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M. Yareмова,

*Doctor of Economic Sciences, Associate Professor, Associate Professor of the
Department of Economics, Entrepreneurship and Tourism,
Polissia National University*

ORCID ID: <https://orcid.org/0000-0001-5636-3538>

O. Kilnitska,

*PhD in Economics, Associate Professor, Associate Professor of the Department of
Economics, Entrepreneurship and Tourism,
Polissia National University*

ORCID ID: <https://orcid.org/0000-0001-9719-120X>

O. Buluy,

*PhD in Economics, Associate Professor, Associate Professor of the Department of
Economics, Entrepreneurship and Tourism,
Polissia National University*

ORCID ID: <https://orcid.org/0000-0003-3368-4835>

**FINANCIAL INSTRUMENTS IN SUSTAINABLE DEVELOPMENT
MANAGEMENT: ENVIRONMENTAL TAXATION AND THE
EMISSIONS TRADING SYSTEM (ETS) FOR THE CIRCULAR
BIOECONOMY**

М. І. Яремова,

*д. е. н., доцент, доцент кафедри економіки, підприємництва та туризму,
Поліський національний університет*

О. С. Кільницька,

*к. е. н., доцент, доцент кафедри економіки, підприємництва та туризму,
Поліський національний університет*

О. Г. Булуй,

*к. е. н., доцент, доцент кафедри економіки, підприємництва та туризму,
Поліський національний університет*

**ФІНАНСОВІ ІНСТРУМЕНТИ В УПРАВЛІННІ СТАЛИМ
РОЗВИТКОМ: ЕКОЛОГІЧНЕ ОПОДАТКУВАННЯ ТА СИСТЕМА
ТОРГІВЛІ ВИКИДАМИ (ETS) ДЛЯ ЦИРКУЛЯРНОЇ БІОЕКОНОМІКИ**

The article examines the role of financial instruments in sustainable development management and substantiates the importance of environmental taxation and the Emissions Trading System (ETS) in stimulating the transition to a circular bioeconomy. It is established that under the conditions of increasing global environmental challenges, the use of financial and economic mechanisms capable of transforming environmental objectives into practical instruments for promoting resource-efficient activities becomes particularly important. Environmental taxation and ETS are identified as key economic incentives for the implementation of clean technologies and the scaling up of circular production and consumption practices.

The current state of environmental taxation in Ukraine is analyzed, particularly the dynamics of tax rates on CO₂ and NO_x emissions, radioactive waste generation, and waste disposal during 2017–2023. It is determined that despite the gradual increase in environmental tax rates, their level remains significantly lower compared to European countries, which reduces the stimulating effect of tax instruments and limits the possibilities for environmental

modernization of the national economy. The necessity of reforming the environmental taxation system through expanding the tax base, strengthening control over compliance with environmental legislation, improving the emissions monitoring system, and ensuring the targeted use of environmental revenues is substantiated.

Special attention is paid to the prospects for implementing the ETS in Ukraine as an instrument of market-based climate policy regulation and support for the circular bioeconomy. The international experience of ETS functioning, particularly the practices of the European Union, China, the United States, Canada, and South Korea, is investigated. The advantages of ETS are identified, including economic efficiency, regulatory adaptability, incentives for environmental innovation, and integration into the international climate framework. The current regulatory framework for ETS development in Ukraine, as well as the directions for its harmonization with European climate mechanisms, including CBAM and the system of monitoring, reporting, and verification of greenhouse gas emissions, are analyzed.

The article proposes directions for improving financial instruments for sustainable development management, including the introduction of targeted financing mechanisms for environmental measures, support for the bioeconomy projects, and the integration of the ETS into the system for stimulating the circular transformation of Ukraine's economy.

У статті досліджено роль фінансових інструментів у системі управління сталим розвитком та обґрунтовано значення екологічного оподаткування і системи торгівлі викидами парникових газів (ETS) для стимулювання переходу до циркулярної біоекономіки. Встановлено, що в умовах посилення глобальних екологічних викликів особливого значення набуває використання фінансово-економічних механізмів, здатних забезпечити трансформацію екологічних цілей у практичні інструменти стимулювання ресурсоефективної діяльності. Визначено, що екологічне

оподаткування та ETS формують економічні стимули для впровадження чистих технологій та масштабування практик циркулярного виробництва та споживання.

