.

5. Negative impact on companies which are highly dependent on natural capital.

6. A decrease in the reputation of a business entity due to non-compliance with the main principles of the concept of sustainable development.

On the other hand, full reflection of information about environmental and energy situation at an enterprise creates the following perspectives:

1. Reflecting the relationship between the profitability of a company and using natural resources.

2. Control over consumption of energy and natural resources for the creation of products, works and services.

3. Increasing the quality of strategic decisions for the company's activities in terms of determining the need for bioenergy assets and the consequences of their use.

4. Formation of a single base of environmental and energy calculations and their impact on profitability.

5. Realization of the principles of the concept of sustainable development in relation to ecology and the use of renewable energy sources.

6. Creation of a high image for an enterprise as a responsible user of production, energy and natural resources.

Information about bioenergy assets that will be presented in accounting and integrated reporting is a strategically important step, as it provides managers with information for making effective decisions and has an effect on the long-term profitability of the enterprise. Therefore, the recognition of bioenergy assets as an innovative object of accounting and the determination of the main criteria for its identification is a priority task for scientists.

Conclusions and prospects for further research. Bioenergy assets are an alternative source of energy that can be used to decarbonize the atmosphere. The main functions of bioenergy assets at different levels of the economy are determined: macro level (resource, restorative, energetic, ecological, environmental protection); meso level (autonomy, protective, energy-saving); micro level (ensuring continuous cyclical activity, controlling, regulatory, innovative); nano-level (energy responsibility, environmental responsibility, moderate consumption). The identified functions show a significant impact on the ecology, climate and energy system at different levels of the economy. From personal environmental and energy responsibility, a permanent culture of economical consumption and the desire

to control changes in the environmental and energy spheres is formed. This is realized through the introduction of accounting and control of information about bioenergy assets in the activities of business entities. Having analyzed the advantages of displaying information about bioenergy assets in the company's accounting and highlighting the risks of not displaying it, it is obvious that they have a high impact on profitability in the long term and the creation of a positive image of the company.

The definition of functions of bioenergy assets at different levels of economic existence is only the first step towards the construction of accounting and analytical support for bioenergy at the level of a business entity. Further research is needed to identify the criteria for recognizing bioenergy assets as an object of accounting and to form a methodology for their display in the information system of agrarian enterprises.

References

1. Ukraine: Commission presents plans for the Union's immediate response to address Ukraine's financing gap and the longer-term reconstruction. Press and information team of the Delegation to UKRAINE. Brussels. 18.05.2022. Retrieved from https://ireland.representation.ec.europa.eu/news-and-events/news/ukraine-european-commission-presents-plans-unions-immediate-response-address-ukraines-financing-gap-2022-05-18_en [in English].
2. Natsionalnyi plan dii z energoefektyvnosti na perion do 2030 roku: Rozporiadzennia Kabinetu Ministriv Ukrainy vid 29.12.2021. № 1803-p. [National Action Plan for Renewable Energy for the Period to 2030: Order of the Cabinet of Ministers of Ukraine from 29.12.2021. № 1803-p.]. Retrieved from <https://zakon.rada.gov.ua/laws/show/1803-2021-%D1%80#Text> [in Ukrainian].
3. Pro shvalennia Energetychnoi strategii Ukrainy na period do 2050 roku: Rozporiadzennia Kabinetu Ministriv Ukrainy vid 21.04.2023. № 373-p [On the approval of the Energy Strategy of Ukraine for the period until 2050: Order of the Cabinet of Ministers of Ukraine from 21.04.2023. № 373-p]. Retrieved from <https://zakon.rada.gov.ua/laws/show/373-2023-%D1%80#Text> [in Ukrainian].
4. International energy agency. News. Global CO2 emissions rebounded to their highest level in history in 2021. Retrieved from <https://www.iea.org/news/global-co2-emissions-rebounded-to-their-highest-level-in-history-in-2021> [in English].
5. Ministerstvo finansiv Ukrainy. Valovyi vnutrishnii product Ukrainy v 2021 rotsi. [Ministry of Finance (Ukraine). Gross domestic product in Ukraine 2021]. Retrieved from <https://index.minfin.com.ua/ua/economy/gdp/2021/> [in Ukrainian].
6. Walter V. Reid, Mariam K. Ali, Christopher B. Field. (2019). The future of bioenergy. *Global Change Biology*. Vol. 26, Issue 1. P. 274-286. Retrieved from <https://doi.org/10.1111/gcb.14883> [in English].
7. Femeena, P.V., Mehan, S., Cibir, R. (2019). Environmental impacts of bioenergy crop production and benefits of multifunctional bioenergy systems. In: *Bioenergy with Carbon Capture and Storage*. Academic Press, pp. 195–217. Retrieved from <https://doi.org/10.1016/B978-0-12-816229-3.00010-7> [in English].
8. Avagyan, A. B. (2021). Theory of bioenergy accumulation and transformation: application to evolution, energy, sustainable development, climate change,

