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Bioenergy Assets as an Innovative Accounting Object: Definition and Recognition Criteria

Abstract. One of the main tasks of Ukraine's Energy Strategy until 2050 is to develop bioenergy and use renewable energy sources. A promising area of energy production is the processing of biomass and energy plants into biofuel. However, the need for a unified approach to the theoretical definition of the main elements of bioenergy and a standardized system of recognizing them as accounting objects determines the urgency of researching this problem. The study aims to substantiate the use of the new term "bioenergy assets" for accounting purposes, to form its definition following the identification parameters and to highlight the main criteria for recognition as an innovative accounting object. Analysis, synthesis, and deduction were used to identify a gap in the regulatory and scientific literature regarding the existence of a term that would combine energy assets of biological origin for accounting purposes. Specification of the term "bioenergy assets" was carried out by comparing existing terms and identifying their shortcomings. The synthesis and comparison became the basis for identifying the characteristic features of bioenergy assets, which will serve as criteria for their recognition in financial and management accounting. The article proposes that energy plants and organic substances (products, waste, residues of livestock and crop production) produced in agriculture, forestry, fisheries and related industries, as well as industrial and household waste of organic origin, which, in the process of biological, physical and chemical transformations, are capable of generating energy for public needs and bringing environmental benefits, should be considered as bioenergy assets. The new terminology that would serve as the basis for identifying an innovative accounting object was formed. The main criteria for recognition of bioenergy assets in the accounting and analytical system of enterprises were highlighted: renewability; non-fossil character; the ability to create energy as a result of biological, physical and chemical transformations; the opportunity to bring environmental benefits; and organic origin.

Keywords: bioenergy, bioenergy assets, biomass, biofuel, energy crops, innovative accounting object.

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Біоенергетичні активи як інноваційний об'єкт обліку: визначення та критерії визнання

Анотація. Одним з головних завдань Енергетичної стратегії України до 2050 року є розвиток біоенергетики та використання відновлювальних джерел енергії. Перспективним напрямом вироблення енергії є переробка біомаси та енергетичних рослин у біопаливо. Проте, відсутність єдиного підходу до теоретичного визначення головних елементів біоенергетики та стандартизованої системи визнання їх об'єктами обліку ускладнює процеси виробництва, що обумовлює актуальність дослідження цієї проблеми. Метою статті є обґрунтування використання нового терміну «біоенергетичні активи» для потреб бухгалтерського обліку, формування його визначення відповідно до параметрів ідентифікації та виділення основних критеріїв визнання як інноваційного об'єкта обліку. Аналіз, синтез та дедукцію використано для визначення прогалини у нормативно-правових актах та науковій літературі щодо наявності терміну, що об'єднав би енергетичні активи біологічного походження для потреб бухгалтерського обліку. Конкретизація терміну «біоенергетичні активи» була здійснена методом порівняння існуючих термінів та визначення їх недоліків. Синтез та порівняння стали основою для виокремлення характерних ознак біоенергетичних активів, які в фінансовому та

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управлінському обліку слугуватимуть критеріями їх визнання. Запропоновано біоенергетичними активами вважати енергетичні рослини та органічні речовини (продукти, відходи, залишки тваринництва і рослинництва), виготовлені у сільському, лісовому, рибному та суміжних господарствах, а також промислові і побутові відходи органічного походження, що в процесі біологічних, фізичних та хімічних перетворень здатні створювати енергію для суспільних потреб і приносити екологічні вигоди. Сформована нова термінологія буде базою для виділення інноваційного об'єкта обліку. Виокремлено основні критерії визнання біоенергетичних активів в обліково-аналітичній системі підприємств: відновлюваність; невикопний характер; здатність створювати енергію у результаті біологічних, фізичних та хімічних перетворень; можливість приносити екологічні вигоди; органічне походження.

Ключові слова: біоенергетика, біоенергетичні активи, біомаса, біопаливо, енергетичні культури, інноваційний об'єкт обліку.

