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Legal mechanisms for ensuring Ukraine's energy security during martial law in the context of natural resource and environmental protection

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Abstract

The aim of the study was to develop a systematic approach to improving the legal mechanisms for ensuring Ukraine's energy security in a state of martial law, based on a balance between the state's security and environmental interests. The methodological basis of the study consisted of systemic-structural, comparative-legal and formal-legal methods used to study national legislation, international regulatory acts and the practical experience of European countries. The main shortcomings of legal regulation were identified: the lack of specialised regulatory and legal acts on the restoration of energy infrastructure taking into account environmental standards, insufficient coordination between authorities and incomplete implementation of European environmental standards. The legislative basis for the successful experience of European countries has been analysed: Germany's achievement of a 45.4% share of renewable energy sources in the electricity sector, France's implementation of a programme to reduce the share of nuclear energy to 50%, Sweden's implementation of a strategy for a

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complete transition to renewable energy sources by 2040, Denmark's achievement of generating more than 50% of its electricity from wind and solar power, and Poland's implementation of a programme to diversify its energy balance with a plan to increase the share of renewable energy sources to 23% by 2030. Based on European practices, comprehensive proposals have been developed to improve Ukrainian legislation: amendments to the Law "On the Legal Regime of Martial Law", the creation of a special Law "On Energy Security", the formation of a single coordination centre under the National Security and Defence Council of Ukraine, and the introduction of mechanisms to stimulate renewable energy through a system of "green" tariffs and simplified administrative procedures. The results of the study provide a theoretical and practical basis for improving state policy in the field of energy security and environmental protection in the context of martial law and post-war reconstruction in Ukraine

Keywords: renewable energy; environmental standards; coordination centre; green tariffs; European integration

Introduction

Ensuring Ukraine's energy security during martial law is one of the key tasks on which the country's economic resilience, social stability and environmental security depend. Military actions deal a serious blow to energy infrastructure, increasing the burden on natural resources and creating additional environmental threats. In this context, there is an urgent need to create legal mechanisms that would not only ensure uninterrupted energy supply, but also take into account environmental challenges and comply with international standards. This issue is particularly relevant given the global trend towards renewable energy sources (RES), the strengthening of international cooperation in the field of energy security, and the tightening of environmental protection requirements. A comprehensive approach combining economic, legal, and environmental aspects is necessary to overcome these challenges and ensure the country's sustainable development.

Scientists are actively researching energy security issues in the context of military conflicts, paying attention to various aspects of this problem. Yu. Drachuk *et al*. (2023) focused on the integration of environmental standards into Ukraine's national policy, emphasising the importance of harmonisation with European legislation. The authors noted that bringing Ukrainian standards into line with European Union (EU) requirements could contribute to greater energy sustainability by protecting natural resources during the economic recovery period. Their analysis also indicates that legal reforms must take into account the new challenges facing the energy sector during wartime. At the same time, the study by L. Yarmol *et al*. (2022) examined the legal aspects of environmental safety in a state of martial law, in particular issues related to the adaptation of international humanitarian law to current realities. The authors emphasised that maintaining environmental balance in crisis situations is only possible if a reliable environmental monitoring system is in place. O. Kravets *et al*. (2024) examined the legal aspects of compensation for environmental damage caused to Ukraine by military actions. They stressed that effective resolution of these issues requires international support and clear legal mechanisms to ensure compensation for damage. L. Melnyk *et al.* (2024) focused on the development of 'green' energy as the basis for the sustainable recovery of Ukraine's economy after the war.

A significant contribution to the development of the theoretical and methodological foundations of the issue under study was made by D.-A. Gună (2023), who conducted a thorough analysis of the international legal framework for environmental protection during armed conflicts, emphasising the importance of complying with international environmental law even in crisis situations. The author noted that disregard for these norms not only leads to environmental disasters, but also poses a threat to the future sustainable development of regions. The author also recommends strengthening the role of international organisations in monitoring the state of the environment in conflict zones.

