

Industries' Bioeconomic Transformation as the Mechanism of Sustainable Development

*Victoria Vostriakova*¹, *Olena Rubanenko*^{2*}, *Iryna Hunko*³, and *Sree Lakshmi Gundebommu*⁴

¹Department of administrative management, Vinnytsia National Agrarian University, Vinnitsya, Sonyachna 3, 21000, Ukraine

²Department of Electric Stations and System, Vinnytsia National Technical University, Khmelnytsky highway 95, 21021, Vinnytsya, Ukraine

³Department of Electric Stations and System, Vinnytsia National Technical University, Khmelnytsky highway 95, 21021, Vinnytsya, Ukraine

⁴EEE Department, CVR College of Engineering, Mangalpalli, Hyderabad, Ibrahimpatnam, Rangareddy, Telangana 501 510

Abstract. The bioeconomic strategy of Ukraine has not been yet formed, the development of biotechnology is slow, the use of biotechnology is still very fragmentary. The main economic biotechnology sectors of Ukraine are agriculture, pharmaceuticals, food industry and bioenergy. A circular, sustainable bio-economy can become the primary tool for Ukraine's integration into the EU Green Economy, making its economy more sustainable and competitive. The article aims to develop scientific and methodical aspects of the bioeconomic transformation of the national economy of Ukraine. The paper conducts a comprehensive assessment of the bioeconomic potential of the agri-food sector of the Ukrainian economy and identifies the main development priorities. The dynamics of alternative energy consumption and production from alternative energy sources have been provided. **Keywords:** bioeconomic strategy, the agri-food sector, sustainable bio-economy, biotechnology.

1 Introduction

The bioeconomic transformation involves the main sectors of the national economy of Ukraine to more innovative, resource-efficient, and competitive technology, primarily due to a number of global problems inherent in the current state of Ukraine's economy: environmental degradation of natural resources, global food crisis, inefficient use of resources and energy, waste generation, social inequality, and economic backwardness. All these factors create uncertainty about the future sustainable development of the country.

* Corresponding author: olenarubanenko@ukr.net

World scientific and technological progress and the inconsistency of the economic model of Ukraine's management with the main development trends of the European space form a number of unresolved issues related to ensuring the sustainable development of the country. Transformation of the national economy in accordance with the principles and goals of sustainable development can be ensured by intensifying the objective process of bioeconomy development. The need and objectivity of the process of bioeconomic transformation are presented in this paper.

2 Bioeconomy potential of Ukraine

Agri-food sector development around the world is accompanied by a large number of by-products and waste. Such waste streams are only partially involved in value-adding at various levels (biofuel, fertilizers and animal feed production, composting), while the main volumes generate waste and become a source of environmental danger, which affects sustainable development negatively [1]. This problem is especially actual for Ukraine as a granary of Europe. Ukraine's agriculture plays a central role in the national economy, as it generates more than 20% of GDP [2] and provides more than 40% of export revenue [3]. Ukraine has significant natural and economic potential for further growth and may become a key player in global food security in the coming decades. So, it is necessary to protect the country from environmental challenges arising from climate change. Climate change is a global problem that all countries must address, but it is also a national and economic priority in the case of Ukraine. According to Central Observatory of Ukraine data, 2020 was the hottest for all history [4]. According to the Ministry of Environmental Protection and Natural Resources of Ukraine [5], the country lost 570 thousand hectares of winter crops due to prolonged droughts and extremely severe spring frosts. Subsequent droughts in the spring and summer seasons have led to additional losses, including 200,000 hectares of corn and declining yields across the country.

This situation poses a threat to Ukraine as one of the world's leading exporters of agricultural products. In the 2019-2020 marketing year, Ukraine shipped 57 million to international markets tons of grain, which is about 16% of world exports. However, the previous period's 2020-2021 marketing year exports decreased sharply (by 16%) due to reduced yields caused by abnormal drought [6].

Over the past few years, Ukraine has been ranked among the top five agricultural exporters to the EU. In 2019, the country ranked second among suppliers of organic products to EU consumers. Experts estimate that Ukraine has the potential to achieve a tenfold increase in organic food production in the coming years, with lower yields offset by higher market prices. The fast-growing segment of organic products is just one of many areas where Ukraine can expand its presence in EU agricultural markets. This makes compliance with the European Union's environmental and food standards a long-term need for the country's entire agricultural sector. The European Green Agreement and the EU's "From Farm to Fork" strategy provides Ukraine with additional motivation for a gradual transition to the principles of sustainable development in the agricultural sector.

