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Mechanisms for ensuring energy security in the system of international relations considering economic sanctions and political conflicts

■ **Abstract.** In the context of globalisation and growing interdependence of economies, energy security has become a critical component of national security. Sanctions and changes in energy markets have forced countries to adapt their strategies to maintain energy independence and competitiveness. The aim was to investigate the mechanisms of ensuring energy security in the system of international relations, in particular, the role of economic sanctions as an instrument of influence on the energy policy of states. The adaptation strategies of countries under sanctions pressure in the energy sector were analysed. The study demonstrated how states diversify their energy supply, seek new markets and suppliers, and promote the development of renewable energy sources as alternatives to fossil fuels. Particular emphasis was placed on the European Union's experience in formulating an energy security policy in response to sanctions imposed on Russia,

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resulting in substantial alterations to energy infrastructure and supply methodologies. The implementation of this systems allows managing energy resources more efficiently, optimising energy supply and storage processes, and reducing costs. The results of the study showed that sanctions have affected global energy markets, changed energy flows, raised prices and created new challenges for countries that depend on energy imports. The study also revealed how countries affected by sanctions are looking for new ways to strengthen their energy positions through international cooperation and partnership. This analysis helped to better understand the mechanisms of countries' adaptation to the conditions of restrictions, and identify key factors that contributed to their success in the context of changing energy policies. The study aimed to formulate robust suggestions for states regarding effective measures to respond to sanctions pressure, thereby enhancing energy security and economic sustainability amid global problems

■ **Keywords:** diversification of energy supplies; renewable energy sources; energy policy; global energy markets; adaptation strategies; energy stability

■ INTRODUCTION

The global economy faces acute challenges in the field of energy security, which have significant economic consequences for the development of states. Political conflicts and economic sanctions imposed on the main energy supplier countries cause instability in the energy markets, which affects the economic stability and competitiveness of energy importing countries. Rising energy prices, limited access to key markets and the need to diversify supplies significantly change the economic strategies of states, forcing them to adapt to new conditions. The economic mechanisms of countries' adaptation to sanctions pressure and new challenges to energy security remain insufficiently studied. The scientific literature on mechanisms for ensuring energy security covers a variety of studies that explore both theoretical aspects and practical cases at the global level.

One of the key studies in this area is the paper by O.A. Shevchenko (2022), in which the author argued that without stable access to energy resources, it is impossible to ensure economic development and social stability in the country. The study by M. Li *et al.* (2024) established sanctions indices and employed the TVP-VAR-DY model to examine the effects of EU economic sanctions on Russia on oil prices and the market shares of third-country energy firms, specifically China and the United States. Energy sector sanctions are key drivers of volatility, with Chinese energy companies being more sensitive to these impacts, while U.S. ones are more sensitive to them; direct sanctions are better at explaining stock fluctuations, while indirect sanctions are better at explaining oil prices. Practical aspects of energy security are also discussed in detail by N. Ryabets & I. Tymkiv (2024), who focused on identifying and analytically assessing the impact of geopolitical changes, particularly the war in Ukraine, on global energy security and sustainability, highlighting destructive factors such as the monopolisation of critical resources. B.O. Pokhodenko (2023) analysed approaches to energy security in the EU and Ukraine, analysing aspects of energy independence, supply stability, energy efficiency and the use of renewable resources. Common features are identified, such as the importance of source diversification and improving energy efficiency, and differences in energy infrastructure, where the EU has an advantage.

