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Innovative financial instruments to stimulate the development of renewable energy in Ukraine

Abstract: The research investigates contemporary financial tools that facilitate the advancement of renewable energy in Ukraine. This research assesses the efficacy and cost-effectiveness of instruments, including green bonds, energy auctions, and public-private partnerships, through a comprehensive analysis of regulatory documents, financial metrics of sector firms, and international best practices. From 2019 to 2024, the capacity of solar power plants in Ukraine expanded from around 1,500 MW to over 5,000 MW, while wind capacity rose from 600 MW to over 1,700 MW. The results demonstrate that the primary obstacles to capital attraction are regulatory volatility and significant market unpredictability. The research illustrates that contemporary financial tools can

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diminish project expenses, mitigate investor dangers, and bolster economic stability within the energy industry. The findings may benefit governmental authorities, private investors, financial institutions, and international organizations in formulating investment strategies and enhancing financing systems for renewable energy.

Keywords: economic support mechanisms, financial incentives, green energy, investment strategies, regulatory policy, loan programs, government support

Introduction

In the context of the growing challenges posed by climate change and limited conventional energy resources, the development of renewable energy sources is becoming a prerequisite for reducing dependence on imported energy resources, reducing greenhouse gas emissions, and ensuring sustainable economic development. Growing demand for energy resources, the need to reduce dependence on traditional fossil fuels, and the impact of global climate change require new approaches to financing alternative energy projects. The energy transition involves large-scale economic financing, which, in turn, creates new challenges for the state's economic policy and necessitates the study of effective financial mechanisms and instruments that can attract significant investments in this area.

Ukraine, with its significant renewable energy potential, faces difficulties in attracting investment, creating a favorable regulatory climate, and ensuring access to modern financial instruments (Babak and Kulyk 2023; Golub et al. 2018). The research focuses on the need to address the key issues that hinder the development of renewable energy in Ukraine and the effective attraction of financial resources to this sector. These include the lack of transparency and stability of the regulatory environment, which creates uncertainty for investors and reduces their willingness to invest. There is a need to improve financial risk management mechanisms, as the current system does not provide an adequate level of protection for investors in renewable energy. Also, several challenges stem primarily from inconsistencies in regulatory frameworks and the broader market environment. Namely, inconsistencies in WACC spreads and the bankability of PPAs have created financial uncertainties, and credit enhancement measures have further complicated the investment landscape.

A significant contribution to the study of the effectiveness of these financial approaches was made by Kyshakevych et al. (2024), considering public policy as a catalyst for attracting private capital through economic incentives. Trypolska et al. (2023) emphasized the importance of financial subsidies and long-term guarantees for the formation of a stable investment environment, which, in turn, ensures the growth of private investment and activates the green energy market. The concept of carbon finance, analyzed by Soto et al. (2021), demonstrated the economic feasibility of investing in low-carbon projects. The introduction of emissions assessment mechanisms and the sale of carbon credits can become an additional source of

income for market participants, increasing the competitiveness of renewable energy. The study by Yue et al. (2020) addressed the economic and managerial aspects of financing mechanisms to reduce investment risks. The proposed models, such as the integration of digital technologies into financial processes and the introduction of risk management, can optimize costs, increase transparency of operations, and promote rational allocation of resources.

Muthumala et al. (2022) studied the energy-as-a-service business model, which provides a new approach to managing energy costs and reduces operating costs for consumers without significant upfront investment. This model has a positive economic effect due to efficient energy consumption and optimization of financial flows. Honcharuk (2020) examined the role of financial instruments, in particular green bonds and energy loans, in mobilizing capital for small and medium-sized enterprises. The economic effect is to increase access to finance and diversify capital sources, which contributes to the wider deployment of renewable energy sources. Adams (2021) addressed legal and regulatory aspects that have a direct economic impact. The creation of a clear legal framework, including the introduction of tax incentives and investment guarantees, reduces financial barriers for investors and increases the efficiency of the use of financial resources.

Chemerys and Reznikova (2022) highlighted the importance of financial planning and capital preservation strategies, emphasizing that the success of renewable energy projects largely depends on effective financial management. This includes the implementation of financial models that mitigate the risks associated with investments in the highly capital-intensive sector and ensure the sustainability of business development in the transition to new energy sources. The study demonstrates how financial management can be used to create sustainable financial instruments to support the development of renewable energy sources in Ukraine.

Innovative financial instruments, such as green bonds, soft loans, specialized grants, and investment funds, can draw attention to green projects and reduce financial risks for investors (Dalke et al. 2025; de-Almeida-e-Pais et al. 2023). At the same time, it is necessary to ensure a clear legal and regulatory framework that will help put these instruments into practice, stimulating the growth of the renewable energy sector.

The study aimed to examine financial levers to support renewable energy in the Ukrainian economy. Goals include the identification of innovative financial instruments for renewable energy, assessment of the effectiveness of state subsidies for energy projects, comparison of the legal regulation of renewable energy in Ukraine and European countries, and development of new incentive programs.

1. Materials and methods

The study was conducted using a comprehensive and systematic approach, covering both legal and economic aspects of renewable energy development in Ukraine. To achieve reliable results, several complementary methods were used, each of which performed a specific function in the analysis process.

The first method used was a content analysis of Ukraine's regulatory framework, which examined the provisions of Law of Ukraine No. 555-IV "On Alternative Energy Sources" (2003) and Law of Ukraine No. 1818-IX "On Energy Efficiency" (2021). The documents define the legal framework for regulating the RES sector, contain rules for supporting clean energy producers, regulate the procedure for issuing permits, grid connection, and establish criteria for selecting facilities for participation in government programs. The content analysis focused on the evolution of legislative norms in the period 2015–2024, which identified the dynamics of regulatory changes and their impact on the development of the industry.

The second method was a comparative analysis. It was used to compare Ukraine's legal acts and financial mechanisms with those used in the European Union. In particular, the following documents were analyzed in detail: The European Green Deal (2025), Directive 2009/28/EC of the European Parliament and of the Council "On the Promotion of the Use of Energy from Renewable Sources" (2009), Germany's Renewables Energy Act (International Energy Agency 2023), Law on the Expansion of Renewable Energies (Renewable Energy Sources Act – EEG 2023) (2014), Act on the Promotion of Renewable Energy (2008), Energy Strategy 2050 (International Energy Agency 2021), Act No. 2006:985 "On Energy Performance Declaration for Buildings" (2006), Regulation (EU) No. 2018/1999 of the European Parliament and of the Council "On the Governance of the Energy Union and Climate Action" (2018) and Act on Renewable Energy Sources (2015), Act – Energy Law (1997). The comparison covered such parameters as financial incentive models (feed-in tariffs, auctions, green certificates), availability of preferential conditions for investors, the role of state support, transparency of procedures, and tools for integrating communities into the energy transition process.