PROBLEM STATEMENT

Ukraine's energy security is threatened due to hostilities on the country's territory and dependence on fossil fuel imports. Therefore, one of the main tasks of Ukraine's Energy Strategy until 2050 [1] is developing bioenergy and using renewable energy sources. According to forecast indicators, the share of renewable energy sources in the total supply of primary energy until 2050 will increase due to a significant reduction in coal and natural gas consumption. In particular, one of the promising areas of bioenergy development is the production of energy from biomass and energy plants. However, the lack of a unified approach to the theoretical definition of the main elements of bioenergy and the lack of a standardized system for their recognition as accounting objects complicates production processes, which necessitates conducting research in this direction.

Analyzing legal acts, statistical data and works of scientists related to bioenergy, we come across the concepts of "biomass", "biofuel", "bioenergy resources", "organic waste", and "energy plants". All this is a biological source of energy creation. However, since one of the problems of implementing bioenergy at the macro level is the lack of a developed methodology and organization of its accounting, it is necessary to define a single term that will unite all available biological products that can be converted into energy. Such identification will help determine specific criteria for recognizing bioenergy assets as an innovative accounting object and form a definition that will most fully reflect their composition, structure and energy value.

LITERATURE REVIEW

In scientific literature, the topic of bioenergy is trendy. In particular, V. Zhuk [2, c. 102] offers a new paradigm of the harmonious development of the economy (sustainable development), which involves accounting for non-standard objects of the "living" economy (renewable energy and biological assets). The researcher emphasizes the need to develop methodological approaches for their accounting based on the theory of physical economy.

The scientific paradigm of information support for managing the bioenergy industry was outlined by N. Pravdyuk et al. [3], defining its main elements, which concern agriculture. L. Hnatyshyn et al. [4] studied the problems of practical improvement of the methods of accounting for the cultivation of energy willow to meet

the information needs for managing the production of bioenergy crops.

V. Deriy [5] works to improve the methods of calculating the cost of biofuel. The scientist recommended specifying the nomenclature of cost items for biofuel production. The subject of L. Gutsalenko and V. Fabiyanska's [6] research is also the accounting and analytical support of the biofuel production process. In particular, the researchers offer a method of cost accounting, production cost calculation and biofuel display on accounting accounts.

Despite the availability of scientific works on the researched topic, the issue of creating a theoretical basis for recognizing energy assets of biological origin as accounting objects to build a new accounting paradigm that will meet the demands of stakeholders and contribute to the implementation of global goals for the development of bioenergy and climate preservation remains unresolved.

Thus, *this study aims* to substantiate the use of the new term "bioenergy assets" for accounting purposes, to form its definition by the identification parameters and to highlight the main criteria for recognition as an innovative accounting object.

RESEARCH METHODOLOGY

Analysis, synthesis, and deduction were used to identify a gap in the regulatory and scientific literature regarding a term combining energy assets of biological origin for accounting purposes. Specifying the term "bioenergy assets" was done by comparing existing terms and identifying their shortcomings. The synthesis and comparison became the basis for identifying the characteristic features of bioenergy assets, which will serve as criteria for their recognition in financial and management accounting.

RESULTS AND DISCUSSION

The Law of Ukraine "On Alternative Fuels" obliges economic entities, as a result of which biomass is formed, which is a raw material for the production of biofuel and biocomponents, to keep records of this type of biomass by the procedure established by the Cabinet of Ministers of Ukraine [7]. In addition, companies producing biofuels must also keep records of biofuels and biocomponents using the procedure established at the legislative level (Figure 1).