Energy security research also focused on the global context (Kyshakevych *et al.*, 2023). I. Shchurov (2022) noted that new global challenges and problems of energy security in Ukraine analyse the definition of economic security, offers the author's vision of energy security as a

multi-factor category, reveals modern determinants of its development, substantiates the directions of integration of Ukraine's energy markets with the EU, examines the impact of climate change, and also emphasises the conflict over the implementation of various mechanisms for ensuring energy security. The studies by V.P. Konenko *et al.* (2022) and A. Lisovyi (2023) emphasised that international cooperation can contribute to the development of joint energy projects and optimise the use of resources. Furthermore, Yu. Kharazishvili *et al.* (2021) presented a model for evaluating energy security that incorporates the dynamics of technological, political, and economic issues on a global scale. It underscored a methodical approach to establishing strategic objectives in energy security, highlighting the necessity for a comprehensive evaluation and formalisation of energy security as a management entity. C. Drago & A. Gatto (2022) highlighted the importance of policies and regulations for sustainable energy development and access to renewable resources. The developed interval indicator evaluates the transparency and effectiveness of institutional mechanisms governing energy policy, comparing 110 countries, among which the United Kingdom, the United Arab Emirates, and the United States stand out in terms of high institutional characteristics.

I. Sotnyk *et al.* (2021) presented methodological frameworks for evaluating the influence of renewable energy advancement and energy efficiency on the energy security of emerging nations. It is recommended to enhance the current technique for evaluating energy security by incorporating new indices that would offer a thorough assessment of energy security in light of contemporary concerns, including the COVID-19 pandemic, which has impacted the Ukrainian energy industry. O. Sukhodia (2019) examined a new model for describing energy security based on a systematic approach, with an emphasis on the importance of goal setting in the field of energy security as part of strategic planning in the national security system. Q. Wang *et al.* (2024) used bibliometric methods to analyse research dynamics, indicating an increase in publications, a focus on the energy transition, and identifying China as a leading country in research partnerships. I. Zharsovska & A. Bobko (2024) emphasised the need for digital technologies to improve energy systems, while acknowledging the associated risks, such as increased vulnerability to cyber threats, potential digital inequality among EU countries, and data privacy concerns that require a clear regulatory framework.

There is a need for a comprehensive analysis of the economic strategies that countries use to minimise the impact of sanctions: in particular, diversification of energy supplies, investment in renewable energy sources, search for new trading partners, and the introduction of energy-efficient technologies. The significance of this topic is determined by the reality that economic sanctions influence not only present macroeconomic statistics but also shape the long-term economic development prospects of nations reliant on oil imports. This study aimed to evaluate the economic mechanisms for ensuring energy security amid sanctions and to identify viable ways for countries' economic adaptation to changing energy market conditions. This will enhance the comprehension of the economic aspects that influence the sustainability of states in situations of restricted access to energy resources and will assist in formulating pragmatic recommendations for bolstering the economic resilience of nations amidst global difficulties.

■ MATERIALS AND METHODS

A sample of 200 respondents was established, which included representatives of government agencies (30%),

energy industry experts (40%), and businessmen (30%). The respondents' ages varied from 25 to 65 years, with a balanced representation of both genders. The criteria for inclusion in the sample included experience in the energy sector or the field of policy, which allowed collecting information from individuals with a sufficient level of expertise to assess energy security issues. In the course of the study, a documentary analysis was conducted, during which a systematic review of scientific literature, reports of international organisations and government documents related to the topic of energy security was carried out. O.A. Shevchenko (2022) and M. Li *et al.* (2024) provided a conceptual framework for further analysis. A survey was conducted, for which a structured questionnaire of 15 questions was developed, covering issues related to energy policy, energy consumption, the impact of international sanctions and technological innovation (Table 1). The questions were formulated based on previous research in this area. All participants were apprised of the study's objective and provided their agreement to engage in it (American Sociological Association's code of ethics, 1997).

Table 1. Questions for the survey

No.	Questions	Answers
1	What is your role in the energy sector?	a) representative of the state structure; b) energy industry expert; c) businessman; d) other (please specify)
2	How old are you?	a) 25-34 years old; b) 35-44 years old; c) 45-54 years old; d) 55-64 years old; e) 65 years or more
3	What is your evaluation of the energy security status in your country?	a) very good; b) good; c) satisfactory; d) bad; e) very bad
4	Which of the following factors do you think are most important for ensuring energy security? (choose up to three options)	a) diversification of energy sources; b) development of renewable energy sources; c) energy independence from importers; d) investment in energy infrastructure; e) reduction of energy consumption
5	What impact do you think international sanctions have on your country's energy policy?	a) very positive; b) positive; c) neutral; d) negative; e) very negative
6	Do you think that your country is responding adequately to sanctions in the energy sector?	a) yes; b) no; c) not sure
7	What strategies for adapting to sanctions, in your opinion, are the most effective? (choose up to three options)	a) supply diversification; b) search for new sales markets; c) investments in energy saving technologies; d) development of partnerships with other countries; e) increase in renewable energy production
8	What impact do you think technological innovations have on energy security?	a) very positive; b) positive; c) neutral; d) negative; e) very negative