Проаналізовано сучасний стан екологічного оподаткування в Україні, зокрема динаміку ставок податку на викиди CO₂, NO_x, утворення радіоактивних відходів та розміщення відходів упродовж 2017–2023 рр. Встановлено, що попри поступове підвищення ставок екологічного податку, їх рівень залишається суттєво нижчим порівняно з європейськими країнами, що знижує стимулюючий ефект податкових інструментів та обмежує можливості екологічної модернізації національної економіки. Обґрунтовано необхідність реформування системи екологічного оподаткування шляхом розширення бази оподаткування, посилення контролю за дотриманням екологічного законодавства, удосконалення системи моніторингу викидів та забезпечення цільового використання екологічних надходжень.

Окрему увагу приділено перспективам впровадження системи торгівлі викидами (ETS) в Україні як інструменту ринкового регулювання кліматичної політики та стимулювання циркулярної біоекономіки. Досліджено міжнародний досвід функціонування ETS, зокрема практики Європейського Союзу, Китаю, США, Канади та Південної Кореї. Визначено переваги ETS, серед яких економічна ефективність, регуляторна адаптивність, формування стимулів до екологічних інновацій та інтеграція до міжнародного кліматичного простору. Проаналізовано сучасний стан формування нормативно-правової бази ETS в Україні, а також напрями її гармонізації з європейськими кліматичними механізмами, зокрема СВМ та системою моніторингу, звітності й верифікації викидів парникових газів.

Запропоновано напрями вдосконалення фінансових інструментів управління сталим розвитком, зокрема запровадження механізмів цільового фінансування природоохоронних заходів, підтримки біоекономічних проєктів та інтеграції ETS у систему стимулювання циркулярної трансформації економіки України.

Keywords: *sustainable development, financial instruments, environmental taxation, Emissions Trading System (ETS), circular bioeconomy.*

Ключові слова: *сталий розвиток, фінансові інструменти, екологічне оподаткування, система торгівлі викидами (ETS), циркулярна біоекономіка.*

A general formulation of the problem and its connection to important scientific or practical issues. Against the backdrop of intensifying global environmental challenges and the implementation of the strategic guidelines of the European Green Deal, the development of effective financial instruments for managing sustainable development has become particularly relevant. The transition to a circular bioeconomy requires the implementation of economic mechanisms capable of stimulating the adoption of resource-efficient technologies and promoting the ecological modernization of the national economy. At the same time, the environmental taxation system in Ukraine is characterized by insufficient efficiency in the use of environmental revenues and imperfect mechanisms for monitoring emissions. Under these conditions, it is particularly important to explore the possibilities of integrating environmental taxation and the emissions trading system (ETS) into the framework for stimulating the development of a circular bioeconomy and harmonizing Ukraine's climate policy with European standards.

Analysis of recent studies and publications. The issues of the ecological transformation of the economy and the use of financial instruments to achieve sustainable development are actively researched by both foreign and domestic scholars. The theoretical foundations of sustainable development and the greening of the economy are explored in the works of H. Daly [6], M. Porter [12], N. Stern [14], and others. A. D. Ellerman, F. Convery [8], G. Metcalf [11], and S. Smith [13] have made significant contributions to the study of mechanisms for environmental taxation, decarbonization, and emissions trading systems. Issues related to the development of the circular bioeconomy, resource efficiency, and the “green” transformation of the economy are explored in the works of M. D’Amato

[7] and J. Korhonen [10]. Among domestic researchers, the issues of environmental regulation, climate policy, and financial mechanisms for sustainable development are examined by V. Butenko [1], O. Vdovichenko [2], V. Krutyakova [3], S. Fedina [4], and others.

At the same time, the issues of integrating environmental taxation and the emissions trading system (ETS) into the system of financial incentives for the development of the circular bioeconomy, as well as the justification for adapting them to the current challenges of sustainable development and European climate policy, remain insufficiently researched. Mechanisms for harmonizing the financial and economic instruments of environmental regulation with the processes of the circular transformation of Ukraine's economy require further research, which determined the choice of the research topic.

Statement of the article's objectives (problem statement). The purpose of this article is to examine the role of environmental taxation and the greenhouse gas emissions trading system (ETS) as financial instruments for managing sustainable development and promoting the transition to a circular bioeconomy, as well as to identify areas for improving environmental regulation mechanisms in Ukraine in line with environmental priorities.