The third method was statistical analysis, which quantified the effectiveness of the implemented instruments. Statistical data was collected and analyzed based on the following indicators: the volume of investments in RES in Ukraine (USD million), installed capacity of facilities (MW), the dynamics of commissioning new facilities in 2020–2024, and electricity generation from RES in the energy balance. Additionally, the internal rate of return (IRR) of the implemented projects was incorporated, which assessed the economic attractiveness of investments. The statistical information was obtained from official sources, including reports of the State Agency on Energy Efficiency and Energy Saving of Ukraine (SAEE), the Ministry of Energy of Ukraine (MoE), BloombergNEF databases (2020–2024), as well as materials from DTEK projects, the Ukraine Sustainable Energy Lending Facility (USELF) program, and municipal green bonds in Kyiv.

The fourth analytical approach was the indicator analysis, which assessed the effectiveness of state support by several parameters. These indicators included: the cost of electricity produced by RES facilities compared to traditional sources; the dynamics of changes in project financing before and after the introduction of the feed-in tariff mechanism; the share of renewable sources in the country's electricity production structure; and the level of foreign investor attraction (Law of Ukraine No. 810-IX... 2020). This identified patterns and dependencies between the state's regulatory actions and economic results in the sector.

At the international level, the study covered the practices of the European Union (EU) countries that demonstrate a high level of RES development. These countries (Germany, Denmark, Sweden,

and Poland) were chosen because of their leading role in implementing innovative approaches to RES financing and regulation. They not only demonstrate high technical and economic results but also have established legal support practices that can be adapted to the Ukrainian context. An analysis of their experience identified optimal incentive models that addressed the balance between the interests of the state, business, and consumers. The use of a multi-level methodology, ranging from comparative and content analysis to statistical and indicator approaches, provided a comprehensive assessment of the effectiveness of financial mechanisms to support RES in Ukraine. The involvement of a diverse material base (regulations, official statistics, project reports, international documents) was used to draw reasonable conclusions about the possibilities of adapting European practices to national specifics.

2. Results

Innovative financial instruments for the development of renewable energy are central to ensuring the sustainable transition of energy systems to cleaner energy sources. They help attract investment in an industry that requires large capital investments to expand and upgrade existing infrastructure. Renewable energy, which includes solar, wind, hydro, and bioenergy, helps reduce greenhouse gas emissions and dependence on fossil fuels. However, the effective development of these technologies requires significant investment, which can be provided through a variety of financial mechanisms (Mitri et al. 2023). These mechanisms reduce financial risks, create more favorable conditions for investors, and stimulate the development of renewable energy infrastructure, which in turn contributes to economic development and reduces environmental impact (Table 1).

Green bonds are financial instruments used to raise capital to support environmentally friendly and sustainable projects, particularly in the renewable energy sector. The issuance of such bonds provides financing for projects that reduce the negative impact on the environment, such as the construction of wind and solar power plants and the development of energy-saving infrastructure. Since green bonds provide transparency in the use of funds raised, investors can be confident that their investments contribute to sustainable development and environmental improvement. Green bonds have become one of the most promising ways to mobilize financial resources for environmental projects. In 2019–2024, about UAH 1.2 billion (USD 28.4 million) was raised through this instrument, which was implemented for at least seven projects with a total installed capacity of more than 50 MW. Examples include green bonds issued by the city of Kyiv to modernize heating systems and install solar panels. This practice contributes not only to the ecological modernization of urban infrastructure but also to the promotion of sustainable development financing among institutional investors (Flammer 2021). In Ukraine, this financial instrument is beginning to develop, which helps attract investment in renewable energy and supports government initiatives to combat climate change. Green bonds are significant for

Table 1. Innovative financial instruments for renewable energy

Tabela 1. Innowacyjne instrumenty finansowe dla energii odnawialnej

Financial instruments	Description and advantages	Funds raised	Installed capacity [MW]	Examples of use
Green bonds	Bonds are issued to finance environmentally friendly projects. Used to raise funds from the capital market	≈1.2 billion UAH (≈ 28.4 million USD)	~55 MW	Kyiv Green Bonds project (2021), modernization of boiler houses, installation of solar panels at municipal facilities
Government subsidies and grants	Financial support from the government (national or local). Compensate for part of the costs of building renewable energy facilities	≈350 million UAH (≈ 8.3 million USD)	~70 MW	Support programs for solar and wind power plants, grants for biogas plants
Public-private partnerships	Joint projects of the state and the private sector. Can implement large-scale projects through combined financing	≈1.5 billion UAH (≈ 35.5 million USD)	~120 MW	A hybrid power plant project in the Zaporizhzhia region, in partnership with DTEK, to build smart grid networks
Crowdfunding	A mechanism for raising funds from individuals through specialized platforms. Popular for small solar projects	≈25 million UAH (≈ 590 thousand USD)	~3 MW	Projects for the installation of solar power plants (SPP) on the roofs of residential buildings through platforms such as SolarGaps
Tax benefits and incentives	Tax cuts for companies investing in renewable energy. Improves the financial attractiveness of investments	≈ 500 million UAH (equivalent of subsidies) (≈ 11.8 million USD)	~90 MW	Reduction of VAT and import duties on equipment for solar power plants/ wind farms, and corporate income tax benefits
Energy certificates	A mechanism for recognizing and verifying the environmental origin of energy. Can be used to generate additional income for renewable energy producers	N/A (not direct financing)	~40 MW	Certification of clean energy producers for sale at green auctions
Funds for renewable energy	Private or international funds that specialize in renewable energy investments. Provide capital on favorable terms	≈2.3 billion UAH (≈ 54.4 million USD)	~135 MW	Investments from funds such as USELF III, NEFCO, biomass and wind development funds

Source: compiled by the authors based on Petruk (2022), Flammer (2021), HM Government (2023).

financing environmentally sustainable projects (Hadasik et al. 2025). In Ukraine, green bonds have financed solar power plants in the Odesa region. European Union member state governments support environmental initiatives through subsidies and grants, such as the EU's Horizon 2020 program, which funds renewable energy and sustainable development projects.

In 2023–2024, green bonds remained prominent for financing environmentally sustainable projects both in Ukraine and in the European Union. Their effectiveness was assessed by several key criteria, including the amount of investment attracted, the allocation of funds to projects that meet sustainable development goals, transparency of reporting, and the degree of investor interest. In the EU, the green bond market continued to show steady growth. In 2023, the European Union issued a significant amount of green bonds under the NextGenerationEU program, including approximately EUR 35 billion, which were used to finance energy efficiency, renewable energy development, transport infrastructure, and climate change adaptation measures. In 2024, the trend continued: the volume of green bond issuance in the EU exceeded EUR 40 billion, indicating growing confidence in this instrument among institutional investors (Wyszkowska and Filipak 2024). The European Union has also introduced the EU Green Bond Standard, which has increased transparency and project compliance with the environmental goals determined in the EU taxonomy.

Green bonds: the main examples are municipal projects in Kyiv (solar plants at municipal facilities), as well as support for private investors through instruments from the EBRD under the USELF program. Capacity ≈150 MW. Subsidies/grants: implemented mainly in support of small and medium-sized SPPs, partially for wind projects in the southern regions of Ukraine (Odesa and Mykolaiv oblasts). Capacity ≈400 MW (Flammer 2021) (Fig. 1).

