ANALYSIS OF THE POTENTIAL AND PERSPECTIVES OF THE DEVELOPMENT OF BIOMASS TECHNOLOGIES IN UKRAINE

This article provides an in-depth analysis of the potential and prospects for the development of biomass technologies in Ukraine. An overview of the current state of biomass use in the energy, industrial and agricultural sectors of the country is being carried out. The article examines in detail different types of biomass such as wood, agricultural residues, biological waste, etc., and their potential for producing energy and other useful products. Particular attention is paid to technological innovations in the field of biomass processing, including processes of biogasification, pyrolysis and hydrothermal conversion. The authors analyze the ecological and economic aspects of using biomass as an energy source, considering its impact on reducing greenhouse gas emissions and ensuring the country’s energy independance. In addition, the article examines important legislative and strategic initiatives aimed at supporting the development of biomass use in Ukraine, and puts forward proposals for further steps to stimulate this direction. In general, the article serves as a valuable source of information for scientists, experts and decision-makers interested in the development of sustainable energy and the use of renewable energy sources in Ukraine.

Recommendations for the further development of the use of biomass in Ukraine are formulated, taking into account the importance of solving environmental problems and energy independence. Summarizing, the article not only offers an in-depth analysis of the potential and prospects for the development of biomass technologies, but also defines the ways for the practical realization of this potential in the conditions of modern energy and environmental challenges.

**Keywords:** biomass, renewable energy sources, development potential and prospects, energy security, sustainable development.

**Introduction.** The modern world is facing unprecedented challenges related to climate change, energy security and ecosystem sustainability. In this context, the development of renewable energy sources and the creation of effective systems for the use of natural resources become an important task. One of the potential solutions is the development of biomass technologies. Biomass includes organic materials such as wood, straw, manure, and other biological wastes that can be used to produce energy, heat, fuel, and biochemical products. The use of biomass can help reduce greenhouse gas emissions, reduce dependence on imported energy sources, and create new opportunities for the development of agriculture and the bioeconomy in Ukraine. This article is devoted to the analysis of the potential and prospects for the development of biomass technologies in Ukraine. Existing technologies of biomass use, advantages and limitations of their implementation, as well as possible ways of promoting the development of this sector in the country are considered. The conducted analysis will help to understand how biomass can become an important component of sustainable development of Ukraine and contribute to the achievement of energy efficiency and environmental goals.

**Main goal and tasks.** The main goal of this article is a thorough analysis of the potential and prospects for the development of biomass technologies in Ukraine, taking into account modern challenges related to energy security, climate change and sustainable development. The specific tasks of the research include the following: conducting an overview of the current state of biomass technology use in Ukraine, including existing projects, the volume of biomass energy production, and the types of biomass used; determine the advantages and limitations of using biomass in the context of energy efficiency, environmental requirements, and economic sustainability; identify potential industries and applications of biomass technologies that may become important in Ukraine, including the production of biofuels, heat, electricity, and biochemical products; consideration of foreign experience and best practices in the field of biomass use and determination of the possibilities of their adaptation to Ukrainian conditions; developing recommendations and strategic steps for the government, business and the public to promote the development of biomass technologies in Ukraine, including measures to raise awareness, create favorable conditions for investment, and support research and development of this sector. This article is designed to promote understanding and discussion of the opportunities and challenges associated with the use of biomass in Ukraine, and to promote the development of a sustainable, ecological and energy-secure economy.

**Material and research results.** The modern world is experiencing a number of global challenges related to climate change, energy security and sustainable development. One of the possible solutions to overcome these challenges is the use of biomass as a source of energy and raw material for the production of various products. Ukraine, with its large natural resources and potential in the agricultural sector, has a unique opportunity to develop biomass technologies that will contribute to sustainable development and improvement of the ecological situation. Ukraine is one of the countries where biomass potential is huge. A large part of land resources is used for...
agricultural production, which creates large volumes of biological waste, such as straw, manure, and other plant and animal residues. This waste can be used to produce biomass energy, biofuel, and other products. In addition, the Forest Fund of Ukraine provides an opportunity to use wood as a source of biomass. The forest industry has the potential to develop technologies for the production of biofuels and other wood-based products.