Table 1. Continued

No.	Questions	Answers
9	What are the main challenges that you think your country faces in ensuring energy security? (open response)	
10	Do you have any suggestions for improving your country's energy policy? (open response)	
11	What is the role of international cooperation, in your opinion, in ensuring energy security?	a) very important; b) important; c) insignificant; e) not important
12	What sources of information do you consider most reliable for assessing the state of energy security? (choose up to three options)	a) government agencies; b) international organisations; c) scientific research; d) mass media; e) professional associations
13	Have you personally felt the impact of changes in energy policy (for example, due to changes in energy prices)?	a) yes; b) no; c) not sure
14	What types of energy do you consider the most promising for your country in the next 10 years? (open response)	
15	Do you have any additional comments on the topic of energy security? (open response)	

Source: compiled by the authors

To collect in-depth interviews, 10 experts, politicians and business representatives were involved, which allowed to obtain detailed data on their views on energy security, and on specific cases that they encountered in their professional activities. Interview recordings were saved and analysed to identify key topics and trends. The gathered data was evaluated utilising the SPSS statistical analysis program. The Students' *t* test was employed for quantitative data to compare average values between groups, while correlation analysis was utilised to examine linkages among several energy security indicators, facilitating the identification of significant correlations that substantiate the research hypotheses. Computers, tablets, and interview recording programmes, were used to collect data during the survey and interview. The collected data was stored in secure files, which ensured the confidentiality of respondents. All materials used in the study included archived data, statistical reports, and regulatory documents related to energy policy.

■ RESULTS AND DISCUSSION

The results showed that 75% of respondents believe that economic sanctions significantly affect the country's

energy security, causing an increase in energy prices. This is confirmed by data from the International Energy Agency, which indicate an increase in average gas prices by 30% and electricity prices by 20% in 2023 compared to 2022. The majority of respondents emphasised that limitations on access to international markets and resources result in heightened energy production costs, according to the International Energy Agency (2023). 90% of experts emphasised the significance of cultivating indigenous resources, particularly renewable energy, which can diminish reliance on imported energy sources and enhance the nation's energy autonomy. Investments in emerging technologies within the energy sector are essential for maintaining energy security. In 2023, international groups reported that global investments in innovative technologies within the energy industry reached USD 180 billion, with USD 35 billion allocated to renewable energy in the European Union. In contrast, investments in renewable energy in Ukraine were about USD 1.5 billion, which is far smaller. Table 2 presents a comparative analysis of investments in innovative technologies between Ukraine and other nations.

Table 2. Analysis of investments in emerging technologies within the energy industry (2023)

Country	Investments (billion USD)
EU	35
USA	60
China	70
Ukraine	1.5

Source: compiled by the authors based on O. Gavrylko (2023)

Questions about the impact of political conflicts on energy security showed that 80% of respondents believe that international and regional conflicts significantly threaten energy stability. The main problems identified by respondents include declining investment in the energy sector, risks of disrupting energy supplies, and unstable energy prices. The survey participants pointed out the importance of Ukraine's active participation in international energy projects, such as the Trans-European energy

network, to improve the reliability of energy supplies. The advancement of renewable energy, including solar and wind, is a critical focus that can assist Ukraine in attaining energy independence and fulfilling obligations to diminish greenhouse gas emissions while transitioning to sustainable development (Shebanin *et al.*, 2024). Domestic investment in this sector can provide employment, foster technological advancement, and enhance the competitiveness of the Ukrainian economy. Attracting investors and partners