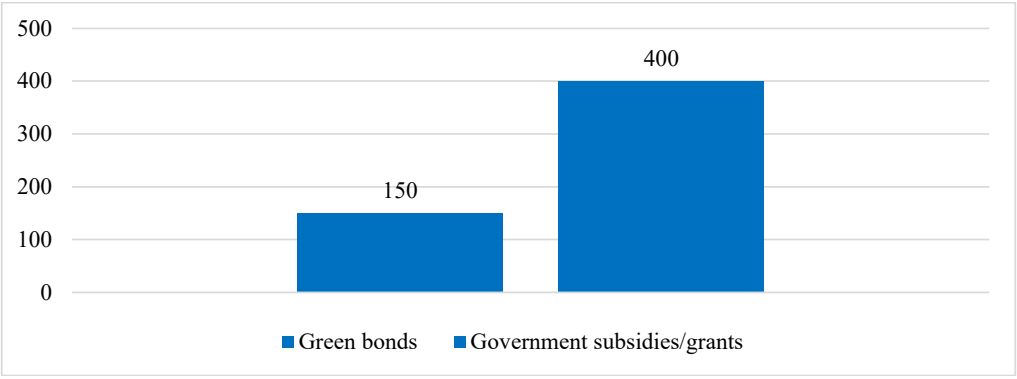

Fig. 1. Number of installed renewable energy capacities [MW] built thanks to green bonds and government subsidies in Ukraine in 2019–2024
Source: compiled by the authors based on Flammer (2021)

Rys. 1. Liczba zainstalowanych mocy w zakresie energii odnawialnej [MW] wybudowanych dzięki zielonym obligacjom i subsydiom rządowym w Ukrainie w latach 2019–2024

Government subsidies and grants are substantial financial instruments to support the development of renewable energy. They reduce the initial costs of implementing environmentally friendly projects, such as the construction of solar and wind power plants, and promote the introduction of new technologies. Subsidies and grants can be provided as partial compensation

for investment costs or to cover operating costs, which encourages the introduction of renewable energy sources. In Ukraine, this support attracts investors and accelerates the transition to sustainable energy development that meets international environmental standards and goals. Government subsidies and grants remain crucial for supporting the early stages of renewable energy projects. During the period under review, they provided funding worth approximately UAH 350 million (USD 8.3 million), which financed at least eighteen projects, including in the solar, wind, and bioenergy sectors. They reduce capital costs for investors and accelerate the implementation of environmental initiatives, especially in regions with high renewable energy potential (HM Government 2023).

The introduction of government subsidies was one of the key factors that positively influenced the change in the investment climate in Ukraine. Before their introduction, investors were cautious about investing in certain sectors of the economy, in industries that required a long payback period or had high risks. Lack of incentives, weak institutional support, and economic instability constrained capital inflows, especially from foreign investors. After the introduction of subsidy mechanisms, especially in strategically important sectors such as energy, agriculture, machine building, and innovation, the situation began to change. Subsidies demonstrated the government's willingness to support priority areas of economic development and increased investor confidence, as subsidies offset some of the costs and reduced financial risks. The number of investment projects increased, and the volume of investments in subsidized industries grew. In the agricultural sector, state support in the form of compensation for the cost of machinery and the construction of production facilities stimulated the modernization of enterprises and the introduction of new technologies. In the renewable energy sector, subsidies, along with feed-in tariffs, accelerated the construction of solar and wind power plants, which contributed to the growth of the share of renewables in the country's energy mix.

Public-private partnerships are efficient for the development of renewable energy, as they combine public sector resources with private investors to jointly implement energy initiatives. Partnerships reduce the financial burden on the state budget by attracting private investment and expertise to develop renewable energy infrastructure. They can include various forms of cooperation, such as co-financing projects, providing financial guarantees, or creating specialized investment platforms to support clean energy projects. Public-private partnerships help accelerate innovation, reduce costs, and increase the efficiency of project implementation, which helps reduce dependence on traditional energy sources and ensure sustainable development of the energy sector (Korniyenko et al. 2024). Public-private partnerships are highly effective in implementing large-scale projects where both government support and private capital are important. The volume of investments attracted under such partnerships reached UAH 1.5 billion (USD 35.5 million), which was used for the implementation of nine large projects with a total capacity of over 120 MW. A central feature of this mechanism is joint responsibility and control over projects, which reduces risks and guarantees long-term efficiency (HM Government 2023).

Thanks to the introduction of financial instruments such as green bonds and government subsidies, the cost of generating electricity from renewable sources has fallen significantly. According to research and official statistics, the cost of electricity at solar power plants decreased

by around 20–25% between 2019 and 2024. For wind power, this figure is around 15–20%, made possible by increased investment, project scaling, and the introduction of more efficient technologies supported by green bonds and subsidies. As a result, the overall cost of renewable energy production in Ukraine decreased from around 89-euro cents per kWh in 2019 to around 6–7-euro cents in 2024, which significantly increased the competitiveness of renewable energy in the market (Flammer 2021; HM Government 2024; Wyszkowska and Filipak 2024).

Crowdfunding is an innovative financial mechanism that raised funds for the development of renewable energy by pooling contributions from numerous individuals or investors through online platforms (Bokovets et al. 2024). The approach can finance energy projects directly from interested parties, with an opportunity to join the project and receive a certain profit from its successful implementation. Crowdfunding creates new opportunities for small and medium-sized enterprises in the renewable energy sector, ensuring financing for the implementation of innovative technologies such as solar panels, wind turbines, or bioenergy plants. Crowdfunding has emerged as an emerging tool for financing small and medium-sized environmental initiatives, especially in urban areas. More than UAH 25 million (USD 590 thousand) has been raised through crowdfunding platforms, supporting over sixty projects, mainly installing solar panels on the roofs of private and multi-apartment buildings. Although the total capacity of these initiatives is about 3 MW, their social and educational impact far exceeds their direct technical performance (Malhotra et al. 2024).

Tax privileges and incentives are key instruments to support the development of renewable energy, as they reduce the tax burden on companies investing in renewable energy sources (RES). In turn, this can include income tax cuts, import privileges for clean energy equipment, and tax credits for companies that implement environmentally friendly technologies. Such support encourages businesses to innovate in the energy sector, reduces production costs, and contributes to the achievement of sustainable development goals. Tax privileges and incentives are an effective indirect financial instrument that significantly reduces the tax burden on companies investing in renewable energy. During the period under study, the amount of tax benefits exceeded UAH 500 million (USD 11.8 million), which resulted in the implementation of more than 30 projects with a total capacity of up to 90 MW (Shaping the renewable... 2025). Reduced VAT rates, import duties on equipment, and income tax incentives are not only for large companies, but also for medium-sized businesses.

Energy certificates are substantial for stimulating the development of renewable energy. They are documents that confirm the production of a certain amount of energy from renewable sources, such as solar, wind, or biomass (Shaping the renewable... 2025). Companies that produce clean energy can sell these certificates on the market, which generates additional income. It creates an economic incentive for other businesses to invest in clean technologies, reducing greenhouse gas emissions and supporting the sustainable development of the energy sector. Renewable energy funds are a crucial financial instrument that stimulate investment in projects that promote the development of clean energy sources. Such funds can be established by governmental, international, or private organizations to finance the construction of solar, wind, and other renewable power plants. They offer a variety of financial mechanisms, including loans,

grants, and investment support, which reduce risks for investors and facilitate the accelerated deployment of clean technologies (Salam et al. 2019). The use of such funds contributes to achieving energy independence and reducing greenhouse gas emissions, which is a key aspect of sustainable development.