- manufacturing, agriculture, military activity and pandemic challenges. *Athens J. Sci.* 2021. 8 (1). P. 57-80. Retrieved from <https://www.athensjournals.gr/sciences/2021-8-1-4-Avagyian.pdf> [in English].
9. Rather Dr-Rauoof, Wani Ab Waheed, Mumtaz, Sumaya, Padder, Shahid, Khan Afzal, Almohana Abdulaziz, Almojil Sattam, Alam Shah Saud, Baba Tawseef. (2022). Bioenergy: a foundation to environmental sustainability in a changing global climate scenario. *Journal of King Saud University - Science*. Vol. 34, Issue 1. Retrieved from <https://doi.org/10.1016/j.jksus.2021.101734> [in English].
 10. Borysiak O., Brych V. (2022). Post-COVID-19 Revitalization and Prospects for Climate Neutral Energy Security Technologies. *Probl. Ekorozw.* 17. P. 31-38. Retrieved from DOI: 10.35784/pe.2022.2.04 [in English].
 11. Zhuk, V. M. (2010). Fiziokratychna pobudova obliku silskohospodarskoi diyalnosti [Physiocratic basis for building accounting for agricultural activities]. *Ahroinkom*, (7–9), 57–62 [in Ukrainian].
 12. Honcharuk, I. V., Ishchenko, Ya. P., Stryhun, I. V. (2017). Organizatsiini aspekty oblikovogo zabezpechennia upravlinnia v integrovanyh naukovo-vyrobnychyh strukturah (na prykladi Instytutu bioenergetychnyh kultur I tsukrovych buriakiv Natsionalnoi akademii agrarnykh nauk Ukrainy) [Organizational aspects of management accounting in integrated research and production structures (on the example of the Institute of Bioenergy Crops and Sugar Beet of the National Academy of Agrarian Sciences of Ukraine)]. *Ekonomika. Finansy. Menedzhment: aktualni pytannia nauky i praktyky – Economics. Finance. Management: Topical Issues of Science and Practice*, (9), 33-45 [in Ukrainian].
 13. Hutsalenko, L. V., Fabiianska, V. Yu. (2013). Organizatsiia obliku ta kontroliu biologichnogo palyva [Organization of accounting and control of biofuel production]. Vinnytsia: Edelveis, K. 259 p. [in Ukrainian].
 14. Derii, V. (2010). Oblik i control za vytratamy na vyrobnytstvo biopalyva [Accounting and control over the cost of biofuel production]. *Ekonomichnyi analiz – Economic analysis*, (6), 414-419 [in Ukrainian].
 15. Rudenko M. Energiia progresu. Vybrani pratsi z ekonomii, filosofii ta kosmologii [The energy of progress. Selected works on economics, philosophy and cosmology]. K: Klio Publishing House. 2015. 680 p. [in Ukrainian].
 16. Sudyn, Y. (2015). Innovative methods of evaluating goodwill in increasing the competitiveness of the company. *Przedsiębiorstwo i Region*, 7 (1), 105-112 [in English].
 17. Global climate change. The Effects of Climate Change. Retrieved from <https://climate.nasa.gov/effects/> [in English].

Юлія БІЛА,

кандидат економічних наук, доцент,
доцент кафедри обліку і оподаткування,
Західноукраїнський національний університет,
вул. Львівська, 11а, м. Тернопіль, 46009, Україна,
e-mail: yuliya.sudyn@gmail.com
ORCID ID: 0000-0002-0741-5597

БІОЕНЕРГЕТИЧНІ АКТИВИ У ГЛОБАЛЬНОМУ КЛІМАТИЧНОМУ СЦЕНАРІЇ: МУЛЬТИРІВНЕВА МОДЕЛЬ ФУНКЦІЙ

Анотація

Вступ. Динамічні Євроінтеграційні процеси та воєнне вторгнення росії в Україну диктують нові умови розвитку національної енергетичної системи. Використання відновлюваних джерел енергії може бути ключовим напрямом реалізації енергетичної незалежності та стратегії декарбонізації. Проте відсутність стандартизованої системи обліку біоенергетичних активів як одного з відновлювальних джерел енергії унеможлиблює розвиток енергетичної політики України в цьому напрямку.

Мета дослідження. Мета статті – обґрунтування важливості визнання біоенергетичних активів об'єктом обліку через позитивний вплив на глобальний кліматичний сценарій та створення мультирівневої моделі функцій їх використання.

Методи. Методологічну основу дослідження становить діалектичний метод пізнання з використанням системного підходу. Індукція та аналіз сприяли виявленню значного впливу відсутності облікової методики біоенергетичних активів на глобальну екологічну систему загалом, що посилює необхідність здійснення дослідження у даному напрямку. Для розробки та наочного прикладу зростання викидів CO₂ в атмосферу за останні 120 років використано економіко-математичний, графічний та історичний методи. Для створення мультирівневої моделі функцій біоенергетичних активів використовувався графічний та факторний аналіз впливу на різні рівні економіки.