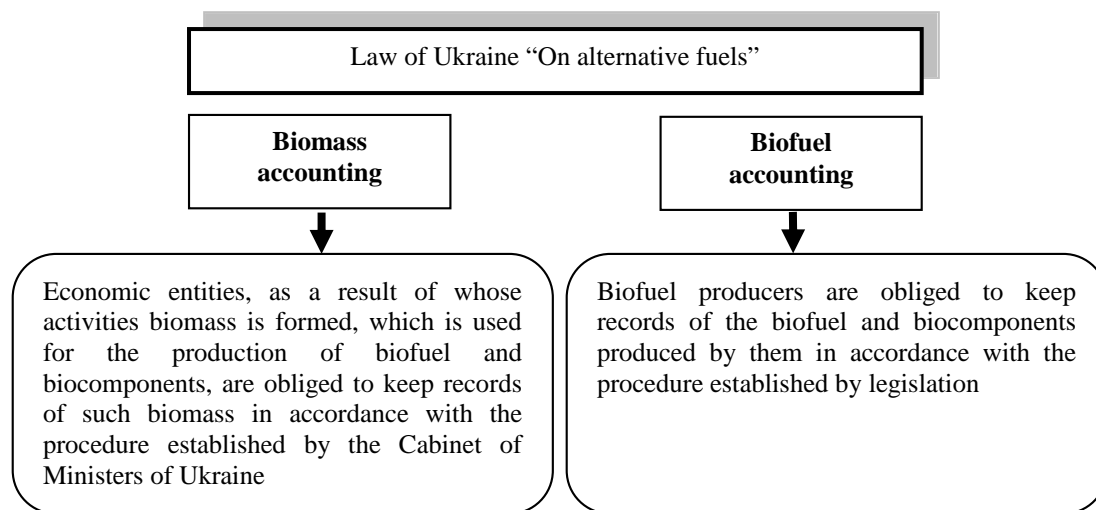


Figure 1. Provisions of the Law of Ukraine “On Alternative Fuels” on the need of accounting of biomass and biofuels

Source: developed by the author based on [7].

The law requires accounting for only that part of biomass used for the production of biofuels and biocomponents, i.e., for energy purposes. This is reasonable, as biomass as a product of agriculture, without the intention of using it for biofuel production, is only a finished or by-product of crop or livestock production. Therefore, for accounting purposes, a separate term should be defined to include this part of biomass and other energy assets of biological origin.

The term “bioenergy resources” can be found in the scientific literature. M. Talavyria et al. define bioenergy resources as “... defined in space and time renewable energy resources of biogenic origin, which are characterized by a certain potential and for which the necessary technologies of extraction/production and use exist” [8]. This concept, in our opinion, is too broad for accounting purposes. Since its main objects are assets, liabilities and capital, let us consider the definition of the term “assets”. According to the National Accounting Standard 1 “General Requirements for Financial Reporting”: “assets are resources controlled by an enterprise as a result of past events, the use of which is expected to lead to economic benefits in the future” [9]. In our opinion, the term “bioenergy assets” would be more appropriate, which would include those types of bioenergy resources that meet the definition of an asset under National Accounting Standard 1. The common feature between bioenergy assets and bioenergy resources, which can serve as a criterion for recognition in accounting, is their renewable nature.

Professor V. Zhuk, in his study of the physiocratic basis of building agricultural accounting, uses the concept of “bioenergy (renewable) assets” but does not correlate it with bioenergy. Instead, he includes its composition: agricultural land, unfinished production in the plant industry, organic fertilizers, seeds and fodder, and finished products from agricultural activities [10]. The author considers agricultural land to be the most

important bioenergy asset. The scientist means the energy which was described in the basic ideas of the physiocrats’ doctrine, the energy of all life on Earth, which is accumulated in biological assets. In our understanding, bioenergy assets are the objects of bioenergy (the energy sector based on biofuels produced after biomass processing). In other words, bioenergy assets can be converted into energy that can be managed (solid, liquid, and gaseous biofuels) and used to meet human needs instead of fossil fuels.

Let us consider the definitions of the concepts related to the proposed term. According to the Law of Ukraine “On Energy Efficiency” No. 1818-IX of January 01, 2023, fuel and energy resources are natural and converted fuels and energy [11]. The definition includes fossil and non-fossil energy fuels. Bioenergy assets are part of fuel and energy resources, but these concepts are not identical since the nature of their production is not fossil. This feature is characteristic of bioenergy assets and is important in identifying this accounting object.

The Law of Ukraine “On Alternative Fuels” No. 1391-XIV of 11.11.2021 defines biomass and other bioenergy terms (Table 1). The definition analysis shows that biomass is a raw material for producing biological fuels (solid, liquid, gaseous) and, therefore, is an asset that benefits an enterprise.

The definition of “biomass” is harmonized with the one provided in European regulations (EU Directive 2018/2001 of December 11, 2018). Until 2015, biomass included only residues and by-products of biological production and organic waste. After the amendments to the Law of Ukraine “On Alternative Fuels” (Law No. 514-VIII of 04.06.2015) came into force, products of agricultural and related industries were also considered biomass. We believe that biomass used for energy purposes can be recognized as a bioenergy asset in accounting.