to finance renewable energy projects will help to achieve ambitious goals faster. Encouraging the adoption of renewable energy at the local level through support programs, incentives for homes and companies, and public education on the advantages of renewable energy sources can greatly enhance energy efficiency (Zakharchuk *et al.*, 2023). It will also diminish reliance on centralised energy sources, which is particularly crucial amid political volatility. Consequently, the advancement of renewable energy is not merely a stride towards energy autonomy, but also a crucial element for guaranteeing sustainable economic development and environmental conservation in Ukraine. Investments in renewable energy might significantly increase Ukraine's energy independence, namely by increasing the amount up to 30% of the energy mix by 2030.

Economic sanctions imposed on energy exporting countries lead to significant changes in supply structures and approaches to ensuring energy security. In particular, sanctions force importing countries to actively look for alternative suppliers or diversify energy sources. This increases the cost of energy resources, creating economic pressure on the economies of countries that depend on imports. Respondents stressed the need to establish new international partnerships to ensure stable energy supplies. Enhancing collaboration with the EU, the US, and additional partners can facilitate the attraction of investments in infrastructure, technology, and energy initiatives, thereby offering Ukraine diverse supply sources. International alliances can facilitate the adaptation of new technologies, the exchange of experiences, and the training of workers, so enhancing the overall efficiency of the energy system.

Political conflicts related to energy resources affect international relations, stimulating the creation of new alliances and economic agreements to ensure the stability of energy supplies (Shukurov, 2022). For example, some EU countries are expanding cooperation with suppliers from the Middle East, Africa and Central Asia, reducing dependence on resources supplied from regions that are subject to sanctions. The implementation of new mechanisms, such as energy contracts with guaranteed supplies or strategic energy reserves, can be an effective tool for ensuring the stability of supplies in the event of a crisis. The diversification of energy sources and the enhancement of local resources are essential for bolstering Ukraine's energy security within the framework of contemporary international relations. The survey also showed that 70% of respondents believe that political conflicts negatively affect the investment climate in the energy sector, hindering attracting foreign investment. The lack of stability in international relations, in particular in the region, forces potential investors to look for safer alternatives, which further worsens the situation in the energy sector. The study identified several key mechanisms for ensuring energy security in the context of international relations, which are essential for reducing Ukraine's dependence on external factors and improving the sustainability of the energy sector. The findings indicate that the diversification of energy sources, including solar, wind, and LNG, is among the most successful ways to enhance energy security. This reduces dependence on individual suppliers and minimises the economic risks associated with sanctions or political conflicts that restrict access to certain types of energy resources.

Market diversification relies on critical procedures that enhance energy solutions in Ukraine, diminish reliance on conventional energy resources, and bolster the nation's energy independence (Dykha *et al.*, 2024). Respondents asked about the need to supply alternative energy sources, such as solar, wind and bio-energy, and nuclear energy. Diversification will reduce the risk associated with instability from traditional resources and political instability. Ukraine is actively advancing solar power facilities in the Odesa Region and other regional initiatives that positively influence the local economy and generate new employment opportunities. Nuclear energy can become an important component of the energy balance, ensuring the stability of stability and reducing the amount of greenhouse gases. Technological advancements, like battery systems and intelligent models, significantly contribute to the swift progression of alternative energy sources (Bandura *et al.*, 2023). Government policies aimed at supporting these initiatives may include financing and investment programmes that allow the organisation of investments.

Economic sanctions and geopolitical tensions have led to fluctuations in energy prices, forcing consumer governments to develop stabilisation policies. These methods encompass subsidies for energy resources for the populace, the advancement of national energy sources, and energy efficiency programs that mitigate reliance on imported resources. The execution of these procedures enhances energy security and stability during extended political confrontations. According to the data obtained, the majority of respondents believe that renewable energy sources can significantly change the energy landscape of Ukraine. Solar and wind energy have already shown their effectiveness in a number of countries, and their introduction in Ukraine can significantly reduce energy dependence on imports. In particular, solar power plants can be implemented on the roofs of buildings, and wind installations – in rural and remote regions, which will ensure energy independence. Participants emphasised the significance of investing in nuclear energy, which continues to be one of the most reliable sources of electricity. The advancement of novel nuclear technologies, including next-generation reactors, presents more prospects to enhance energy efficiency.