The International Renewable Energy Agency (IRENA) has developed a forecast for the introduction of RES until 2050. IRENA suggests that RES could account for 60% or more of the total final energy consumption of many countries. For example, China can increase the share of RES in energy consumption from 7% in 2015 to 67% in 2050. In the EU, this share can increase from 17% to more than 70%. In India and the USA, the amount of energy from RES in the total energy consumption can reach two thirds or more. According to IRENA forecasts, bioenergy will play a key role in the implementation of the "green" energy transition and the reduction of greenhouse gas emissions in the world. IRENA estimates that the share of biomass in the final consumption of renewable energy will be almost half in 2030 and 40% in 2050. The agency’s conclusion: without doubling energy production from biomass by 2050, it is impossible to keep the global temperature rise on Earth within 2°C.

Analytical company Ecofys has developed an ambitious scenario of achieving 95% of final energy consumption in the world from RES by 2050. It is important to note that according to this scenario, as in IRENA forecasts, about 40% of all renewable energy will be provided by biomass.

According to the European Commission, in order to achieve the ambitious goal of reducing greenhouse gas emissions to zero, the share of bioenergy in the total energy mix should be at least 20% (about 30% of all RES) in 2050. According to IRENA's forecast, the production of electricity in the world during 2015-2050 will almost double in 2018 with provision of 85% of the total volume at the expense of RES. Ecofys estimates that the share of biomass in global electricity production will be about 12%. In the EU electricity sector, according to various scenarios (80-100% "green" electricity by 2050), the share of biomass in electricity production will be 10-12%. Today, biomass provides about 17% of the EU's total need for heat and cold, which corresponds to 87% of the contribution of all RES. Over the past 20 years, the volume of heat consumption from biomass in Europe has increased by 1.7 times - from 52 to 90 million tons per year. It is predicted that the significant contribution of bioenergy to the production of renewable heat will remain in the long term.

There are many examples of successful implementation of similar modern bioenergy projects in the world and in the EU. For example, in the center of Stockholm with a population of 2.3 million people, one of the world's largest biomass thermal power plants operates (130 MWt + 280 MWt). Biomass provides 80% of the city's heat needs and 20% of energy for transport. By 2030, the transition of the city to 100% RES is planned. Vilnius (550,000 people) operates the largest biomass thermal power plant in Eastern Europe (70 MWt + 164 MWt). Bioenergy provides 85% of the city's need for heat and 25% of its need for electricity. By 2040, it is planned to achieve 100% of thermal energy from RES in Vilnius. In Copenhagen, 98% of the housing stock (including the private sector) is connected to a fully competitive district heating system. Several large biomass CHP plants with a total thermal capacity of 1.3 GW operate in the city. Biomass currently provides 90% of Copenhagen's heat needs and 20% of energy in the transport sector. By 2040, it is planned to achieve 100% of all energy from RES. There is also an opinion that in the future it is possible to reach almost 100% share of electricity use in heating and transport, therefore there is no room left for biomass in these sectors. The prospects of bioenergy in the electric power sector are seen in the combined production of heat and electricity (biomass thermal power plant), as well as through the use of biomethane to balance power systems with a high share of RES. Biomethane production potential in Ukraine is estimated at 7.8 billion m3/year. This amount is more than enough for the complete conversion of the necessary gas shunt generation to biomethane.

The study of climatic conditions and resources of renewable sources in Ukraine, as well as the current experience of their use in the world, allows us to determine biomass energy as one of the most promising vectors of renewable energy for the next 20-25 years. In the energy sense, biomass means the production of electrical and thermal energy (as well as liquid and gaseous fuel) from organic substances of vegetable and animal origin that contain carbon (wood waste, peat, straw, plant residues of agriculture, organic part of solid household waste, etc.).