In 2012, the European Union adopted the strategy of "Innovation for Sustainable Development is Bioeconomy for Europe". Thus, the European Union tried to protect itself from a number of threats faced by Europe and the world at that time [7]. In 2017, this strategy was updated, and a new document called "Review of the European Bioeconomy Strategy 2012" was developed based on the current state of the economy. The primary purpose of this document is to transform countries' economies into more innovative, resource-efficient and competitive, which should ensure the country's food security with the conservation and efficient use of renewable resources, including the preservation of the natural environment [8].

The EU's bioeconomy strategy for 2018 aims to develop a circular, sustainable bioeconomy for Europe, strengthening the link between the economy, society and the environment. It addresses global challenges such as the achievement of the United Nations Sustainable Development Goals (SDGs) and the climate goals of the Paris Agreement. Today, the bioeconomy is the only system that provides the population with food, animals which food base and provides many ecosystem processes, so it is indispensable. As an agrarian country, Ukraine is sufficiently provided with safe and affordable biomass, which, both in the medium and long term, provides an opportunity to meet the needs of the bioeconomic transformation of the national economy. According to some studies, the potential of biomass in Ukraine is so significant that it can provide all sectors of the national economy, and probably outside it, as well as return organic carbon back to the soil.

Ukraine has signed the Paris Agreement, so increasing the share of renewable energy sources is crucial for Ukraine, and the potential and economic benefits of alternative energy development are significant. Bioenergy in Ukraine accounts for the largest share of the total primary energy supply (PES) from renewable energy sources (RES), with approximately 1.9 million tons of energy (59.3%). However, according to official statistics in Ukraine in the field of bioenergy is accounted for only 1.6% of General Electricity Supply (GES); in practice, the renewable energy sector accounted for only 2.8% of Ukrainian GES in 2013 [9]. At the same time, the sale of 20-30% of the 120 million tons of biomass raw materials (including crop, waste, livestock, wood and food industry residues) produced in Ukraine, electricity and heat generators on biomass would allow not only to obtain additional income for farmers but also the ability to guarantee the supply of biomass to numerous operators. Moreover, UABIO research has confirmed that the cultivation of 1.5% -3% of unproductive land (approximately 118 thousand hectares) creates opportunities for alternative energy production in the amount of 0.57 million tons of fuel equivalent in 5 years [10].

In addition, in 2018, the Government of Ukraine adopted the Strategy of Low Carbon Development of Ukraine until 2050. This document provides the emission reduction and the greenhouse gases absorption increase, the introduction of environmentally friendly production using "green" technologies in all sectors of the economy. Following international obligations, particularly the Paris Agreement of 2015, all member states must develop their own national strategies for low-carbon development until 2050. Ukraine was one of the first countries to develop a relevant strategic climate document and submit it to the Secretariat of the UN Framework Convention on Climate Change. The strategy identifies a possible vector of economic growth, taking into account public policy objectives to reduce greenhouse gas emissions. At the national level, the Strategy is a tool for public governance and establishing climate-responsible behaviour of business and citizens [11]. However, for effective practical implementation of this strategy, it is necessary to coordinate it with the Sustainable Development Goals of Ukraine [12] and adopt a bioeconomic development strategy to other regulatory documents of the country (Fig. 1).

The EU bioeconomic strategy [13, 14] encourages member states to develop their national bioeconomy strategies and other policies to foster links between the raw materials sectors, the bio-industries and the scientific community to achieve the strategic goals of the EU and member states [15]. Most Central and Eastern European (CEE) countries lag in developing specific national bioeconomy strategies and/or action plans that directly impact economic, environmental, and social issues [16]. One of the specific indicators is the uneven distribution of industrial and bio-processing enterprises [17], with high value-adding along the entire sustainable value chain. Developing a national bioeconomic strategy can be an excellent alternative for Ukraine, which is now dependent on fossil fuels, increasing access to sustainable and affordable renewable energy, building a "green" industrial base, preserving and ensuring the transformation of the economy in line with sustainable development goals.