Diversification includes the establishment of strategic energy reserves and the enhancement of infrastructure for their conveyance. This will allow Ukraine to reduce the risks associated with unstable energy supplies from other countries. Commissioning of new energy projects using renewable sources will reduce the vulnerability of energy infrastructure to external threats, such as political conflicts or economic sanctions. The study confirmed that deepening international cooperation is a key factor in strengthening Ukraine's energy security. The country's active participation in international organisations, the European Union and the International Energy Agency, and in joint energy projects, contributes to expanding access to energy resources and technologies.

One of the important components of international cooperation is Ukraine's participation in Trans-European energy networks. These networks provide additional energy supply channels, which significantly reduces the risks associated with dependence on a single source of supply. In particular, integration into European energy systems can

improve supply reliability, reduce vulnerability to political and economic shocks, and create favourable conditions for attracting investment in the energy sector. The exchange of technology and knowledge is also an important aspect of international cooperation. Engagement in collaborative initiatives enables Ukraine to implement cutting-edge technology in renewable energy, energy conservation, and energy efficiency (Parkhomets *et al.*, 2023). This, in turn, helps to reduce energy production costs and improve environmental performance. In addition, sharing experience in developing energy security strategies with other countries can help Ukraine better adapt to the challenges that arise in the energy sector.

Collaboration with global partners can also enhance the infrastructure development for energy initiatives. Securing foreign investment in the modernisation and development of new energy infrastructure, including power plants and gas pipelines, is essential for achieving energy independence. Participation in international financing programmes can help Ukraine implement ambitious projects in the energy sector. An important aspect that respondents emphasised is the support of innovative developments in the energy sector. Investing in new technologies for energy storage, transportation, and production can significantly improve resource efficiency and reduce costs. The advancement of contemporary energy storage technology, including high-capacity batteries, is crucial for maintaining the stability of energy networks, particularly given the increasing proportion of intermittent renewable energy sources.

The use of innovation in energy transportation is also of great importance. For example, the introduction of Smart Grid technologies can significantly optimise the distribution of electrical energy. These technologies facilitate the incorporation of renewable energy sources into the grid, minimising losses and enhancing energy transfer efficiency. With Smart Grid, energy companies can monitor consumption in real time, respond to changes in demand, and manage resources, making the system more resistant to external shocks. In addition, the introduction of new pipelines and systems for gas and oil transportation based on modern materials and technologies can reduce the risk of leaks and improve the security of energy infrastructure. The use of composite materials that are more resistant to corrosion and mechanical damage can extend the service life of pipelines and reduce the likelihood of accidents. Monitoring systems that use sensors and automated technologies help to quickly identify potential threats and respond to them before they lead to serious consequences.

Energy storage systems, in particular batteries, can ensure a stable supply of electricity during periods of peak loads or insufficient generation, reducing dependence on traditional energy sources. Integrating energy technologies with electric vehicles can also create additional opportunities for storing and distributing electricity. Furthermore, the advancement of novel technology for the treatment and processing of waste in the energy sector, along with the implementation of a circular economy, can mitigate the environmental impact of energy operations and foster sustainable development. Utilising secondary resources, such as biogas or agricultural waste, can serve as an alternative energy source and diminish reliance on fossil fuels (Dovgal *et al.*, 2024). Investments in research and

development, as well as the modernisation of existing capacities, will enable Ukraine to maintain competitiveness in the international energy resources market. Assistance for start-ups and creative enterprises in the energy sector can facilitate the development of novel solutions that address contemporary demands and difficulties. Investments in renewable energy technology, such as advanced solar panels and high-efficiency wind turbines, can substantially lower energy expenses and enhance environmental conditions.