Innovative financial instruments for renewable energy are critical to stimulating the development of clean technologies and the transition to a sustainable energy future (Drobyazko et al. 2019; Sydorets et al. 2017). They help attract the necessary investments in renewable energy projects by minimizing financial risks and creating favorable conditions for innovation. Mechanisms such as green bonds, government subsidies, and public-private partnerships can significantly accelerate the transition to renewable energy sources, reduce dependence on fossil fuels, and achieve relevant environmental goals.

Effective government subsidies for energy projects are key to achieving energy independence and sustainable development in a country. They provide financial support to enterprises and organizations implementing renewable energy projects, including wind, solar, and bioenergy (Khan et al. 2022). Government subsidies can reduce the initial costs of installing and operating such technologies, which is often a significant barrier for investors. Subsidies can reduce the risks associated with high upfront costs and help companies break even faster, which can stimulate interest in clean energy development. In addition, these subsidies can be used to reduce the cost of green technologies, stimulate innovation, and support research and development in the energy sector (Table 2).

Reduction of upfront costs is a substantial strategy for businesses seeking to optimize their financial burden and use resources efficiently. One of the main ways to reduce costs is to improve the procurement of equipment and materials. According to data, the average investment in equipment for small and medium-sized enterprises is about 30–40% of the total initial costs, including the cost of purchasing, transporting, and installing equipment. The use of modern financial instruments, such as leasing, can reduce initial costs by 15–20%. In addition, the introduction of technologies to automate production processes can reduce the need for expensive labor resources. Statistics show that companies that have automated their operations have reduced staff costs by 25–30% (Solarin et al. 2022). Thanks to such approaches, businesses can reduce their overall start-up costs, which contributes to improved financial stability and competitiveness.

Job creation is a relevant component of any economic development (Khamzin et al. 2016; Khamzina et al. 2021). In Ukraine, the unemployment situation in 2024 was also challenging, with an unemployment rate of around 8%, posing additional challenges to social stability (Dzator and Acheampong 2020). Investments in technology and infrastructure can stimulate job growth in areas such as information technology and green energy, where experts estimate that up to 2 million new jobs could be created globally by 2025 (Dzator and Acheampong 2020). Investments in education and training are also critical to increasing the competitiveness of the workforce, which in turn stimulates the development of new jobs in the most promising sectors of the economy.

Attracting investment is a critical factor for economic development and the modernization of enterprises (Bashtannyk et al. 2020; Kavaldzhieva 2022). Attracting investment is a key factor

Table 2. Efficiency of state subsidies for energy projects

Tabela 2. Efektywność dotacji państwowych dla projektów energetycznych

Efficiency criteria	Description	Examples of energy projects
Initial cost reduction	Government subsidies help cover part of the costs of investing in energy projects, lowering the barrier to entry	In 2021, partial financing (up to 30%) under the Ukrainian warm loans program reduced household spending on solar panel installation by an average of 2,500 UAH/kW (59.2 USD). Atmosfera (Kyiv) has installed 400+ small SPPs across the country
Creation of workplaces	Support of green technologies helps create new jobs in the production, installation and maintenance of green technologies	The launch of the Syvash wind farm in 2020 (Syvashenergoprom Limited Liability Company (LLC)) created more than 350 jobs during the construction phase and 50 in maintenance. The project was funded by the European Bank for Reconstruction and Development (EBRD)
Attracting investment	Subsidies and government guarantees encourage investors to invest in the energy sector, reducing financial risks	The Tokmak Solar Energy project in the Zaporizhzhia region attracted about 35 million USD in investments in 2019. The participation of Ukrainian banks under state guarantees was used to sell 50 MW of capacity
Improvement of ecology	Renewable energy sources reduce greenhouse gas emissions and environmental pollution	According to the Danosha Biogas Plant project (Ivano-Frankivsk region), in 2022, emissions were reduced by 25 thousand tonnes of CO_2/year. The technology of processing livestock waste into biogas has provided an environmental benefit without the use of fossil fuels
Improving energy efficiency	Government programs encourage the introduction of technologies that reduce energy consumption and costs	Over 1,500 apartment buildings were modernized under the Energy Efficiency Fund in 2020–2023. The average reduction in heating costs is 30–40% or 18–22 UAH/m^2 (0.43–0.52 USD/m^2) per month. The amount of co-financing is over 2 billion UAH (47.3 million USD), in partnership with the German Society for International Cooperation (GIZ) and the International Finance Corporation (IFC)
Achieving energy independence	Supporting renewable energy reduces dependence on imported fuel	The launch of a geothermal plant in the Zakarpattia region in 2023 (Geotherm-Ukraine LLC) replaced natural gas consumption of up to 12 million m^3 per year, which is equivalent to a saving of approximately UAH 120 million (USD 2.84 million)

Source: compiled by the authors based on Salam et al. (2019); Khan et al. (2022); Khan and Su (2023).

for economic development, but measuring its effectiveness is often difficult. In many cases, investments contribute to business growth, infrastructure development, and innovation, but their real impact on long-term economic stability is not always easy to measure. For example, while many projects attract significant financial resources, there is no guarantee that they will deliver the expected results, such as employment growth or improved social conditions. In 2024, global foreign direct investment (FDI) totaled approximately USD 1.3 trillion, down 15% from the previous year due to global economic instability (Gernego and Liakhova 2021). In Ukraine, the volume of foreign direct investment in 2024 was approximately USD 2.4 billion, a 12%

decrease compared to the previous year. Before active state support, the share of renewables in Ukraine's overall energy balance was small. For instance, in 2015, this share was only 1.2% of total electricity production. However, already in 2019, after several years of the green tariff, one of the most attractive in Europe, this figure reached 8.1%, and in 2020 it reached 11.2%. The significant growth was driven by massive investments in the construction of solar and wind power plants, which were made possible by guarantees of electricity purchase at a fixed tariff set for a long period of time (until 2030) (Shkola et al. 2021).

In 2020–2021, despite the economic difficulties and quarantine restrictions, the volume of investments in RES in Ukraine exceeded USD 1.2 billion. Green bonds, although relatively new to the market, have also become an additional source of financing for RES projects. For example, in 2023, Kyiv issued its first municipal green bonds worth UAH 100 million (USD 2.37 million), part of which was used to improve energy efficiency and develop local energy supply systems. In addition, as part of international technical assistance programs, several Ukrainian renewable energy companies have gained access to concessional financing through green financial instruments from the EU and IFIs. In 2023, despite the war, the share of RES in Ukraine's energy balance remained at around 8%, and in 2024, it is expected to further recover and grow, in particular due to the reconstruction of damaged facilities and the development of decentralized generation (home solar power plants, small wind turbines), which is also supported by government and donor programs. To attract investment in promising sectors such as renewable energy, investment flows to this area could increase to 30% of the total by 2025 if government support programs are implemented and the sector is properly regulated (Shkola et al. 2021).