Table 1. Definitions of terms in the Law of Ukraine “On Alternative Fuels”

No.	Concept	Definition
1	Biomass	Non-fossil, biologically renewable substance of organic origin, capable of biological decomposition, in the form of products, waste and remains of forestry and agriculture (plant growing and animal husbandry), fisheries and technologically related branches of industry, as well as a component of industrial or municipal waste capable of biological decomposition
2	Biological fuels (biofuels)	Solid, liquid and gas fuels made from biologically renewable raw materials (biomass) which may be used as a fuel or component of other fuels
3	Biocomponent	Biofuels used as a component of other fuels
4	Bioethanol	Dehydrated ethyl alcohol produced from biomass or raw ethyl alcohol for use as a biofuel
5	Biobutanol	Butyl alcohol produced from biomass used as a biofuel or biocomponent
6	Biodiesel fuel (biodiesel)	Methyl and/or ethyl ethers of higher organic acids derived from vegetable oils or animal fats used as biofuels or biocomponents
7	Biogas	Gas obtained from biomass used as fuel
8	Biohydrogen	Gas obtained from biomass used as fuel
9	Biomethane	Biomethane, which according to its physical and chemical characteristics meets the requirements of legal acts for natural gas to be supplied to the gas transportation or gas distribution system or for use as motor fuel

Source: systematized by the author based on [7].

The definition under study does not specify that biomass is characterized by the ability to create energy to meet the needs of society. Since the main feature of an asset in accounting is the ability to generate certain benefits in the future, a characteristic feature of bioenergy assets is to generate energy for public use.

According to the International Renewable Energy Agency in its report “World Energy Outlook 2023: The Path to 1.5°C”, the amount of CO₂ emitted by renewable energy sources can be completely absorbed in the process of photosynthesis [12]. We believe the ability to generate environmental benefits can be considered a sign of bioenergy asset identification.

It is also advisable to include energy plants in the composition of bioenergy assets. According to the definition proposed by the Bioenergy Association of Ukraine: “energy crops are perennial plants whose root system remains in the soil after harvesting and continues the vegetation process, grown in a plantation manner with a harvest frequency of 1 to 5 years to obtain biomass for further energy production from it” [13].

According to the State Register of Plant Varieties Suitable for Distribution in Ukraine, 36 types of energy crops have been entered, including several types of willow, giant miscanthus, pavlovnia, and rod-like millet [14]. That is, there are separate crops of plants grown for energy production.

Plants such as rapeseed, sunflower, and rice are not classified as energy plants, but biomass can be harvested from their remains, which will become a raw material for biofuel. Corn is one of the popular sources of biomass since all parts of the plant are used for the production of

bioenergy products: grain - as a raw material for the production of first-generation bioethanol; stem, rod, leaves, wrapper – as raw materials for the production of biogas, second-generation biostandard and solid biofuels (pellets and briquettes) [15]. Corn can be grown for both agricultural and energy purposes. The technology of its cultivation will differ, so it will be advisable to separate its accounting into different analytical accounts.

A method of accounting for biological assets has been developed [16, 17, 18]. According to national accounting standards: “A biological asset is an animal or plant that, in the process of biological transformations, is capable of producing agricultural products and/or additional biological assets, as well as bringing economic benefits in another way” [19]. Bioenergy assets cannot be considered identical to biological assets. Their main difference is that the assets that are created by energy undergo physical (direct combustion) and chemical transformations (pyrolysis, gasification, production of alcohols and oils) in addition to biological [20]. Hence, the recognition feature of bioenergetic assets is the ability to create an effect resulting from biological, physical and chemical transformations.

The prefix “bio” in the studied term indicates the relation to natural life cycles and the presence of organic processes. In particular, bioenergy assets have an organic origin (animal or plant) and the ability to biodegrade, which are criteria for their recognition as an accounting object. However, in the definition, it is possible not to duplicate these two features since biodegradation is a consequence of organic origin.

Accounting

We consider it necessary to highlight the term “bioenergy assets” and propose a definition that will combine all the features of this accounting object and the criteria for their recognition (Fig. 2). Bioenergy assets are energy plants and organic substances (products, waste, residues of livestock and crop production) produced in

agriculture, forestry, fishing and related industries, as well as industrial and household waste of organic origin that is in the process of biological, physical and chemical transformations can create energy for public needs and bring environmental benefits.