To ensure energy security, Ukraine needs to develop a long-term national energy strategy that considers all the challenges associated with economic sanctions and political conflicts (Shahini *et al.*, 2024). This strategy should be based on an in-depth analysis of the current situation in the energy sector, and include forecasting possible risks that may arise as a result of changes in international relations. The main components of such a strategy are risk analysis, which allows assessing both external and internal threats to energy security; investment planning, which sets priorities for the development of energy infrastructure, including renewable energy sources and modernisation of traditional capacities; vulnerability reduction measures, which include the creation of reserve capacities and integration into European energy networks; and the involvement of all stakeholders, which will contribute to an integrated approach to ensuring energy security. The implementation of such a strategy will not only improve energy stability, but also ensure the country's sustainable development in a changing international environment. Having a clear national energy strategy will also help attract international investment and partnerships, which is critical for the development of the Ukrainian economy and increasing its competitiveness on the world stage.

The procedures for guaranteeing energy security within the framework of international relations encompass various critical elements. Diversification of supply sources is critical to reducing dependence on traditional energy resources. Ukraine ought to concentrate on advancing alternative energy sources, including renewable (solar, wind, biofuel) and nuclear energy. This will not only increase the country's energy autonomy, but also reduce the vulnerability of energy infrastructure to external threats. Deepening international cooperation is necessary to strengthen energy security. Ukraine's active participation in international energy projects, such as the Trans-European energy network, can provide new energy supply channels, reduce risks and improve the reliability of energy supplies. Collaboration with international entities, including the European Union and the International Energy Agency, will enhance access to technology and resources.

Investment in innovative technologies is an important aspect that will help Ukraine to remain competitive in the international energy market. The use of new technologies for energy storage, transportation and production can significantly improve resource efficiency and reduce costs. For example, advanced energy storage systems allow storing excess electricity generated from renewable sources, which ensures stable supply during peak consumption (Sikorska *et al.*, 2024). Innovations in the field of energy transportation, such as "smart" power grids, can reduce losses during electricity transmission. In addition, the introduction of new production technologies that use clean energy sources

can help to reduce emissions of pollutants, which, in turn, will improve the environmental situation in the country.

The development of a national energy strategy is a key element for ensuring energy security. The strategy should consider all the challenges associated with economic sanctions and political conflicts, including risk analysis, investment planning, and measures to reduce the vulnerability of the energy system. In summary, it may be contended that the execution of these actions can markedly enhance the stability of Ukraine's energy system, diminish reliance on external influences, and secure the nation's energy autonomy throughout political and economic adversities. Diversification of supply sources, advancement of renewable energy, investment in cutting-edge technology, and formation of new international alliances are essential elements that will foster the foundation of a stable and autonomous energy system. Diversifying energy sources and enhancing domestic resources are essential for fortifying Ukraine's energy security within the framework of contemporary international relations. Ukraine must prioritise attracting investment in innovative technologies that enhance energy efficiency and mitigate the energy system's susceptibility to external threats.

The data obtained indicate that deepening international cooperation, diversification of supply sources and investment in innovative technologies are key aspects for ensuring Ukraine's energy autonomy. This study is significant not only for Ukraine but also for other nations aiming to diminish their reliance on conventional energy resources and promote sustainable development. The results of the study showed that energy security is a complex concept that covers economic, social, and technological aspects. An important conclusion is that cooperation with international partners can significantly contribute to the development of infrastructure for energy projects. This is confirmed by researchers such as O. Gavrylo (2023), who highlighted the importance of attracting foreign investment to modernise energy infrastructure. Without proper funding and technologies, Ukraine will not be able to implement its ambitious projects in the energy sector. Diversification of energy sources, which is supported by the results of this study, is an important mechanism for reducing dependence on traditional suppliers. This aligns with the findings of V. Omelchenko (2022), who asserted that the advancement of renewable energy sources, including solar and wind energy, can substantially enhance Ukraine's energy autonomy. Research demonstrates that the active development of alternative energy sources ensures energy independence and mitigates environmental damage.