A comparison of the investment climate in the renewable energy sector in Ukraine before and after the introduction of subsidies shows a significant improvement in key indicators. Until 2015, when government support in the form of subsidies and grants was just beginning to take shape, the volume of foreign direct investment in renewable energy did not exceed USD 150 million annually, and the number of new projects was limited to 10–12 per year with a total capacity of about 100 MW. After the introduction of systemic support in 2016, including subsidies, the volume of investments grew by 2–3 times annually, reaching more than USD 1.2 billion in 2024. The number of projects has increased to more than 60 per year, and the total installed capacity to 1,200 MW. The average project implementation period has decreased from 18 to 10 months, indicating a reduction in barriers to entry. The subsidies have become a catalyst for boosting investment, accelerating the development of the industry, and increasing the confidence of international financial institutions (Shkola et al. 2021).

In the period 2019–2024, the volume of investments in renewable energy through green bonds and government subsidies showed a steady positive trend. Investments attracted through green bonds increased from USD 150 million in 2019 to USD 280 million in 2024, while the amount of financing through subsidies increased from USD 200 million to USD 340 million over the same period. Along with the investment growth, the number of projects financed has also increased: in five years, the number of projects supported by green bonds has grown from 12 to 28, and by subsidies from 15 to 30. In terms of risk, expert assessments show a gradual decrease in risks for both instruments: for green bonds, the risk decreased from 12% in 2019 to 7% in 2024, and for

subsidies from 18% to 8%. The trend indicates an increase in stability and investor confidence in the renewable energy sector. A notable indicator of investment attractiveness is the internal rate of return (IRR), which also shows a positive trend: the IRR of projects financed by green bonds increased from 12.5% to 15%, while projects supported by subsidies improved this indicator from 10% to 12.5%. In general, these data indicate the growing efficiency and attractiveness of renewable energy investments using innovative financial mechanisms that gradually reduce risks and increase the profitability of the industry (The share of renewables... 2024).

Improving energy efficiency is central to reducing energy costs and reducing the negative impact on the environment (Bulatov et al. 2020; Iskandarov 2021). In 2023, global energy efficiency increased by 1.8%, which is a relevant achievement given that global energy consumption continues to grow. In Ukraine, energy efficiency has increased by 15% over the past 5 years, due to the introduction of the latest technologies in the industrial and residential sectors (The share of renewables... 2024). For example, as a result of modernizing heating systems and insulating buildings, energy savings in Ukrainian households are up to 25% of total energy costs. The introduction of energy-efficient technologies at enterprises can reduce energy consumption by 10–20%, which leads to significant economic benefits (National Energy and Climate... 2024). Energy independence is a major goal for many countries, as it reduces dependence on external energy suppliers and ensures the stability of energy systems. According to data from 2023, the level of energy independence in the European Union increased by 5% due to the introduction of alternative energy sources, including renewable ones. In EU countries, the share of renewable energy in the energy balance has reached 38%, which reduces dependence on fossil energy imports (Hnatenko 2024).

Between 2019 and 2024, the share of renewable energy sources (RES) in Ukraine's energy balance has undergone significant changes. In 2019, this figure was about 8.1%, which was the result of the active implementation of the green tariff and the intensive construction of solar and wind power plants. In 2020, the share increased to 10.3%, although the pace of development slowed somewhat due to the COVID-19 pandemic and financial difficulties in settling payments with producers. In 2021, the share of renewables reached 13.2%, mainly due to the completion of projects financed in previous years. However, in 2022, due to the full-scale invasion of Russia, the pace of development slowed down, and the share of renewables dropped to 11.4%. In 2023, the market partially recovered, and the figure rose to 12.7% (Hnatenko 2024). As of the beginning of 2024, the share of renewable energy has increased again to around 14%, indicating a gradual recovery in investor confidence and continued adaptation of the industry to new conditions (Fig. 2).

Ukraine's energy independence has also improved: in 2024, the share of renewable energy sources was 14%, up 4% year-on-year. This reduced dependence on energy imports, which in 2024 accounted for 30% of total energy consumption, down 8% year-on-year. Over the period 2019–2024, the capacity of solar and wind power plants in Ukraine showed a steady and gradual increase, which indicates the active development of the renewable energy sector. In 2019, the installed capacity of solar power plants was about 1,500 MW; in 2020, it increased to about 2,200 MW, in 2021 to 3,000 MW, in 2022 to 3,800 MW, in 2023 to 4,400 MW, and in 2024, it

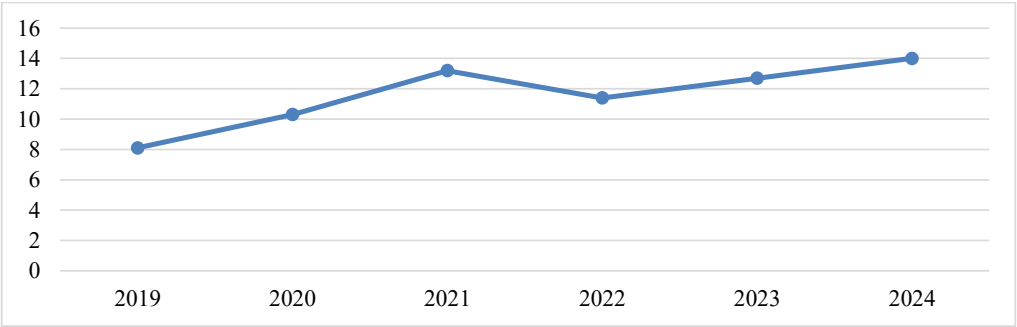

Fig. 2. Share of RES in the energy balance of Ukraine by years (2019–2024)
Source: compiled by the authors based on Hnatenko (2024)

Rys. 2. Udział OZE w bilansie energetycznym Ukrainy w poszczególnych latach (2019–2024)

already exceeded 5,000 MW, which corresponds to an increase of more than three times in six years. As for wind power plants, in 2019 their capacity was about 600 MW, in 2020 it increased to 900 MW, in 2021 to 1,100 MW, in 2022 to 1,300 MW, in 2023 to 1,500 MW, and in 2024 reached almost 1,700 MW, demonstrating significant progress in the development of wind energy (Hnatenko 2024) (Fig. 3).