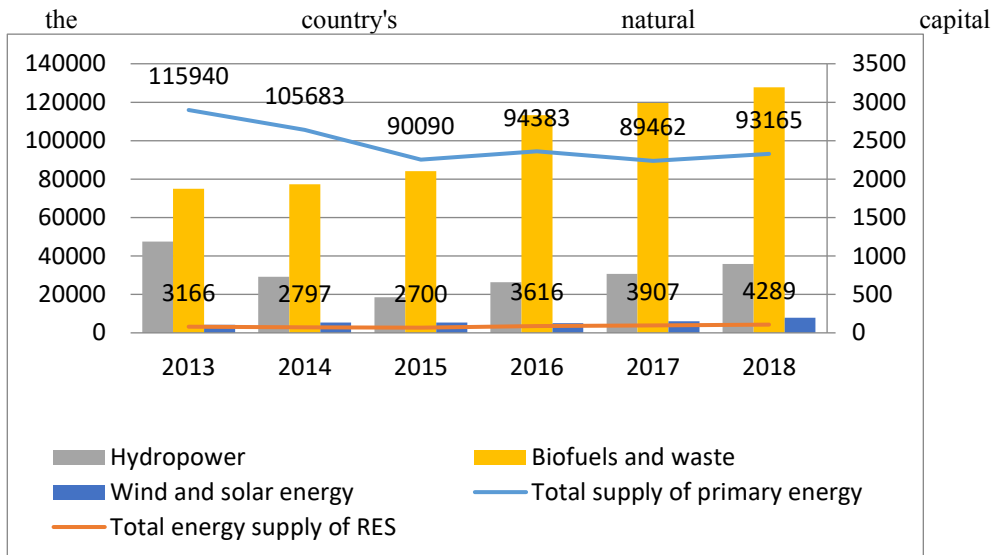


Fig. 1. Produced from alternative energy sources, thousand tons fuel equivalent.

In this regard, it is important to develop and implement a system for assessing and monitoring indicators of the impact of bioeconomic activities on achieving the Sustainable Development Goals and economic growth, improving and systematizing the regulatory framework for bioeconomy in Ukraine in accordance with Sustainable Development Goals, intersectoral balance modeling, substantiation of strategic vision and modeling of bioeconomic transformation of branches of national economy.

3 Use of biogas plants

According to NEC Ukrenergo, the power system of Ukraine already requires the use of approximately 2 GW of high-shunting capacity, which can provide at least four starts per day and have a significant range of regulation (80% of the installed capacity). The development of biogas technologies allows the efficient use of gas turbines (pickers) and medium-speed internal combustion engines (balancers) as high-shunting power. The use of biogas technologies as balancers makes it possible to reduce the forecasting error for RESs with an uneven generation schedule [18-20].

The use of biotechnology is divided into two main categories: "traditional" and "modern". "Traditional" is the use of biomass in such forms as wood, animal waste, etc. Modern bioenergy technologies include the production of liquid biofuels, the raw materials for the manufacture of which are plants; production of biogas obtained as a result of the anaerobic conversion of animal residues; heating systems on wood pellets, and others. About three-quarters of the world's renewable energy use is related to bioenergy, with more than half of it consisting of traditional biomass use. In 2015, bioenergy accounted for about 10% of total final energy consumption and 1.9% of world electricity production. Biomass already has significant potential to increase energy supply in densely populated countries such as Brazil, India, and China, and biogas can be used efficiently to increase the energy efficiency of RES with an irregular generation schedule in the power system electricity balance [21-22]. Biogas technologies can solve the most critical challenges of our time: the fight against the growing amount of organic waste generated by modern society and the economy and the need to reduce CO₂. By converting organic waste into a renewable energy resource, biogas production is one of the ways to accumulate electricity that meets the requirements of

resource reuse and waste disposal and meets the growing demand for energy balancing services and environmental requirements. According to IRENA, the installed capacity of power plants that generate electricity from liquid biofuels, municipal waste, biogas, and solid biofuels grows every year (Fig. 2) [19].