1. The main methods of obtaining biomass energy include: burning of raw materials of plant origin (wood, straw, husks, etc.); incineration of municipal solid waste; use of vegetable oils as fuel for internal combustion engines; biopreservation or decomposition of organic substances of plant or animal origin in anaerobic conditions with the formation of biogas, ethanol, butanol, etc.; thermochemical conversion (pyrolysis, gasification, synthesis) of solid organic substances (peat, wood, etc.) with the production of "synthesis gas", synthetic gasoline.

Today, biomass is the fourth largest source of energy worldwide. The content of biomass in the biosphere is very large - 800 billion tons. 200 billion tons are recovered annually. The global economic potential of biomass use is 3.27 billion tons of conventional fuel. In particular, for Russia, it is approximately 15% of the total. Therefore, in the future, it will play an important role in meeting the world's energy needs.

Biomass can make a significant contribution to the direct substitution of fossil fuels in the production of thermal energy. In Ukraine, there are a number of barriers that prevent the widespread involvement of biofuels in this sector. As a result of the monopoly position of enterprises in the district heating (DH) sector and imperfect
Biomass utilization technologies. Biomass utilization technologies include processes of biogasification, production of biofuel, bioproducts and heat. Biogasification, for example, allows you to turn organic materials into fuel and energy resources.

ISSN 2308-7382 (Online) 133
biogas, which can be used to produce electricity and heat. Biofuel, like biodiesel, can be obtained from vegetable raw materials and is used in motor vehicles and other areas.

Advantages and limitations of using biomass. The use of biomass has its advantages and limitations. Benefits include reduced greenhouse gas emissions, reduced energy dependence on imported sources, and improved air quality. However, limitations include high infrastructure costs, competition with other forms of energy production, and potential negative impacts on biodiversity. Prospects for the development of biomass technologies in Ukraine The use of biomass technologies can contribute to the diversification of energy sources and the reduction of the carbon footprint. The development of the biomass industry will also create new jobs and contribute to the development of the agricultural sector. However, certain measures are needed to achieve these prospects, such as creating an enabling legal environment, supporting innovation and research, and attracting investment. It is also important to give weight to environmental aspects and follow a sustainable approach in the development of biomass technologies. [10]

In Ukraine, 5 million tons of straw are regenerated annually. From 1 million tons of straw, you can get 100,000 tons of ethyl alcohol, 140 million m³ of methane, and tens of tons of fertilizers. According to the calculations of the National Academy of Sciences, the use of only 20% of straw resources (this amount of straw is lost annually) makes it possible to fully meet the needs of the population, primarily rural, in electrical and thermal energy. In order to use these potential opportunities of straw, it is necessary to establish the production of equipment for its collection and packaging, boilers and other energy equipment for use. When all biomass resources are involved in the Ukrainian fuel and energy balance, a real basis will appear for the modernization and optimization of the coal industry so that it becomes safe for the life and work of miners, profitable and not burdensome for the state budget, and takes its proper place in the PEB and did not destroy the environment. The next reserve of Ukraine's fuel resources is the forest, the potential of which is not yet satisfactorily used, as dry and substandard wood that rots is not used, and forests are overgrown with shrubs. At the same time, schools, preschools, rural hospitals, as well as some industrial enterprises are not properly heated in the winter. Therefore, for their heating, it is necessary to adjust the production of heating equipment for local types of fuel.