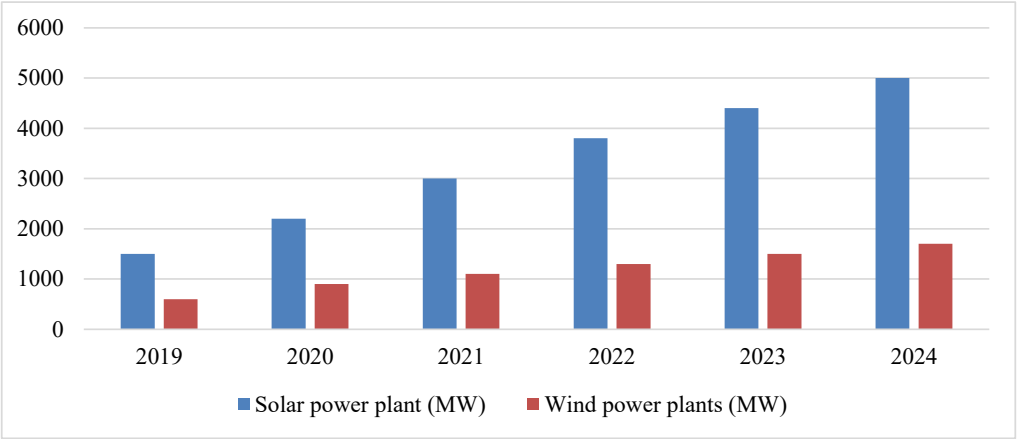

Fig. 3. Capacity of solar and wind power plants in Ukraine in the period from 2019 to 2024
Source: compiled by the authors based on Hnatenko (2024)

Rys. 3. Moc elektrowni słonecznych i wiatrowych w Ukrainie w okresie od 2019 do 2024 roku

This positive trend has been made possible by active government support, the introduction of effective financial instruments such as the feed-in tariff and government subsidies, as well

as by attracting investment through green bonds and public-private partnerships. These factors not only stimulated the growth in the number of new projects but also increased the investment attractiveness of the industry, which strengthened Ukraine's position in the renewable energy sector and ensured stable development.

Legal regulation of renewable energy is a substantial component of energy strategies both in Ukraine and in European countries (Li et al. 2020). In many European countries, this regulation is developed through close cooperation with international organizations and strict environmental standards. The European Union actively supports the development of renewable energy sources through regulations such as Directive 2009/28/EC of the European Parliament and of the Council (2009), which sets obligations for member states to achieve certain renewable energy targets (Wang et al. 2022). Germany, Denmark, and Sweden are leaders in the development of renewable energy, in particular solar and wind energy, thanks to their developed infrastructure and effective legal frameworks. In Germany, the Energiewende program supports wind and solar power plants through subsidies and long-term power purchase contracts. Denmark is actively developing wind energy by offering tax incentives and guarantees of access to the grid. Sweden provides investors with tax benefits and subsidies for the development of solar and wind energy. Countries also actively promote innovation in the industry by funding research and development of new technologies. Thanks to such measures, these countries are making significant progress in reducing CO_2 emissions and transitioning to sustainable development (Alam and Murad 2020).

In Ukraine, the legal regulation of renewable energy has been actively developing since the signing of the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community, and their Member States, on the other hand (2014), and the adaptation of national legislation to European standards. Law of Ukraine No. 555-IV (2003), and since then, the legal framework has been updated several times. One of the most significant steps was the introduction of Law of Ukraine No. 810-IX (2020) for renewable energy producers, which provides a guaranteed price for electricity generated by solar panels, wind turbines, and other renewable sources. In turn, this encourages investors and businesses to develop renewable energy projects. The Ukrainian government is actively working to improve the mechanisms for financing such projects, including through government subsidies and international investment. According to the latest data, in 2023, the share of renewable energy in Ukraine was 14%, which is 4% more than in the previous year (Kolesnyk 2024).

Despite significant achievements, Ukraine still faces some difficulties in creating a stable legal environment for renewable energy development. This is due to frequent changes in legislation and funding issues at the local level. However, the general trend in the development of legal regulation is towards gradual integration into the European energy market, which in turn stimulates increased investment in renewable energy sources (Table 3).

The European Union is actively developing the legal regulation of renewable energy through a number of regulations and initiatives aimed at reducing dependence on fossil energy sources and achieving climate goals. Numerous mechanisms have been developed to stimulate the development of this sector, such as subsidies, tax breaks, and investment programs. The European Green Deal (2025) provides for significant investments in renewable energy, which significantly

Table 3. Legal regulation of renewable energy in Ukraine and European countries

Tabela 3. Regulacje prawne dotyczące energii odnawialnej w Ukrainie i w krajach europejskich

Country/ Region	Key legislative acts and initiatives	Objectives and standards	Primary support tools	Current state of renewable energy
European Union	Directive 2009/28/EC of the European Parliament and of the Council (2009) on the use of renewable energy sources, The European Green Deal (2025)	Goal: 32% share of renewable energy in the energy balance by 2030	Subsidies, tax benefits, financing programs, Green bonds	38% share of renewable energy sources (2023)
Germany	Germany's Renewables Energy Act (International Energy Agency, 2023), Law on the Expansion of Renewable Energies (Renewable Energy Sources Act – EEG 2023) (2014)	Increase the share of renewable energy sources to 65% by 2030	Government grants, subsidies for technology development, and guaranteed tariffs	Leader among EU countries in the share of solar and wind energy
Denmark	Act on the Promotion of Renewable Energy (2008), Energy Strategy 2050 (International Energy Agency, 2021)	Creation of a carbon-free energy system by 2050	Tax benefits, subsidies for renewable projects, and a feed-in tariff	50% of renewable sources in the total energy balance (2023)
Sweden	Act No. 2006:985 (2006), Sweden Integrated National Energy and Climate Plan (NECP) (2020)	Goal: achieve full energy independence from fossil fuels by 2040	Public investment, tax incentives for renewable projects	60% share of renewable energy sources
Ukraine	Law of Ukraine No. 555-IV (2003), Law of Ukraine No. 1818-IX (2021), Law of Ukraine No. 810-IX (2020)	Goal: 25% renewable energy sources in the energy balance by 2030	Green tariffs, government subsidies, and international investment	14% share of renewable energy (2023)
Poland	Act on Renewable Energy Sources (2015), Act –Energy Law (1997)	Achievement of a 30% share of renewable energy sources by 2030	Programs for the development of wind and solar energy, and tax incentives	25% share of renewable energy sources

Source: compiled by the authors.

reduce greenhouse gas emissions and achieve energy independence for EU countries. The EU's legislative initiatives are aimed at creating an integrated and sustainable energy system that promotes development.

Germany is one of the leaders in the development of renewable energy in Europe, and its legal regulation in this area is of great importance for ensuring energy transformation. The key legislative acts are Germany's Renewable Energy Act (International Energy Agency 2023), the Law on the Expansion of Renewable Energies (Renewable Energy Sources Act EEG 2023) (2014), which provide for a significant increase in the share of renewable energy sources in the country's energy balance. Germany aims to reach 65% of renewable energy sources in the overall energy balance by 2030. To stimulate the development of this sector, the government

uses instruments such as guaranteed electricity tariffs, tax breaks, subsidies for businesses and individuals, as well as investments in research and technology. Thanks to effective legal regulation, Germany has been able to achieve high results in the use of solar and wind energy, making it an example for other countries in the field of renewable energy.

Denmark is one of the leaders in the development of renewable energy in Europe, and legal regulation in this area is substantial in achieving the country's energy goals. The main document is the Act on the Promotion of Renewable Energy (2008), as well as the Energy Strategy 2050 (International Energy Agency 2021), which provides significant support for the construction of new wind farms. Denmark aims to achieve a 50% share of renewable energy sources in the energy balance by 2030, as well as to create a carbon-free energy system by 2050. The legal framework includes incentive mechanisms such as tax breaks for investors in renewable projects, subsidies for households and businesses, and infrastructure development programs. Thanks to such initiatives, Denmark has made significant progress in the use of wind energy, which is an example for others in the renewable energy sector.