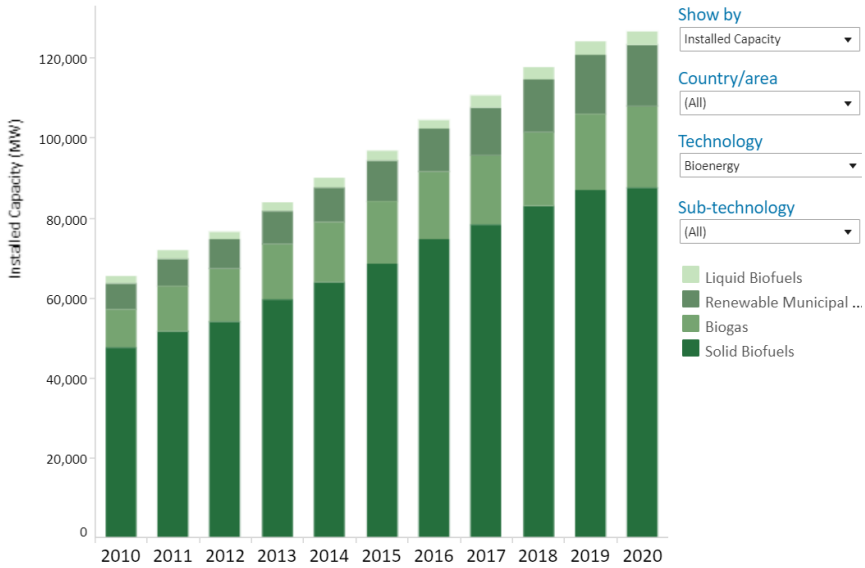


Fig. 2. Changing the installed capacity of power plants that generate electricity from liquid biofuels, municipal waste, biogas, and solid biofuels worldwide.

According to IEA forecasts, bioenergy will provide only 5% of the total amount of electricity produced in 2050, but it is already one of the sources of manoeuvrability with low CO₂ emissions.

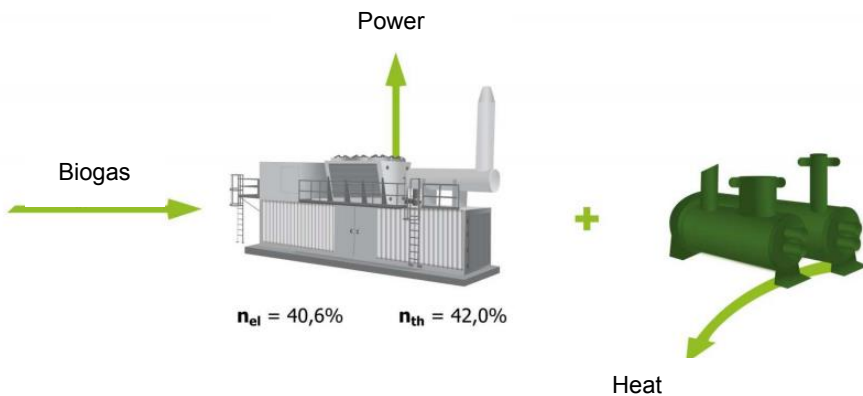


Fig. 3. Generation of electricity and heat.

Biogas is used to generate electricity, consisting of 50-75% methane, 25-45% carbon dioxide, 2-8% water vapour and impurities (O₂, N₂, NH₃, H₂, H₂S). For comparison, natural gas contains 80 to 90% of methane. The average calorific value of biogas is about 21-23.5 MJ / m³, so that one m³ of biogas corresponds to 0.5-0.6 litres of diesel fuel or about 6 kWh. The yield of biogas from plant raw materials depends not only on the type of raw material

but also on the plant's design, fermentation temperature and retention time; for example, corn silage gives about eight times more biogas per ton than cow manure [19].

4 Conclusion

The EU Bioeconomic Strategy [1, 7] encourages member states to develop their national bioeconomy strategies and other policies to foster links between the raw materials sectors, the biological industries and the scientific community to achieve the strategic goals of the EU and member states [3]. Most Central and Eastern European (CEE) countries lag in developing specific national bioeconomy strategies and/or action plans that directly impact countries' economic, environmental, and social well-being [8]. One of the specific indicators is the uneven distribution of industrial processing and bio-processing enterprises [9], which create high added value along the entire stable value chain.

Developing a national bioeconomic strategy can be an excellent alternative for Ukraine, which is now dependent on fossil fuels, increasing access to sustainable and affordable renewable energy, building a "green" industrial base, preserving the country's natural capital and transforming the economy in line with sustainable development goals.