A significant scientific contribution to the study of the relationship between environmental challenges and energy security was made by M. Nevitt (2024) has made a significant scientific contribution to the study of the relationship between environmental challenges and energy security. The author analysed the impact of the Russian-Ukrainian war on climate security, emphasising that the war may slow down international progress in combating climate change, but in the long term may accelerate the global transition to renewable energy sources. In turn, Yu. Petlenko (2024) conducted a detailed study of renewable energy financing, emphasising its importance for strengthening Ukraine's energy independence. The author noted that investments in RES have the potential not only to stabilise the energy sector, but also to stimulate economic development in the regions. At the same time, I. Irtyshcheva *et al.* (2022) studied the problems of environmental safety in areas affected by military operations, developing methodological approaches to assessing the environmental safety of territories and identifying the regions most affected by hostilities.

H.H. Nguyen *et al*. (2024) made a significant contribution to understanding the economic aspects of energy security by conducting an empirical study of the impact of economic sanctions against Russia on the profitability of energy companies in 57 countries, finding that renewable energy companies perform better financially than traditional energy companies in times of geopolitical tension. In the same context, P. Flamm and S. Kroll (2024) explored the relationship between environmental security and peacebuilding initiatives, emphasising the need to involve local communities and civil society in environmental restoration processes to achieve sustainable peace. S. Onyshchenko *et al*. (2023) analysed in detail the risks to Ukraine's environmental and economic security in a state of martial law, documenting the impact of military aggression on all components of the environment, including air, water and soil pollution and the destruction of flora and fauna, and proposed strategies for preserving the country's environmental and economic security.

All these studies indicate that ensuring Ukraine's energy security during martial law requires the integration of environmental standards, the adaptation of international law to Ukrainian realities, the development of renewable energy, and the creation of transparent resource management mechanisms. The authors emphasise the importance of harmonising national legislation with international standards, introducing innovative solutions for sustainable development, and strengthening international cooperation. However, questions remain regarding effective compensation for environmental damage, strengthening international environmental monitoring in conflict zones, and the practical implementation of renewable energy in crisis conditions.

The aim of the study was to identify effective legal mechanisms for ensuring Ukraine's energy security in a state of martial law, taking into account the requirements for the conservation of natural resources and environmental protection.

Materials and Methods

The source base of the study was based on international regulatory and legal acts in the field of energy and environmental protection of the European Union, in particular: Directives of the European Union and of the Council No. 2018/2001 (2018), No. 2018/2002 (2018), No. 2009/119/EC (2009), No. 2011/92/EU (2011). An analysis of these documents has made it possible to identify the basic principles and mechanisms of legal regulation of energy security in the EU. The national legislation of Ukraine was represented by Law of Ukraine No. 1264-XII (1991), Law of Ukraine No. 389-VIII (2015), Law of Ukraine No. 2019-VIII (2017), as well as relevant subordinate regulatory acts. An analysis of these documents made it possible to assess the current state of legal regulation of energy security in Ukraine and identify the main problems in this area.

Particular attention was paid to the study of the legislation of neighbouring EU member states in the field of environmental impact assessment and energy security. Polish legislation was analysed, in particular the Acts of Poland "On Energy Law" (1997) and "On Access to Information on the Environment and its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments" (2008), which establishes EIA procedures for projects with a potential impact on the environment, including a simplified procedure for urgent cases. The Law of Hungary No. LIII "On the General Rules of Environmental Protection" (1995), which implements the requirements of Directive of the European Parliament and of the Council No. 2018/2001 (2018) on the environmental assessment of energy projects, was examined.

Analytical reports and studies by international organisations were an important source of information: GOLAW (2024) data on the assessment of damage to Ukraine's energy infrastructure, reports by the European Environment Agency (Renewable energy in the EU, n.d.) and the IEA (2020). Materials from WWF (2024) studies on the environmental consequences of military actions and their impact on the environment were used. Statistical information was obtained from Eurostat databases (Renewable energy statistics, 2024), which made it possible to analyse the dynamics of renewable energy development in EU countries. The work also uses national strategic documents of European countries: the German Energiewende strategy (n.d.), the French Law of France No. 2015-992 (2015), Sweden's Integrated National Energy and Climate Plan (2020), the Danish experience of transitioning to renewable energy (State of Green, 2021), Ministry of Climate and Environment of Poland (2021).