Presentation of the main research findings. Financial and economic mechanisms are key tools for the practical implementation of the circular bioeconomy, as they significantly influence the ability to translate policy decisions and institutional prerequisites into actual investment resources. An effective system of financial incentives provides economic entities with access to funding sources, offsets high costs, and creates conditions for scaling up bio-innovative practices. An important feature of financial and economic methods is their dual impact: direct, through tax relief and preferential loans; and indirect, through the generation of market signals and the encouragement of behavioral changes among consumers. The use of tools such as "green" tariffs, a CO₂ emissions tax, carbon credit markets, or "green cashback" creates a new motivational framework within which economic viability is combined with environmental responsibility, which, in

turn, ensures the transformation of traditional production and consumption models into innovative practices based on the principles of circularity.

In this context, fiscal policy instruments are a priority, among which the environmental tax is of particular importance as a nationwide mandatory payment and one of the key means of regulating the impact of economic activity on the environment. In accordance with the provisions of the Tax Code of Ukraine, the environmental tax includes: 1) levies on emissions of pollutants into the atmosphere from stationary and mobile sources (in particular, CO₂); 2) payments for discharges of pollutants into water bodies (in particular, for NO_x); 3) fees for the generation of radioactive waste and its disposal by business entities engaged in its storage, recycling, or disposal. Environmental tax rates in Ukraine are determined annually and adjusted to account for the inflation index (Table 1).

Table 1. Environmental tax rates in Ukraine for 2017–2023

Year	CO ₂ tax, UAH per ton	NO _x tax, UAH per ton	Radioactive waste, UAH per m ³	Non-recycled waste, UAH per ton
2017	0,37	1456	396	4,80
2018	0,41	1456	426	5,20
2019	10,0	1623	426	5,20
2020	10,0	1623	426	5,2
2021	30,0	1623	426	5,2
2022	30,0	1900	450	6,5
2023	52,0	2200	470	7,0

Source: adapted from [5].

Accordingly, the tax rate on NO_x emissions is gradually increasing, but remains low compared to levels in European countries. The rate of increase in tax rates on non-recyclable waste classified as radioactive is significantly slower, due to existing socioeconomic constraints. The CO₂ tax rate for businesses emitting more than 500 tons per year was raised to 10 UAH/ton in 2019, to 30 UAH/ton in 2021, and to 52 UAH/ton in 2023. The gradual increase in environmental tax rates in Ukraine indicates the government's growing focus on enterprises that generate significant environmental risks, as well as its efforts to encourage them to

minimize waste volumes and reduce emissions of pollutants into the atmosphere and water bodies.

Despite the gradual increase in rates, their effectiveness remains low, which calls for a systematic review of approaches to environmental taxation. Rates in Ukraine remain quite low compared to international standards and global sustainable development requirements. It is worth noting that the average global tax rate on CO₂ emissions varies depending on countries' economic development, the nature of their environmental policies, and regional characteristics; however, Ukraine has one of the lowest environmental tax rates among European countries, underscoring the need to reform it to improve effectiveness and align it with European practices (Table 2).

Table 2. International CO₂ pricing practices (per ton in U.S. dollars)

Year	Average rate	Regional characteristics
2010	5–10	Initial implementation phase in many countries (EU, Japan)
2015	10-15	Policy intensification following the 2015 Paris Climate Agreement
2020	20-25	Increased rates in the EU, Sweden, Canada, and South Korea
2023	30-40	Sweden (\$137), Switzerland (\$100), EU (approximately \$88 in the ETS)

Source: compiled by the authors based on data from [9; 15].

The environmental tax was introduced as a fiscal policy tool in 2010. Sweden, Norway, and Switzerland emerged as the main pioneers, and following the signing of the Paris Climate Agreement (2015), Canada, South Korea, European Union member states, and other countries stepped up their efforts. In 2023, the highest greenhouse gas emission tax rates were recorded in Sweden \$137 and Switzerland \$100 per ton. At the same time, in Ukraine, the rate of 52 UAH (about \$1.40) remains one of the lowest in Europe, which necessitates reforming national environmental policy. Among the main areas for improvement, the following are proposed: 1) increasing tax rates as an incentive to implement environmental innovations, integrating them with subsidies for biotechnology, grants, and emissions trading systems; 2) creating mechanisms for the targeted use

of revenues; 3) improving the monitoring and reporting system for economic entities, which is currently hampered by the inadequacy of tracking actual emission volumes and monitoring compliance with environmental legislation.

