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UKRAINE'S ENERGY TRANSITION AND INTERNATIONAL COOPERATION INSTRUMENTS

The article examines the features of Ukraine's energy transition in connection with transformational changes in the energy paradigm of world economic development, scenarios for the development of Ukraine's energy sector in the context of the transition to renewable energy sources by 2050 – conservative, liberal, revolutionary. It is emphasized that the important aspects in this direction are the instruments of international cooperation, which combine the resources of countries to finance "green" projects, accelerate the exchange of clean technologies, harmonize climate norms and mitigate geopolitical risks. The main instruments of international cooperation of Ukraine in the context of energy transition are investigated.

Keywords: energy, energy sector, energy market, energy policy, energy security, energy transition, renewable energy sources, energy efficiency, European Union, integration, energy strategy, climate neutrality, international cooperation, "green" investments.

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ЕНЕРГЕТИЧНИЙ ПЕРЕХІД УКРАЇНИ ТА ІНСТРУМЕНТИ МІЖНАРОДНОГО СПІВРОБІТНИЦТВА

У статті досліджено особливості енергетичного переходу України в контексті трансформації глобальної енергетичної парадигми, зумовленої посиленням кліматичних викликів, технологічними інноваціями, необхідністю декарбонізації економіки та зміною підходів до забезпечення енергетичної безпеки. Охарактеризовано сучасні тенденції розвитку світового енергетичного ринку та визначено чинники, що впливають на формування національної енергетичної політики, зокрема структурні диспропорції енергетичного сектору, наслідки воєнних руйнувань, потребу в модернізації інфраструктури й підвищенні енергоефективності. Розглянуто перспективи трансформації енергетичного сектору України на основі розширення використання відновлюваних джерел енергії до 2050 року. Проаналізовано три можливі сценарії його розвитку — консервативний, ліберальний та революційний, які відрізняються темпами впровадження чистих технологій, обсягами інвестицій, рівнем державної підтримки та масштабами структурних змін. Наголошено, що реалізація відповідних сценаріїв потребує узгодження економічних, екологічних і соціальних пріоритетів, посилення гнучкості енергосистеми, розвитку розподіленої генерації та створення сприятливих умов для залучення приватного капіталу. Особливу увагу приділено значенню міжнародного співробітництва як інструменту прискорення енергетичного переходу. Визначено його ключові напрями: мобілізація фінансових ресурсів для реалізації «зелених» проєктів, трансфер інноваційних технологій, розвиток транскордонної енергетичної інфраструктури, гармонізація нормативно-правового регулювання з вимогами Європейського Союзу та координація кліматичної політики. Підкреслено роль міжнародних партнерств у зниженні інвестиційних і геополітичних ризиків, зміцненні стійкості енергетичного сектору та інтеграції України до європейського енергетичного простору. Узагальнено можливості застосування інструментів міжнародного співробітництва для забезпечення сталого, безпечного та конкурентоспроможного розвитку національної енергетики.

Ключові слова: енергетика, енергетичний сектор, енергетичний ринок, енергетична політика, енергетична безпека, енергетичний перехід, відновлювані джерела енергії, енергоефективність, Європейський Союз, інтеграція, енергетична стратегія, кліматична нейтральність, міжнародне співробітництво, "зелені" інвестиції.

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STATEMENT OF THE PROBLEM IN GENERAL AND ITS RELATIONSHIP WITH IMPORTANT SCIENTIFIC OR PRACTICAL TASKS

The key decision that will affect the development of the world economy and energy was the adoption of the Paris Climate Agreement, since it aims to keep the increase in the average temperature on the planet below 2°C, compared to the pre-industrial level, and to make efforts to limit the temperature increasing to 1.5°C. For this, it is necessary for the energy sector to become carbon-neutral. That is, the so-called "energy transition" should take place on the principles of sustainable development from fossil energy resources to renewable ones, while stimulating a significant increase in energy efficiency and rational use of energy resources [1].

The Energy Strategy of Ukraine until 2050, which is based on the target indicators of the Ukrainian economy development, on the international obligations assumed by Ukraine, in particular the obligation to take into account the positions of the Association Agreement between Ukraine and the European Union (EU) and the Paris Climate

Agreement, provides that by 2050 the energy sector of our country should be as close as possible to climate neutrality. This means the availability of clean energy, the full functioning of national energy markets, the gradual integration of national energy markets into international ones, overcoming energy poverty, and the development of the decentralized energy system based on innovations [2].