In this regard, it is essential to develop and implement a system for evaluating and monitoring indicators of the impact of bioeconomic activities on achieving the Sustainable Development Goals and economic growth, improving and systematizing the regulatory framework for bioeconomy in Ukraine following Sustainable Development Goals, intersectoral balance modelling, substantiation of strategic vision and modelling of bioeconomic transformation of branches of the national economy.

References

- 1 V. Vostryakova, *Bioeconomic Potential of Agrologistics Losses in Sustainable Value Chains*. Economy. Finances. Management: current issues of science and practice, **4**, (2018).
- 2 State Statistics Service. URL: <http://www.ukrstat.gov.ua/>
- 3 National Institute for Strategic Studies. Results of Ukraine's foreign trade for the first half of 2020 URL: <https://niss.gov.ua/doslidzhennya/ekonomika/pidsumki-zovnishnoi-torgivli-ukraini-za-pershe-pivrichchya-2020-r>
- 4 Central Observatory of Ukraine. URL: <http://cgo-sreznevskiy.kyiv.ua/>
- 5 Ministry of Environmental Protection and Natural Resources of Ukraine. URL: <https://mepr.gov.ua/>
- 6 Ministry of Agrarian Policy and Food of Ukraine. Exports of cereals, legumes and flour from Ukraine. URL: <https://minagro.gov.ua/en/investoram/monitoring-stanu-apk/eksport-z-ukrayini-zernovih-zernobobovih-ta-boroshna>
- 7 European Commission. Strengthening the link between the economy, society and the environment; European Commission (EC): Brussels, Belgium (2018).
- 8 European Commission. Review of the European Bioeconomy Strategy 2012; European Commission (EC): Brussels, Belgium (2017).
- 9 MEA. Energy balances of non-OECD countries, OECD / IEA, Paris (2015).
- 10 Bioenergy Association of Ukraine (UABIO). Prospects for the development of bioenergy as a tool for replacing natural gas in Ukraine, UABIO, Kyiv (2015).

- 11 European integration portal. Ukraine is in the top ten in the implementation of the Paris Agreement on Climate Change. URL: <https://eu-ua.kmu.gov.ua/novyny/ukrayina-v-desyatci-lideriv-z-realizaciyi-paryzkoyi-ugody-shchodo-zminy-klimatu-minpryrody>
- 12 On the Goals of Sustainable Development of Ukraine for the period up to 2030: Decree of the President of Ukraine of September 30, 2019 № 722.
URL: <https://zakon.rada.gov.ua/laws/show/722/2019#Text>
- 13 COM. Innovation for Sustainable Growth: A Bioeconomy for Europe, EC (2012).
- 14 COM. Sustainable bioeconomy for Europe - Strengthening the link between the economy, society and the environment. Updated bioeconomy strategy (2018).
- 15 Panel of countries with bioeconomics from the Center for Knowledge of Bioeconomics of the European Commission.
URL: https://knowledge4policy.ec.europa.eu/visualisation/bioeconomy-different-countries_en
- 16 Biological industry and bioprocessing plants in the EU.
URL: https://knowledge4policy.ec.europa.eu/visualisation/bio-based-industrybiorefineries-eu_en
- 17 Chemical and material bioprocessing in the EU.
URL: https://knowledge4policy.ec.europa.eu/visualisation/chemical-materialbiorefineries-eu_en
- 18 V. Vostriakova, The Renewable Energy Sources Contribution to Sustainable Economic Growth, in *2021 IEEE 2nd KhPI Week on Advanced Technology (KhPIWeek)*, 2021, 381-386, doi: 10.1109/KhPIWeek53812.2021.9569993
- 19 The International Renewable Energy Agency (IRENA). <https://www.irena.org/>
- 20 G. S. Lakshmi, O. Rubanenko, and I. Hunko, *Control of the Sectioned Electrical Network Modes with Renewable Energy Sources*, in Proceedings of the International Conference on Sustainable Energy and Future Electric Transportation, SeFet (2021).
- 21 G. S. Lakshmi, O. Rubanenko, G. Divya, and V. Lavanya, *Distribution Energy Generation using Renewable Energy Sources*, in Proceedings IEEE India Council International Subsections Conference, INDISCON, 2020, 108-113, India (2020).