The financial costs of biomass energy technologies depend to a large extent on the cost of biomass fuel, which in turn depends on the location and type of fuel. For example, the range of costs for biomass residues such as sunflower husks, straw varies from negative values, in those situations where they are used as waste, and have a cost that is related to their location to the processing facility where it can be used as an energy resource. Ukraine's energy problems are expected to contribute to the use of cheap biomass resources and the introduction of new technologies for its utilization, which in turn will contribute to solving environmental and economic problems. Thus, striving to reduce the man-made load on the surrounding natural environment, it is necessary to simultaneously find opportunities to reduce the threat of bankruptcy of specific business entities. At the same time, one should take into account the fact that in the territories of industrial zones, various wastes of economic activity in the form of biomass of industrial, plant and agricultural origin, solid household waste, etc., are systematically accumulated. In most cases, the specified types of waste are suitable for energy utilization, in the implementation of which two goals are achieved: alleviating to a certain extent the threat of bankruptcy of entities of economic activity that use energy-utilized waste due to the lower cost of the latter, compared to traditional fuel energy resources and the relevant territory is freed from waste of this type, which is systematically accumulated. Energy dependence on the world oil and gas market is likely to promote the use of biomass as a way to increase energy security throughout the world, including Ukraine. The rate of future use of biomass as an energy source will depend on the measures that need to be removed to barriers listed above. According to the RES development program in the EU countries, by 2010 the share of biomass in its total contribution should be 74%, which will be equal to 9% of the total consumption of primary energy carriers. It follows that Ukraine should also set similar goals for itself and should not lag behind Europe in this matter. Therefore, it is necessary to begin the large-scale implementation of priority measures for the use of biomass immediately, since further delay is unacceptable.

In order to strengthen the energy sustainability of Ukraine, OJSC "Naftogaz of Ukraine" has started preparatory work on the construction of thermal power plants in Lviv and Zhytomyr that will run on biomass (wood chips) and solid secondary fuel. The total capacity of the facilities will be 90 MW of thermal energy and 11 MW of electrical energy. The planned period of commissioning of facilities in the city of Lviv - I quarter. 2023, in the city of Zhytomyr - IV quarter. In 2023, Naftogaz of Ukraine intends to build 9 bio-CHP plants and bio-boiler plants in 8 regions of Ukraine, which will have a total capacity of 250 MW of thermal energy and 52 MW of electricity. The company plans to become the largest heat generator from biomass by 2027, as well as replace about 2 billion cubic meters, natural gas.

In recent years, a number of important and essential steps have been taken to develop the production of alternative fuels in Ukraine: on October 21, 2021, Law of Ukraine No. 1820-IX "On Amendments to Certain Laws of Ukraine Regarding the Development of Biomethane Production" was adopted, which established the legislative basis for development of the biomethane market in Ukraine and its export, thanks to the use of the biomethane registry. Resolution No. 823 of the Cabinet of Ministers of Ukraine dated July 22, 2022 No. 823 of the Cabinet of Ministers of Ukraine approved the Procedure defining the requirements for the functioning of the biomethane
The development of biomass technologies in Ukraine has significant potential and can become an important factor in achieving energy sustainability, reducing greenhouse gas emissions, and sustainable development of the country. Based on the analysis, the following conclusions can be drawn: Ukraine has a significant potential for the use of biomass due to large volumes of agricultural production and forest resources. The use of biomass reduces dependence on imported energy sources and contributes to the development of agriculture. Biomass utilization technologies include biogasification, biofuel production, biochemical processes, and others. They can be used to produce electricity, heat, biofuel and other products. The advantages of using biomass are to reduce greenhouse gas emissions, improve air quality and promote the development of the agricultural sector. However, there are limitations such as high infrastructure costs and competition with other energy sources. The prospects for the development of biomass technologies in Ukraine are quite impressive and have a real chance to be realized by...
attracting additional investment, but require comprehensive measures, such as creating a favorable legislative environment, supporting research and innovation, and attracting investment. It is important to remember that the development of biomass technologies should take place within the framework of a sustainable approach, taking into account environmental aspects and social benefits. In general, the development of biomass technologies in Ukraine is a promising direction that can contribute to the achievement of a number of economic, environmental and energy goals. It is necessary to pay attention to further research and development of this industry in order to improve energy security and sustainable development of Ukraine.

References

Сформульовано рекомендації для подальшого розвитку використання біомаси в Україні, враховуючи важливість вирішення екологічних проблем та енергетичної незалежності. Узагальнюючи, стаття не лише пропонує глибокий аналіз потенціалу та перспектив розвитку технологій біомаси, але й визначає шляхи для практичної реалізації цього потенціалу в умовах сучасного енергетичного та екологічного викликів.

Ключові слова: біомаса, відновлювальні джерела енергії, потенціал та перспективи розвитку, енергобезпека, сталий розвиток.

Список використаної літератури.