Countries that actively implement green technologies demonstrate examples of successful transformation of their energy systems (Ivashura *et al.*, 2022). Thus, the study by E. Assareh *et al.* (2023) focused on the benefits of implementing energy storage technologies that can solve problems related to the instability of renewable sources. Energy harvesting also requires processes, technologies, arrangements and operations that convert a form of energy (such as electrical) into a more economical form of energy (such as mechanical) for further utilisation (Namrata *et al.*, 2024; Yang, 2024). Thus, the findings are consistent with the available studies, but also indicate the need for in-depth analysis in this area, in particular, regarding the real

possibilities of introducing new technologies and investing in the energy infrastructure of Ukraine.

O.A. Shevchenko (2022) observed that investment in innovative technology for energy storage and transportation can markedly enhance the efficiency of the energy sector. The researcher underscores the significance of emerging technologies in cost reduction and enhancement of energy system efficiency. The implementation of these technologies can enhance flexibility in energy production and consumption, essential for adapting to fluctuating market conditions. The research conducted by N.P. Reznik *et al.* (2024) underscored the principal challenges of bioenergy advancement in Ukraine, accentuating its significant function as an alternative to conventional fuel sources. Notwithstanding the substantial potential of biomass for energy generation in Ukraine, its development rate is markedly inferior to that of European nations. The world is entering the fourth energy transition, which requires the creation of a new concept of energy security for both energy supplier countries and consumers (Hamidova *et al.*, 2022). The paper by A. Mazaraki & T. Melnyk (2024) aimed to develop a conceptual framework for energy security management, considering current challenges, in particular, the "green" transition and growing dependence on renewable energy sources. The findings confirm that not only investment in alternative sources, but also active participation in international programmes and cooperation with foreign partners can play an important role in achieving Ukraine's energy independence. Thus, analysing the results obtained, it can be argued that Ukraine needs to continue developing strategic partnerships and introduce innovative technologies to ensure stability and security in the energy sector.

In conclusion, the results show that while Ukraine has already made some progress in diversifying energy sources, there are still many challenges that need to be overcome. Studies in this domain should concentrate on examining the effects of international collaboration on the advancement of energy initiatives in Ukraine, as well as investigating particular technologies that might be employed to enhance energy efficiency. The research carried out as part of this study opens up new prospects in the field of energy security. It is important to investigate how specific innovative technologies can be adapted to the conditions of Ukraine, and to assess their impact on the overall efficiency of the energy system. For example, it is necessary to investigate what energy storage technologies can be implemented, considering the geographical and climatic features of Ukraine. This will help to determine the best solutions for integrating renewable energy sources into existing energy systems. Also, it is advantageous to examine the influence of international collaboration on the advancement of energy initiatives in particular areas of Ukraine. This will identify regional characteristics and obstacles that may influence the execution of energy programs. The study of local conditions and needs can help in the development of adapted development strategies that consider the specifics of each region.

The examination of public policy's role in promoting investment in renewable energy sources is equally significant. This may include examining the effectiveness of existing policies and their impact on the investment climate. An analysis of successful government regulation practices

in other countries, such as Germany and Denmark, where renewable energy sources are actively being implemented, can provide useful lessons for Ukraine. For example, it is important to analyse how various support mechanisms, such as subsidies, tax breaks, and government programmes, affect investment attraction. In general, these areas of research can significantly deepen the understanding of the mechanisms for ensuring Ukraine's energy security and contribute to the development of effective strategies for strengthening it. The primary objectives will be to tailor international expertise to domestic circumstances and foster innovation in the energy industry, thereby enhancing Ukraine's energy independence and sustainability. The results show that, despite the existing successes, Ukraine still faces serious challenges in the field of energy security. The need to intensify international cooperation, which contributes to attracting investment and new technologies, is urgent. Diversification of energy sources will diminish reliance on conventional providers and create new prospects for the advancement of alternative energy sources, including wind and solar energy. Investments in novel technology can markedly enhance the efficiency of the Ukrainian energy sector, hence reducing costs and optimising resource utilisation.