ANALYSIS OF THE LATEST RESEARCH AND PUBLICATIONS

The publications of such foreign and domestic scientists as Boshell F., Bazilian M., Wagner N., Gilen D., Gorini R., Sabi O., Saygin D., Busarev D., Zaverbnyi A., Zelenko N., Palamarchuk D., Palamarchuk N., Slyusar O., etc. are devoted to the issues of energy sector development, energy policy formation, and energy security. The energy policy of the European Union is considered in the works of Kukuruz O., Batanova N., Orekhova T., Seleznyova O., etc. The problem of the alternative energy sources development in Ukraine, as well as in the EU countries, is the subject of research of the following scientists: Melnyk L., Polyansky O., Dyakonova O., Kubatok O., Skrypyuk A., Chygrin O. But problematic issues of Ukraine's energy transition, as well as instruments of international cooperation on the way to its provision, require additional scientific justification.

HIGHLIGHTING THE PREVIOUSLY UNSOLVED PARTS OF THE GENERAL PROBLEM TO WHICH THE ARTICLE IS DEDICATED

The instruments of international cooperation that combine the resources of the countries to finance "green" projects, accelerate the exchange of clean technologies, coordinate climate norms and mitigate geopolitical risks are very important aspects of the energy transition.

THE ARTICLE GOALS FORMULATION

The purpose of the publication is to consider the features of the energy transition of Ukraine in connection with the transformational changes in the energy paradigm of world economic development and explore the instruments of international cooperation on the way to its provision.

THE MAIN MATERIAL OUTLINE

According to the results of the study by the Heinrich Böll Foundation in Ukraine on the possibility of the maximum transition of the Ukrainian energy sector to renewable energy sources by 2050, which was conducted with the support of the State Institution "Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine", conservative, liberal and revolutionary scenarios for the energy sector development were proposed. The subject characteristics of them are presented in Table 1.

When modeling the scenarios, specialists took into account the energy needs of the industrial sector, agriculture, transport infrastructure and other sectors of the economy, and the results of the study confirmed that Ukraine has an opportunity to implement the energy transition within the specified time frame and join sustainable post-industrial development.

Table 1

Scenarios for the energy sector of Ukraine development in the context of the transition to renewable energy sources by 2050

Scenarios for the development of Ukraine's energy sector	Characteristics of scenarios for the development of the energy sector of Ukraine
Conservative scenario	The conservative scenario is considered as a basic, hypothetical one, when the characteristics of the most energy technologies remain unchanged until 2050 compared to 2012. There is practically no increase in the efficiency of energy resources and insignificant amounts of renewable energy sources are used. This scenario is used as a basis for comparing two other scenarios, which are defined as alternative, in particular for assessing the effectiveness of measures that stimulate technological changes in the economy and energy
Liberal scenario	The conditions for using the liberal scenario assume perfect competition in the national energy market. Under its using, the expected share of renewable energy sources in the structure of gross final energy consumption by 2050 may exceed 30 %, and thanks to the implementation of energy efficiency measures, the need for energy resources will decrease against the background of economic growth. The results of such a scenario demonstrate the prospects for the competitiveness of renewable energy compared to traditional energy, without additional incentives for the development of renewable energy sources
Revolutionary scenario	In the case of implementing a targeted policy for the development of renewable energy, which was a condition of the revolutionary scenario of Ukraine's "energy transition", the share of renewable energy in the structure of the final consumption of energy resources by 2050 can be increased to 91 %, reducing energy needs by 42 % compared to the conservative scenario due to the implementation of measures concerning energy efficiency and energy saving increasing

Source: completed by the author on the bases [1; 3]

The main instruments of Ukraine's international cooperation in the direction of energy transition are: integration into the European market through the Energy Community, bilateral and regional partnerships, "green" transformation financing through funds, programs, projects. Among them are the following: the Energy Support Fund for Ukraine, created by the Energy Community to purchase equipment and repair damaged networks with the funds

of international partners; the multi-annual financial program of the European Union, which is aimed at the reconstruction and green transformation of the energy sector, – the Ukraine Facility; the multilateral coordination platform of G7+ donors, which task is to coordinate the provision of emergency assistance and strategic support for the energy market modernization; the Funds of the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB), which focus on preferential lending for green investments in the private and public sectors. And the priority areas of transformation are: synchronization of the energy network with ENTSO-E for the European market; development of distributed generation based on solar and wind; reform of gas and electricity markets according to EU standards; increasing energy efficiency of buildings and industry.

The Ukraine Energy Support Fund, established in 2022, is one of the effective tools for the uninterrupted functioning of the domestic energy industry with the support of governments, international financial institutions, international organizations, and the corporate sector, which ensures the energy facilities restoration, damaged by the missile attacks, the losses elimination, and the emergency reserves formation.