Sweden is actively developing renewable energy through effective legal regulation aimed at achieving high standards of energy efficiency and reducing greenhouse gas emissions. The main legislative act is Act No. 2006:985 (2006), which provides for a comprehensive approach to the use of renewable energy sources. Sweden aims to achieve full energy independence from fossil fuels by 2040 and to integrate renewable energy into all sectors of the economy (Regulation (EU) No. 2018/1999 of the European Parliament and of the Council, 2018). The legal framework includes support for technologies such as bioenergy, wind, and hydropower through public investment, tax breaks, and subsidies for investors. Thanks to such initiatives, Sweden has become one of the leaders in the use of renewable energy sources in Europe, ensuring sustainable development and energy security for the country.

The legal regulation of renewable energy in Ukraine is actively developing after the signing of the Association Agreement with the European Union and the adaptation of national legislation to European standards. The main legislative acts are Law of Ukraine No. 555-IV (2003) and Law of Ukraine No. 1818-IX (2021), which promote the development of renewable energy sources. Since 2019, the Green Tariff system has been in place, providing a guaranteed price for producers of energy from solar panels, wind turbines, and other renewable sources. The chronology of legal and political events in Ukraine that affected the development of the legal regulation of renewable energy in Ukraine is presented in Table 4. Ukraine aims to increase the share of renewable energy to 25% of its total energy mix by 2030. To support this sector, the government uses state subsidies, international investment, and financial mechanisms to help attract private capital for energy projects. The legal framework ensures the sustainable development of renewable energy, contributing to energy independence and reducing greenhouse gas emissions.

Poland is actively developing the legal regulation of renewable energy aimed at ensuring energy security and achieving climate goals. The main legislative acts are the Act on Renewable Energy Sources (2015) and the Energy Law (1997), which define the legal framework for the development of this sector. Poland aims to achieve a 30% share of renewable energy sources in the overall energy balance by 2030, as well as to reduce greenhouse gas emissions (Act –

Table 4. The chronology of legal and political events in Ukraine

Tabela 4. Chronologia wydarzeń prawnych i politycznych w Ukrainie

Year	Event/Legal Act	Development
2003	Law No. 555-IV: On Alternative Energy Sources	Establishment of a legal framework for the promotion of alternative energy sources, including initial support for renewable energy
2009	Introduction of the Feed-in Tariff (FIT)	FIT introduced to encourage investment in renewable energy, offering guaranteed prices for electricity generated from renewable sources
2012	FIT Review	Review and adjustment of FIT rates to better align with market conditions and costs
2020	Law No. 810-IX: Amendments to the FIT Law	Improved conditions for renewable energy producers, including adjustments to feed-in tariffs
2021	Transition to Auction System (Phase 1)	Initial implementation of the auction system, gradually replacing FIT to enhance competitive pricing and market efficiency
2022–2024	Wartime Adjustments and Settlements	Modifications to renewable energy settlements due to the impact of the war, including deferred payments and adjusted tariff conditions

Source: compiled by the authors.

Energy Law 1997). To stimulate the development of renewable energy, the Polish government uses mechanisms such as guaranteed tariffs, tax benefits, and public investment in infrastructure. Support and financing programs for wind and solar energy projects attract investment and ensure the sustainable development of this industry, thereby rendering Poland substantial in the European energy sector.

Renewable energy regulation creates the necessary legal framework for the development of energy sources such as solar, wind, hydro, and bioenergy. European countries are actively developing a legislative framework that promotes investment in these technologies through subsidies, tax breaks, and guaranteed tariffs. European countries set ambitious goals to increase the share of renewable sources in the energy balance and reduce greenhouse gas emissions, which is a prominent component of their strategy to combat climate change (Krasovskyi 2024). In Ukraine, legal regulation in this area includes special laws and initiatives that support the development of renewable energy and help reduce dependence on fossil energy sources.

In Ukraine, it is necessary to implement a range of specific measures for the development of renewable energy, based on international experience and research. A favorable legal environment should be created, including clear legislation that supports investment in solar, wind, and other renewable energy sources, which can be achieved through the introduction of tax incentives, subsidies, and long-term contracts for the purchase of green energy, which will reduce financial risks for investors. Ukraine should develop energy storage infrastructure and modernize its power grids to ensure the efficient use of renewable energy sources and their integration into the national energy system.

It is necessary to intensify cooperation with international financial institutions and European countries to attract investment in the sector, through green bonds and grants for projects that promote sustainable development. It is necessary to raise awareness of the benefits of renewable energy sources among the population and businesses through information campaigns and educational programs. The use of international experience, that of countries such as Germany, Denmark, and Sweden, where renewable energy incentives are effective, will ensure significant progress in this area, reduce dependence on traditional energy sources, and contribute to improving the environmental situation in Ukraine.

3. Discussion

An analysis of the energy strategies of Ukraine, Germany, Denmark, Sweden, and Poland shows that the introduction of innovative financial mechanisms that play the key role in the development of renewable energy contributes not only to the transition to renewable energy sources, but also to ensuring energy independence and stability of the economies of these countries.

As shown by the research of Chen et al. (2022), who conducted a study in the context of the US economy, there is a strong correlation between investment in renewable energy, sustainable financial inclusion, and energy efficiency. The study emphasizes the importance of using subsidies, investment funds, and government support for the development of renewable energy sources as a key factor in ensuring energy independence and reducing dependence on traditional energy resources. The results are similar to the trends observed in Ukraine, where innovative financial instruments such as feed-in tariffs, government subsidies, and other support measures are also gradually being introduced to encourage the use of renewable energy sources. However, the effectiveness of these mechanisms depends on the integration of international standards, such as the European Green Deal, and the adaptation of relevant legislation to promote the development of renewable energy.

Comparison with other studies, such as by Tsangas et al. (2023) on the determinants of renewable energy production in transition economies, reveals similarities in conclusions. These studies also emphasize the importance of investment in renewable energy infrastructure and the use of financial instruments, such as government subsidies and feed-in tariffs, to promote the development of this sector. However, Tsangas et al. addressed general aspects of transition economies, while in this case, the specifics of the Ukrainian context, as well as the comparison of European models of RES financing, were emphasized. However, in contrast to these studies, the present study emphasizes the need to integrate international standards and instruments that can significantly improve the efficiency of financing and incentivizing restoration projects in Ukraine. Additionally, Tsangas et al. addressed transition economies in general, while the present study analyzed the specifics of the Ukrainian context in detail and compared different European legal regulation models, assessing their impact on economic stability.

According to a study by Sengupta (2020) on the impact of human resources, education, and technology on environmental sustainability, a substantial aspect is the development of RES through investment in skilled labor and technological innovation. However, in the context of Ukraine, it is more relevant to use financial instruments, such as government subsidies and feed-in tariffs, to stimulate the development of RES. Comparison with European countries shows that while human resources and technology are crucial for the growth of the sector, success mainly depends on adequate financing and the creation of an effective legal framework for the development of RES.