A systemic-structural method was used to analyse Ukraine's energy security regulatory framework, which made it possible to identify structural elements and the links between them. This method was used to identify gaps in legislation and develop proposals for their elimination. A comparative legal method was used to study the experience of European countries in the field of legal regulation of energy security. This method made it possible to identify common and distinctive features in the approaches of different countries to ensuring energy security and environmental protection, as well as to determine the possibilities for adapting successful European experience in Ukraine. The formal legal method was used to analyse the content of legal norms, interpret them, and develop proposals for improving legislation. This method was used to analyse the current regulatory and legal acts of Ukraine and the EU in the field of energy and environmental protection, determine their legal nature and specific features of application. The legal modelling method was used in developing proposals for improving the legal mechanisms for ensuring Ukraine's energy security and formulating recommendations for changes in legislation.

Results

Legal mechanisms for ensuring Ukraine's energy security under martial law and their impact on the conservation of natural resources and environmental protection. Ensuring Ukraine's energy security during martial law has taken on a special strategic importance, as the stable functioning of the energy sector is fundamental for maintaining societal life, ensuring economic resilience, and guaranteeing national security. The legal regulation of this critical area is based on a comprehensive system of legal acts that establish a clear procedure for actions in emergencies, define the scope of authority of state bodies, and ensure a necessary balance between the needs of the energy sector and the imperatives of protecting the natural environment. The fundamental legislative act in this area is Law of Ukraine No. 389-VIII (2015), which establishes the specifics of the functioning of state institutions, the economic sector, and the energy industry during martial law. It grants state bodies expanded powers to make urgent decisions in the field of energy security, including the ability to introduce a special operating regime for energy sector enterprises, mobilise necessary resources, and regulate energy supply processes in an emergency.

Military actions on the territory of Ukraine have had a massive negative impact on energy infrastructure and the state of the environment. According to the World Bank, Ukraine's energy infrastructure has suffered more than USD 11 billion in damages due to military actions. Over 60% of the energy infrastructure was damaged, causing mass power outages across the country. Green energy was also affected, which accounted for 13% of the energy mix before the war (GOLAW, 2024). Such destruction has led to systematic interruptions in electricity and heat supply, which directly affected the life support of millions of citizens and caused significant socio-economic consequences. It is especially critical that the destruction of energy facilities often leads to large-scale environmental disasters that cause significant environmental pollution. For example, the 1986 reactor explosion at the Chernobyl nuclear power plant caused radioactive contamination of groundwater and surface water over a large area of Ukraine, Belarus, and neighbouring countries, the consequences of which are still felt today. Or the Deepwater Horizon oil rig disaster in 2010, which caused millions of barrels of oil to spill into the Gulf of Mexico, polluting the oceanic ecosystem and coastline. Also, the destruction of the Kakhovka HPP in 2023 led to massive flooding of territories and chemical pollution of the Dnieper River due to spills from industrial facilities. All these cases demonstrate the danger of the destruction of energy facilities to ecosystems and human life, emphasising the need to strengthen measures for their protection and the elimination of the consequences of such disasters. The legal regulation of natural resource conservation is carried out in accordance with Law of Ukraine No. 1264-XII (1991), which enshrines the fundamental principles of the state's environmental policy, establishes the priority of environmental interests over economic ones, and provides mechanisms for responsibility for damage caused to the environment. However, under martial law, the implementation of the provisions of this law faces objective difficulties due to the limited available resources and the need to prioritise military needs.

The impact of military actions on the environment is complex and multi-directional, including both direct and indirect consequences for ecosystems. Direct consequences include the physical destruction of natural landscapes, the pollution of atmospheric air and water resources, and the mass death of flora and fauna. Indirect consequences are manifested in the gradual degradation of ecosystems, a significant decrease in biodiversity indicators, and negative changes in the region's climatic conditions. For example,

large-scale fires at oil depots lead to significant emissions of carbon dioxide and other greenhouse gases, which significantly accelerates global warming (WWF, 2024).