At the end of December, the Energy Support Fund for Ukraine announced a significant increase in contributions during the last two months of 2025. Now the Fund is supported by 35 partners, and the volume of signed contributions is 1.65 billion euros. Donors have confirmed their commitment to transparent and accountable provision of emergency assistance to the energy sector in Ukraine [4]. This increasing will play a key role in the current year – 2026, as a new streamlined procurement process and the creation of a strategic reserve of equipment for energy companies contribute to reducing the response time to emergencies [5]. In particular, among the numerous contributions from many countries, the contribution made by Sweden in 2025 in the amount of 63.3 million euros increased the total support to the Fund to 203 million euros; the assistance of the United Kingdom in the amount of approximately 11.4 million euros increased the total amount of support to 168 million euros, and the contribution of Germany – 160.1 million euros from the Federal Ministry of Economic Affairs and Energy through the KfW Development Bank and 7.5 million euros from the Federal Ministry of Foreign Affairs of Germany – increased the total amount of support through the Fund to 557 million euros. 217 thousand euros contribution, in addition to the previously provided 400 thousand euros, increased the total amount of financial support to Ukraine through the Fund from Latvia [4].

According to the annual report of the Energy Support Fund of Ukraine for 2025, the Fund allocated funding for 250 out of 398 applications approved by the Ministry of Energy this year [6]. In total, during the operation of the Energy Support Fund of Ukraine, it received grant funds in the amount of more than 2 billion euros from 39 foreign sponsors from 26 partner countries and 3 international organizations [7].

The Ukraine Facility is a large-scale program of financial support for Ukraine, approved by the Council of the European Union in 2024 for the period 2024–2027 and with a total volume of 50 billion euros, the purpose of which is macro-financial support for Ukraine on the path of reconstruction and European integration reforms.

According to the Ukraine Facility Roadmap, in 2024 Ukraine fulfilled all 36 planned measures (commitments). 22 measures were fulfilled on time; 9 – ahead of schedule; 5 – with violation of the deadlines. Among the main achievements in the energy sector, it should be noted: independence in regulation, development and approval of the National Energy and Climate Plan for the period until 2030, adoption of the Strategy for Thermal Modernization of Buildings until 2050 [8], and regulatory acts on integrity and transparency in the energy market [9; 10]. The requirements apply to wholesale energy market participants and individuals or legal entities, persons who professionally organize transactions with wholesale energy products. They define a list of practices that may be understood as manipulation or attempted manipulation in the wholesale energy market; prohibitions on handling insider information in the wholesale energy market; requirements for the disclosure of insider information; requirements for persons who professionally organize transactions with wholesale energy products; signals that may indicate suspicious behavior in the wholesale energy market; principles of cooperation between the National Commission for State Regulation in the Energy and Utilities Sectors and the Council of Regulators of the Energy Community [10]. The Ukrainian side has implemented 75 % of the total number of measures (commitments) of the Plan for the Ukraine Facility, planned for implementation in the first quarter of 2025, 66 % of the total number of measures of the Plan for the Ukraine Facility, planned for implementation in the second quarter of 2025, 60 % of the total number of commitments planned for the third quarter of 2025, and 35 % of the total number of measures planned for the fourth quarter of 2025 [11].

The G7+ Donor Platform was established at the initiative of the G7 countries in 2022, which brings together 25 permanent and temporary members and observers, 7 participants, including international financial institutions and the Organisation for Economic Co-operation and Development (OECD), which committee consists of senior officials from Ukraine, the G7 countries, and the European Union [12]. It coordinates international financial assistance to Ukraine to ensure macroeconomic stability, promotes the implementation of reforms, and provides support for economic recovery and integration into the EU.

According to the results of the fifth Rapid Damage and Needs Assessment (RDNA5), jointly developed by the World Bank Group, the Government of Ukraine, the European Commission, and the United Nations, the direct damage to Ukraine from a full-scale invasion by Russia is estimated at \$195.1 billion by the end of 2025. The total cost of reconstruction and recovery is almost \$588 billion over the next decade [13]. The total damage caused to the

domestic energy sector during a full-scale war is approximately \$25 billion, while the total need for energy recovery and reconstruction over the next decade is estimated at \$91 billion [14].

On November 24, 2025, the 15th meeting of the Ukrainian Donor Platform Steering Committee was held in Kyiv, during which the progress of reforms and the European integration process, budget support for Ukraine for 2026, energy needs and reconstruction, veteran policy, and involvement of the private sector in the reconstruction of Ukraine were discussed [12]. The key areas of further joint work, identified during the “energy Ramstein” in the G7+ format in January 2026, in addition to the expansion of decentralized generation for heat and water supply ensuring, were identified as replenishing the National Reserve of Mobile Energy Equipment, forming a “bank” of critical equipment for rapid response after attacks, and scaling up physical protection of energy facilities [15].