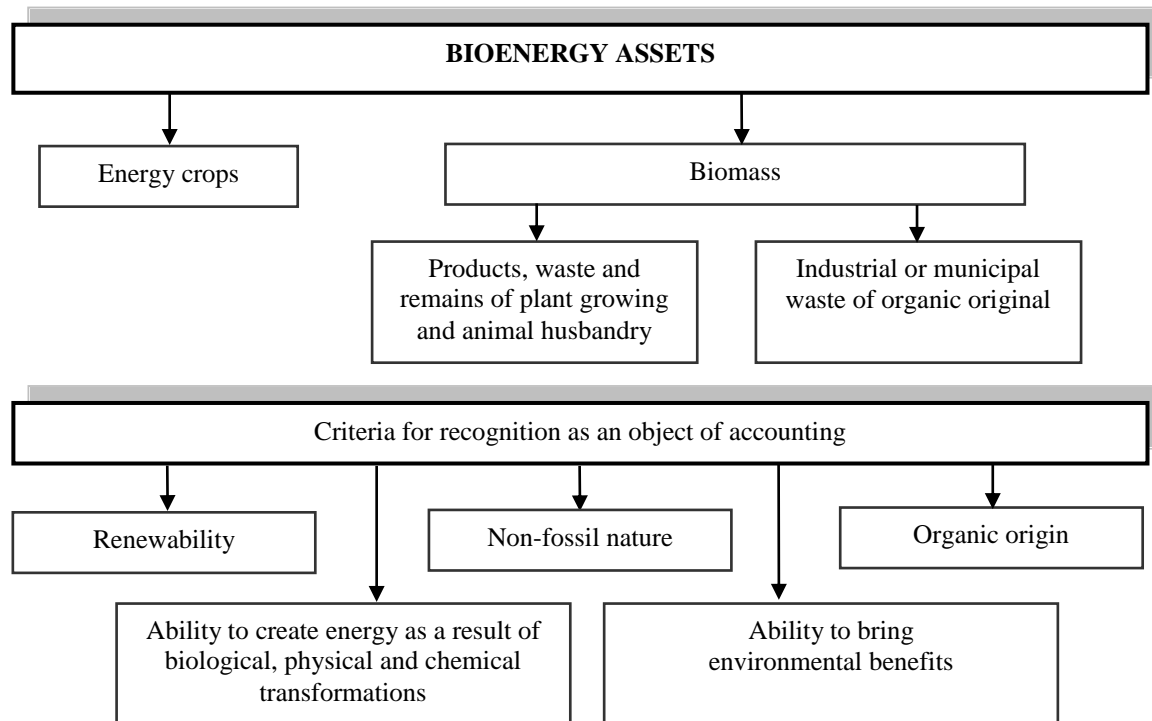


Figure 2. Conceptual approach to the recognition of bioenergy assets as an object of accounting

Source: developed by the author.

We suggest including the definitions summarized in the study and provided in legislative documents and scientific literature as the criteria for recognizing bioenergy assets:

- renewability;
- non-fossil nature;
- ability to create energy as a result of biological, physical and chemical transformations;
- ability to bring environmental benefits;
- organic origin.

CONCLUSIONS

Based on the analysis of the definitions of terms related to bioenergy, it was found that there needs to be more regulatory and legal acts and scientific literature regarding a single term that would most accurately meet accounting requirements. It has been proposed to use the term “bioenergy assets” with the following definition: energy plants and organic substances (products, waste, residues of livestock and crop production) produced in agriculture, forestry, fishing and related farms, as well as industrial and household waste of organic origin, which

in the process of biological, physical and chemical transformations can create energy for public needs and bring environmental benefits.

It has been proved that bioenergy assets can be an innovative accounting item if they meet the following recognition criteria:

- They have the nature of non-fossil fuels.
- They are renewable.
- They are capable of generating energy as a result of biological, physical and chemical transformations.
- They can bring environmental benefits.
- They are organic in origin.

These features characterize bioenergy assets and can serve as criteria for their identification in accounting.

The allocation of bioenergy assets as an innovative accounting object in managing agricultural enterprises is only the first step towards building accounting and analytical support for bioenergy at the level of an economic entity. Further research is needed on the methodology for their valuation and the reflection in the accounting and reporting of agricultural enterprises.

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