■ CONCLUSIONS

The study of Ukraine's energy security has identified several key aspects that are critical for its stability and development. In particular, the results obtained confirmed that energy security is a complex concept that covers economic, social and technological dimensions. The importance of international cooperation, diversification of energy sources and investment in innovative technologies proved crucial for ensuring the country's energy autonomy. Active diversification of energy sources is necessary to reduce dependence on traditional suppliers, in particular from the Russian Federation. Attracting foreign investment, which accounts for 70% of all investment in new technologies,

is a key factor for modernising the energy infrastructure. Without this, Ukraine will not be able to implement its ambitious projects, such as the development of a renewable energy network.

The findings indicated that investments in solar and wind energy might substantially enhance Ukraine's energy independence, namely by elevating the proportion of renewable energy sources to 30% in the energy mix by 2030. It will positively affect the country's environmental conditions by diminishing greenhouse gas emissions. Investment in new technologies can significantly improve the efficiency of the energy sector, reducing the cost of energy production and transportation. However, despite the potential of alternative energy sources, Ukraine remains highly dependent on imported energy resources – more than 60% of the gas consumed is imported, which is a serious threat to energy security.

The study highlighted the importance of Ukraine's active participation in international energy projects and financing programmes, which can lead to the strengthening of energy infrastructure. For example, participation in European energy initiatives can provide access to the technologies and funding needed for modernisation. The issues of interaction between economic sanctions and political conflicts remain relevant for further research. It is recommended to conduct a deeper study of specific innovative technologies that can be adapted to Ukrainian conditions, and analyse the impact of international cooperation on the development of energy projects in different regions of Ukraine. This will help to identify features and problems that need urgent solutions, and contribute to the development of effective policies in this important area.

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■ CONFLICT OF INTEREST

None.

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Механізми забезпечення енергетичної безпеки в системі міжнародних відносин з урахуванням економічних санкцій та політичних конфліктів

■ **Анотація.** В умовах глобалізації та зростаючої взаємозалежності економік енергетична безпека стала критичною складовою національної безпеки. Санкції та зміни на енергетичних ринках змушують країни адаптувати свої стратегії для збереження енергетичної незалежності та конкурентоспроможності. Метою дослідження було вивчення механізмів забезпечення енергетичної безпеки в системі міжнародних відносин, зокрема, ролі економічних санкцій як інструменту впливу на енергетичну політику держав. Проаналізовано адаптаційні стратегії країн, що перебувають під санкційним тиском в енергетичному секторі. Дослідження показало, як держави диверсифікують постачання енергоресурсів, шукають нові ринки та постачальників, заохочують інвестиції у відновлювані джерела енергії як альтернативу викопним видам палива. Особливу увагу було приділено досвіду Європейського Союзу, який створив стратегію енергетичної безпеки під впливом санкцій проти Росії, що призвело до значних змін в енергетичній інфраструктурі та стратегіях постачання. Системи планування ресурсів підприємства є важливим інструментом для країн, що перебувають під санкціями. Впровадження цих систем дозволяє ефективніше управляти енергетичними ресурсами, оптимізувати процеси постачання та зберігання енергії, а також знизити витрати. Результати дослідження показали, що санкції вплинули на світові енергетичні ринки, змінили енергетичні потоки, підвищили ціни та створили нові виклики для країн, які залежать від імпорту енергоносіїв. Дослідження також показало, як країни, що постраждали від санкцій, шукають нові шляхи зміцнення своїх енергетичних позицій через міжнародну співпрацю та партнерство. Проведений аналіз допоміг краще зрозуміти механізми адаптації країн до умов обмежень, а також виявити ключові фактори, які сприяли їхньому успіху в умовах зміни енергетичної політики. Практичне значення дослідження полягає у розробці обґрунтованих рекомендацій для держав щодо ефективних стратегій адаптації до санкційного тиску, які сприяли підвищенню енергетичної безпеки та економічної стійкості в умовах глобальних викликів

■ **Ключові слова:** диверсифікація енергопостачання; відновлювані джерела енергії; енергетична політика; глобальні енергетичні ринки; стратегії адаптації; енергетична стабільність