Among the other instruments of international cooperation of Ukraine towards energy transition, it is worth highlighting the financing of “green” investments through special funds, programs and initiatives of the European Bank for Reconstruction and Development and the European Investment Bank (table 2).

Table 2

Key special funds and initiatives of the European Bank for Reconstruction and Development and the European Investment Bank that finance green investments in Ukraine

Green funds, programs and initiatives of the European Bank for Reconstruction and Development		Green funds, programs and initiatives of the European Investment Bank	
GEFF (Green Economy Financing Facility) [16]	A green economic transition financing mechanism that provides preferential lending through local banks for energy-efficient technologies and renewable energy sources	Global Gateway / EIB Global [17]	A large-scale global EU strategy for implementing innovative or environmental projects, with priorities in digital technologies, energy, transport, etc. The Global Gateway finances infrastructure and sustainable projects in Ukraine, promoting integration into the EU single market. Financing through EIB Global is a specialized division of the EIB for work outside the EU, which acts as a partner in the European Global Gateway strategy. Areas of financing for the Ukrainian economy include: projects to support the sustainability of the energy system, critical infrastructure and the private sector
• ESP (Eastern Europe Energy and Environment Partnership) [18]	The energy efficiency and environmental partnership fund is a multi-donor fund for municipal energy efficiency projects in the Eastern Partnership region	EU for Ukraine (EU4U); EU for Ukraine Fund [19; 20]	A special initiative and multilateral fund created to support the restoration of roads, railways, energy networks, sustainability, “green” modernization of domestic infrastructure and municipal services
• SEFF (Sustainable Energy Financing Facility) [21] GEFF (Green Economy Financing Facilities), and Energy Security Support Facility (ESSF)	A special financing program aimed at lending to local banks to support energy efficiency, sustainable energy development, renewable energy projects in the industrial and residential sectors, and strengthening climate resilience. Program for financing energy-efficient and environmental projects. A large-scale program to support resilience in wartime	European Fund for Sustainable Development (EFSD+) [22]	The European Fund for Sustainable development Plus is a comprehensive EU investment package that provides budgetary guarantees and blended finance to reduce the risks of environmental projects outside the EU. The Fund’s financial support to Ukraine is aimed at rebuilding critical infrastructure, strengthening economic and energy resilience, and developing entrepreneurship [23]
• EU4Business-ЄБП [24]	A preferential lending program through the provision of long-term investment incentives (grants) for small and medium-sized businesses, aimed at “green” technologies and EU standards modernization and implementation	Ukraine Investment Framework (UIF) [25]	The investment component of the Ukraine Facility program, which focuses on mobilizing public and private capital for the purpose of decarbonization and renewable energy sources development. The program is aimed at restoring and modernizing the economy of Ukraine
• Green Cities [26]	The Green Cities Initiative is a large-scale investment and financial program focused on increasing green areas, developing environmentally public transport, and increasing the resilience of cities to climate change	Joint Assistance to Support Projects in European Regions (JASPERS) [27]	This is a joint advisory program of the European Investment Bank and the European Commission to provide free expert, advisory and technical support in the preparation of high-quality investment projects according to EU standards

Source: completed by the author on the bases [16-27]

Special funds and initiatives of the European Bank for Reconstruction and Development and the European Investment Bank provide critical financing for green investments in Ukraine, directing financial resources towards energy efficiency, decarbonization, and renewable energy.

CONCLUSIONS FROM THIS RESEARCH AND PROSPECTS FOR FURTHER INVESTIGATIONS IN THIS DIRECTION

Thus, Ukraine's energy transition ensures the abandonment of fossil fuels and integration with the European Union through decarbonization, development of renewable energy sources, decentralization. The main instruments of international cooperation of our state towards the implementation of the energy transition sector are projects and initiatives of the Energy Support Fund of Ukraine, the financial program aimed at the reconstruction and green transformation of the domestic energy sector – Ukraine Facility, projects of the G7+ Multilateral Coordination Platform of Donors, as well as numerous EU funds, programs and initiatives implemented by the European Bank for Reconstruction and Development and the European Investment Bank.

The Energy Strategy of Ukraine until 2050, which is based on the target indicators of the Ukrainian economy development and international obligations assumed by Ukraine, in particular the obligation to take into account the positions of the Association Agreement with the EU and the Paris Climate Agreement, provides that by this date the energy sector of our country should be as close as possible to climate neutrality. This means the availability of clean energy, the full functioning of national energy markets, the gradual integration of national energy markets into international ones, overcoming energy poverty, the development of the decentralized energy system based on innovations.

Today, in war conditions, the renewable energy sources development, as well as the energy saving measures implementation will allow Ukraine to get rid of dependence on imports of traditional energy resources, increase the level of energy security, and create a competitive energy market.

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