Результати та перспективи подальших досліджень. У статті обґрунтовано, що біоенергетичні активи є чинником позитивних змін у глобальному кліматичному сценарії у частині декарбонізації атмосфери. Досліджено функції біоенергетичних активів крізь призму рівнів економіки та створено мультирівневу модель функцій біоенергетичних активів з метою оцінювання їх значення для глобального економічного та екологічного простору. Визначено переваги від відображення інформації про біоенергетичні активи в бухгалтерському обліку та інтегрований звітності підприємства і виділено ризики її невідображення для оцінювання наслідків впровадження інноваційного об'єкта обліку.

Подальших досліджень потребує виокремлення критеріїв визнання біоенергетичних активів об'єктом обліку та формування методики їх відображення в обліково-аналітичній системі аграрних підприємств.

Ключові слова: бухгалтерський облік, біоенергетика, клімат, екологія, біомаса, інновації.

Формули: 0, рис.: 4, табл.: 0, бібл.: 16.

Література

1. Ukraine: Commission presents plans for the Union's immediate response to address Ukraine's financing gap and the longer-term reconstruction. *Press and information team of the Delegation to UKRAINE*. Brussels. 18.05.2022. URL: <https://ireland.representation.ec.europa.eu/news-and-events/news/ukraine-european->

- commission-presents-plans-unions-immediate-response-address-ukraines-financing-gap-2022-05-18_en
2. Національний план дій з відновлюваної енергетики на період до 2030 року: Розпорядження Кабінету Міністрів України від 29.12.2021 р. № 1803-р. URL: <https://zakon.rada.gov.ua/laws/show/1803-2021-%D1%80#Text>
 3. Про схвалення Енергетичної стратегії України на період до 2050 року: Розпорядження Кабінету Міністрів України від 21.04.2023 р. № 373-р. URL: <https://zakon.rada.gov.ua/laws/show/373-2023-%D1%80#Text>
 4. International energy agency. News. Global CO2 emissions rebounded to their highest level in history in 2021. URL: <https://www.iea.org/news/global-co2-emissions-rebounded-to-their-highest-level-in-history-in-2021>
 5. Міністерство фінансів України. Валовий внутрішній продукт України у 2021 р. URL: <https://index.minfin.com.ua/ua/economy/gdp/2021/>
 6. Walter V. Reid, Mariam K. Ali, Christopher B. Field. The future of bioenergy. *Global Change Biology*. 2019. Vol. 26, Issue 1. P. 274–286. URL: <https://doi.org/10.1111/gcb.14883/>
 7. Femeena P.V., Mehan S., Cibin R. Environmental impacts of bioenergy crop production and benefits of multifunctional bioenergy systems. *In: Bioenergy with Carbon Capture and Storage. Academic Press*. 2019. P. 195–217. URL: <https://doi.org/10.1016/B978-0-12-816229-3.00010-7>
 8. Avagyan A. B. Theory of bioenergy accumulation and transformation: application to evolution, energy, sustainable development, climate change, manufacturing, agriculture, military activity and pandemic challenges. *Athens J. Sci.* 2021. 8 (1). P. 57–80. URL: <https://www.athensjournals.gr/sciences/2021-8-1-4-Avagyan.pdf>
 9. Rather Dr-Rauoof, Wani Ab Waheed, Mumtaz, Sumaya, Padder, Shahid, Khan Afzal, Almohana Abdulaziz, Almojil Sattam, Alam Shah Saud, Baba Tawseef. Bioenergy: a foundation to environmental sustainability in a changing global climate scenario. *Journal of King Saud University - Science*. 2022. Vol. 34, Issue 1. URL: <https://doi.org/10.1016/j.jksus.2021.101734>
 10. Borysiak O., Brych V. Post-COVID-19 Revitalization and Prospects for Climate Neutral Energy Security Technologies. *Probl. Ekorozw.* 2022. 17. P. 31–38. URL: DOI: 10.35784/pe.2022.2.04
 11. Жук В. М. Фізюократична основа побудови обліку сільськогосподарської діяльності. *Агроінком*. 2010. № 7–9. С. 57–62.
 12. Гончарук І. В., Іщенко Я. П., Стригун І. В. Організаційні аспекти облікового забезпечення управління в інтегрованих науково-виробничих структурах (на прикладі Інституту біоенергетичних культур і цукрових буряків Національної академії аграрних наук України). *Економіка. Фінанси. Менеджмент: актуальні питання науки і практики*. 2017. № 9. С. 33–45.
 13. Гуцаленко Л. В., Фабіянська В. Ю. Організація обліку і контролю виробництва біологічного палива: моногр. Вінниця: Едельвейс і К., 2013. 259 с.
 14. Дерій В. Облік і контроль за витратами на виробництво біопалива. *Економічний аналіз*. 2010. Вип. 6. С. 414–419.
-

-
15. Руденко М. Енергія прогресу. Вибрані праці з економії, філософії та космології. Київ: ТОВ «Видавництво «Кліо», 2015. 680 с.
 16. Sudyn, Y. Innovative methods of evaluating goodwill in increasing the competitiveness of the company. *Przedsiębiorstwo i Region*. 2015. 7 (1), P. 105–112.
 17. Global climate change. The Effects of Climate Change. URL: <https://climate.nasa.gov/effects/>

Статтю отримано 03 серпня 2023 р.

Article received August 3, 2023.