The environmental tax system in Ukraine requires ongoing analysis and modernization, including a review of tax rates, expansion of the tax base (for example, to cover new types of pollution, such as soil, groundwater, microplastic pollution), as well as strengthening oversight of compliance with environmental standards and transparency in the use of funds, especially at the regional level. Given that waste disposal in Ukraine is subject to taxation, certain specific forms of pollution—such as the excessive use of hazardous pesticides and agrochemicals, and their improper storage, which leads to soil degradation and water pollution—remain outside the scope of fiscal regulation. Under these conditions, it is advisable to introduce an environmental tax on the use of hazardous agrochemicals, as well as a “pollution at the source” tax, that is, on manufacturers and importers of substances with potentially hazardous effects on the environment throughout their life cycle. This would shift the focus of environmental policy from reactive mitigation of consequences to preventive pollution control, in accordance with the principles of sustainable development, the circular bioeconomy, and the “polluter pays” principle.

The issue of microplastic pollution—that is, the spread of plastic particles smaller than 5 mm that can enter food chains, aquatic environments, and the atmosphere, posing negative environmental and potentially toxicological risks—is of particular concern. While Ukraine’s national legislation focuses primarily on regulating macroplastic waste (particularly packaging materials), the issue of microplastics remains unregulated. The current regulatory framework does not cover products that generate microplastics through wear and tear (such as car tires and synthetic textiles) or contain them as an additional component (for example, microbeads in cosmetics). In this context, it is advisable to introduce an extended producer responsibility (EPR) mechanism for microplastic pollution, which would entail financial and organizational responsibility for the entire product lifecycle, as

well as the introduction of a targeted environmental tax on the production and import of products that are the primary source of microplastic particles (synthetic textiles, cosmetics and hygiene products containing microbeads, automobile tires, etc.). The implementation of these measures will help reduce anthropogenic pressure and bring Ukraine closer to EU standards in the field of environmental safety.

Another problem is the inefficient use of funds collected from environmental taxes. Instead of directing financial resources toward specific environmental protection measures, these funds are often pooled into the general budget and used for other, non-environmental needs, which diminishes the tax's incentive function and undermines its role as a tool for implementing the "polluter pays" principle. Ensuring the targeted and transparent use of environmental revenues is a key factor in achieving the Sustainable Development Goals and transitioning to an environmentally oriented bioeconomy model. To this end, it is necessary to: 1) introduce a clear mechanism for tracking the flow of environmental payments through digital monitoring and public reporting systems; 2) legislate a minimum share of resources to be directed exclusively toward environmental protection and climate action; 3) expand the participation of the public and independent experts in determining environmental budget priorities at the regional level.

Thus, the environmental tax remains a powerful financial tool for promoting sustainable development in Ukraine; however, to realize its full potential, it is necessary to improve the targeting of these funds, ensuring that they are concentrated on financing environmental projects (in particular through public-private partnerships and the creation of a specialized investment fund for bioeconomy projects), as well as expanding the system of subsidies, grants, and financial incentives, which will help boost budget revenues, stimulate innovation in resource efficiency, and bring Ukraine closer to fulfilling its international commitments under the UN Sustainable Development Goals.

In the context of these measures, the greenhouse gas emissions trading system (ETS) takes on particular importance, as it generates price signals for

businesses, creating favorable conditions for investment in circular solutions. The introduction of the ETS integrates Ukraine into the global climate framework, ensuring synergy between domestic incentives and international commitments, and promotes the development of new economic models focused on resource efficiency and low-carbon practices.

In the context of developing a circular bioeconomy, the ETS serves as an effective tool for providing financial incentives to businesses to reduce emissions and adopt clean technologies as part of the transition from fossil fuels to bio-based resources. Known as the “carbon market” or “cap-and-trade system,” the ETS combines regulatory and market principles, as the government sets a cap on allowable emissions, while allowances are allocated or traded by businesses. Excess allowances can be traded on specialized markets, while exceeding the limits results in financial penalties. This mechanism ensures the achievement of climate goals at minimal aggregate cost to the economy, while providing businesses with flexibility in choosing optimal strategies for environmental modernization.