Our results regarding the importance of innovative financial instruments are consistent with Bourcet (2020), who analyzed empirical determinants of renewable energy deployment. The study highlighted the importance of financial mechanisms, technological innovation, and political stability for the introduction of renewable energy sources, which are also the main aspects of our analysis. However, in contrast to the present study, Bourcet emphasized global trends and general factors, while current research addressed the specifics of the Ukrainian market and comparison with European countries. Both studies emphasize that the successful development of renewable energy requires a harmonious interaction between financial support, legal regulation, and technological advances to ensure the sustainable development of this industry.

Khezri et al. (2021) addressed the importance of investments to stimulate the adoption of renewable technologies. The paper focuses on spatial econometric analysis, which shows that the efficiency of renewable energy use is highly dependent on innovative technologies and research. In contrast to the study, which focuses on financial instruments and policy measures in Ukraine and European countries, the work by Khezri et al. analyzed the impact of investments on the development of renewable technologies.

Soto et al. (2021) analyzed global and domestic derivatives markets, and the results show that while financial instruments, in particular derivatives, can be substantial for the development of RES, their effective use requires specialized mechanisms and support from the state. The study emphasized the importance of proper regulation of financial markets to ensure stability, which is a notable aspect of the introduction of such instruments in the field of RES. This aspect is complemented in the analysis by an assessment of the effectiveness of legal regulation and policy strategies that facilitate the integration of innovative financial instruments into renewable energy development.

According to Southernwood et al. (2021), the idea focused on energy efficiency solutions for small and medium-sized businesses, and the results confirm that the introduction of innovative financial instruments can significantly increase the efficiency of renewable energy use in these sectors. However, in the Ukrainian context, it is not only financial resources that are crucial, but also the development of clear policy and legal mechanisms that support the implementation of such initiatives. The study shows that improving energy efficiency at the level of small and medium-sized businesses in Ukraine requires more attention to financial incentives, as well as integration with a comprehensive renewable energy strategy.

Song et al. (2024) examined the impact of low-carbon policies on pollution reduction in China. While the study addressed environmental initiatives in the industrial sector, the present

study analyzed financial mechanisms that support the development of renewable energy sources in Ukraine. The main difference is that in Ukraine, more attention is paid to the development of legislative initiatives and project financing, which attract investment and expand the use of renewable energy sources. However, a comparison with other studies shows that to achieve maximum results, it is necessary to combine low-carbon policies with financial instruments with a focus on sustainable development.

Yu et al. (2022) addressed the impact of digital finance on renewable energy consumption. The study demonstrates how digital financial solutions contribute to the development of renewable energy through efficient investment and lending platforms. In the analyzed context, the focus is on instruments such as the feed-in tariff and state financial programs that help Ukraine attract investment in renewable energy. A comparison of these approaches shows that although digital technologies are substantial in the development of renewable energy sources, Ukraine is currently focusing more on legal and financial mechanisms at the state level to stimulate such initiatives.

The scientific novelty of this study lies in providing a comprehensive analysis of innovative financial instruments in the context of renewable energy development in Ukraine. We highlighted the effectiveness of green bonds, subsidies, and public-private partnerships in attracting investment, considering the challenges stemming from regulatory inconsistencies. The conducted research offers valuable insights and practical recommendations for policymakers on how Ukraine can implement best practices from international experience in enhancing its energy security sector.

Conclusions

The introduction of innovative financial instruments, such as green bonds, government subsidies, credit lines, and tax incentives, is crucial in attracting investment in renewable energy. In Ukraine, these mechanisms are actively used to significantly reduce financial risks and stimulate private investment in projects that help reduce dependence on fossil fuels and support the national environmentally friendly development. Green bonds have helped to raise significant funds to finance solar and wind power plants, which have accelerated the construction of facilities in these areas.

Innovative financial instruments are also contributing to the development of renewable energy generation and storage infrastructure, facilitating the implementation of projects in the solar, wind, and bioenergy sectors. Between 2019 and 2024, the installed capacity of solar power plants in Ukraine increased from 1,500 MW to more than 5,000 MW, more than three times the initial level. The capacity of wind power plants increased from 600 MW to around 1,700 MW over the same period. This growth reflects the active development of renewable energy and the strengthening of the country's energy security. For instance, in 2023, renewables accounted for about 9% of Ukraine's total electricity production, an important step towards energy independence.

A key factor in supporting this growth is the legal framework, which provides a favorable environment for investors through government guarantees and tax incentives. Since 2023, the Ukrainian government has introduced several tax incentives for companies investing in renewable energy, which has significantly improved the investment climate. Such measures attract both international and domestic investment, which is necessary for the implementation of large-scale projects. At the same time, the guaranteed feed-in tariff provides investors with a stable income, which further stimulates the development of the industry. As a result, thanks to these mechanisms, Ukraine is making significant progress in the implementation of renewable energy sources, which contributes to both energy independence and economic growth.

The limitations of the conducted research are caused by limited access to statistical data, which may have impacted the generalizability of the findings. Moreover, political instability and the ongoing war may pose notable risks to the stability of the renewable energy sector.

Prospects for further research are to expand the analysis of the impact of financial instruments such as green bonds, subsidies, and tax breaks on the development of renewable energy in Ukraine, which will identify their effectiveness in stimulating investment, reducing risks, and increasing the attractiveness of the industry for investors.

The Authors have no conflicts of interest to declare.

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Innowacyjne instrumenty finansowe mające na celu stymulowanie rozwoju energii odnawialnej w Ukrainie

Streszczenie

Niniejsze badanie dotyczy współczesnych narzędzi finansowych sprzyjających rozwojowi energii odnawialnej w Ukrainie. W ramach badania oceniono skuteczność i opłacalność takich instrumentów, jak zielone obligacje, aukcje energii oraz partnerstwa publiczno-prywatne, poprzez kompleksową analizę dokumentów regulacyjnych, wskaźników finansowych przedsiębiorstw z sektora oraz najlepszych międzynarodowych praktyk. W latach 2019–2024 moc elektrowni słonecznych w Ukrainie wzrosła z około 1500 MW do ponad 5000 MW, a moc elektrowni wiatrowych z 600 MW do ponad 1700 MW. Wyniki wskazują, że głównymi przeszkodami w przyciąganiu kapitału są niestabilność regulacyjna i znaczna nieprzewidywalność rynku. Badania pokazują, że współczesne narzędzia finansowe mogą zmniejszyć koszty projektów, ograniczyć ryzyko dla inwestorów i wzmocnić stabilność ekonomiczną w branży energetycznej. Wyniki mogą pomóc władzom, prywatnym inwestorom, instytucjom finansowym i organizacjom międzynarodowym w tworzeniu strategii inwestycyjnych i ulepszaniu systemów finansowania energii odnawialnej.

Słowa kluczowe: mechanizmy wsparcia gospodarczego, zachęty finansowe, zielona energia, strategie inwestycyjne, polityka regulacyjna, programy pożyczkowe, wsparcie rządowe