The advantages of the ETS system in the context of promoting the development of a circular bioeconomy lie primarily in its ability to reduce greenhouse gas emissions, creating attractive financial conditions for investment in biotechnology, bioenergy, and other areas of bio-oriented activity based on the principles of resource efficiency and low-carbon practices (economic efficiency). In addition, the ETS provides flexibility for market participants; in particular, businesses gain the ability to independently choose optimal strategies for achieving environmental goals by reducing their own emissions, implementing circular solutions, or participating in the secondary carbon credit market (regulatory adaptability). The innovative effect of the ETS holds particular value; specifically, the rising cost of carbon allowances provides a powerful incentive to modernize production processes in line with the requirements of transitioning to bio-based models, which aligns with the goals of greening the economy and strengthening its circular nature.

International experience confirms the effectiveness of the ETS system, which has been in operation since 2005 and covers approximately 40% of all EU emissions. China's national ETS, officially launched in 2021, is the world's largest in terms of the volume of emissions covered. In the U.S., the aforementioned system operates at the state level in the form of regional initiatives. The California Cap-and-Trade program and the Regional Greenhouse Gas Initiative (RGGI) have demonstrated the effectiveness of market-based mechanisms in reducing emissions, particularly in the energy sector. In addition, ETS instruments are actively used in other countries, including South Korea, Canada, and New Zealand, which employ the emissions trading mechanism as a key component of national climate policy and a tool for achieving the goals of the Paris Agreement.

In Ukraine, the national ETS system is in the early stages of establishing its regulatory and institutional framework. In accordance with the Association Agreement with the EU and climate policy commitments, the system is expected to be launched in phases. In June 2024, the Ministry of Environmental Protection and Natural Resources of Ukraine presented a roadmap for ETS implementation through 2033, which includes the creation of an emissions registry, the development of quota allocation rules, alignment with the Carbon Border Adjustment Mechanism (CBAM), and the launch of a monitoring, reporting, and verification (MRV) system, as regulated by the Law of Ukraine "On the Principles of Monitoring, Reporting, and Verification of Greenhouse Gas Emissions" No. 377-IX of December 12, 2019. The law entered into force in 2020 and took effect on January 1, 2021, establishing the legal and organizational framework for the creation and operation of the MRV system. In accordance with the provisions of the law, operators of facilities engaged in certain activities are required to register their facilities, submit annual reports on emission volumes, and undergo an external verification procedure.

Given the strategic importance of the ETS as a market-based instrument, its gradual implementation in Ukraine should be viewed not only as an element of climate policy but also as a mechanism for economic transformation toward a

circular bioeconomy. In this context, it is deemed necessary to define the directions for integrating the ETS to stimulate the development of the circular bioeconomy; specifically, it is advisable to: 1) include bioeconomic sectors as priority areas for the pilot implementation of the ETS; 2) provide mechanisms for preferences or preferential access to allowances for enterprises using circular and biotechnologies; 3) ensure transparent administration of the ETS and scientifically sound calculation methods; 4) direct ETS revenues toward financing innovative bioeconomic projects. Given the need to implement these measures, the creation of a national emissions trading system in Ukraine should be considered a strategic tool for stimulating the circular transition, developing “green” markets, and enhancing the competitiveness of the Ukrainian economy within the European climate framework.

Conclusions and prospects for further research in this area. The study found that environmental taxation and the emissions trading system (ETS) are important financial instruments for managing sustainable development and promoting the transition to a circular bioeconomy. It was determined that the current environmental taxation system in Ukraine requires further reform by increasing the effectiveness of tax rates, broadening the tax base, improving the emissions monitoring system, and ensuring the targeted use of environmental revenues. It is argued that the introduction of an ETS will help create economic incentives for the development of bioeconomic projects and Ukraine’s integration into the European climate space. Implementing the proposed improvements to environmental taxation and the phased introduction of an ETS will help harmonize Ukraine’s climate policy with European regulatory mechanisms, create the conditions for low-carbon development, and accelerate the circular transformation of the national economy. Prospects for further research focus on developing mechanisms for integrating the ETS into the system of incentives for the circular bioeconomy and evaluating the effectiveness of financial instruments for environmental regulation.

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