An analysis of the provisions of current Ukrainian legislation reveals several gaps that make it impossible to effectively account for both energy and environmental challenges during martial law. For instance, while Article 8 of the Law of Ukraine No. 389-VIII (2015) outlines the general powers of state authorities, there is no mention of the procedure for the rapid restoration of damaged energy facilities while considering the need to preserve the environment. This law also fails to provide a procedure for assessing the environmental impact of repairs or reconstruction of energy infrastructure damaged by military actions. This gap becomes particularly critical in practice because, on one hand, the state must ensure the uninterrupted functioning of the energy sector during martial law, while on the other, it must avoid additional environmental pollution or destruction. Furthermore, Article 15 of the Law of Ukraine No. 2019-VIII (2017) regulates relations between market participants but does not contain provisions for emergency state intervention in the event of the destruction of critical energy facilities, nor does it establish mandatory environmental measures for the reconstruction of damaged generation or power lines. In contrast, Article 3 of the Directive of the European Parliament and of the Council No. 2018/2001 (2018) explicitly states the need for environmental impact assessment in the implementation or restoration of renewable energy projects, including those carried out in emergency or crisis situations. This highlights the priority of environmental safety alongside ensuring energy resilience. This difference in approaches reveals a significant inconsistency between national and EU law, which hinders the effective implementation of European norms in Ukraine and jeopardises both the environment and the state's energy security.

Ukrainian legislation in the field of energy and ecology, especially during martial law, differs significantly from the corresponding regulations in neighbouring EU countries. In Poland, the approach to regulating energy and ecology is different due to a clear procedure for environmental impact assessment (EIA) for projects with a potential significant environmental impact. Although the Act of Poland "On Energy Law" (1997) does not contain direct provisions on EIA, the environmental aspects are regulated by the Act of Poland "On Access to the Provision of Information on the Environment and its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments" (2008). This law mandates EIA for projects that may have a significant environmental impact, including emergency cases. In addition, Poland provides for simplified procedures for urgent projects, which allows for environmental risks to be taken into account even in emergency conditions.

In neighbouring Hungary, Law No. LIII (1995) and relevant by-laws require a mandatory environmental impact assessment (EIA) for projects that may have a significant impact on the ecosystem. Although the law does not explicitly mention emergency work on infrastructure facilities, it establishes general principles for assessing environmental impact, including provisions for projects carried out on a tight schedule. This allows for environmental aspects to be considered even in emergency situations, establishing minimum requirements for environmental protection. This approach was aimed at minimising risks to ecosystems even in critical conditions, ensuring a balance between the speed of project implementation and the preservation of the natural environment. Romania, in its environmental legislation, is based on the Directive of the European Parliament and of the Council No. 2018/2001 (2018), which

requires environmental aspects to be taken into account during the design, construction, and reconstruction of energy facilities. This applies even to projects implemented in emergency situations, as a simplified EIA procedure is provided.

Features of legal regulation of energy security in European countries: Environmental aspect. The European Union and its member states have developed and implemented a comprehensive system of legal regulation for energy security, which is closely integrated with environmental requirements and sustainable development strategies. An analysis of European legislation in this area demonstrates the EU's consistent desire to achieve an optimal balance between ensuring a reliable energy supply and minimising negative environmental impact. The foundational document that defines the strategic directions of the EU's energy policy is the European Green Deal (2019), which sets the ambitious goal of achieving climate neutrality by 2050. The strategy provides for a reduction in greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, an increase in energy efficiency, and a greater share of renewable energy sources in total energy consumption. RES includes types of energy such as solar, wind, hydropower, and bioenergy, which have the ability to regenerate naturally and have a minimal impact on the environment.

The EU's legal framework for energy security includes a number of important directives and regulations, among which are the Directives of the European Parliament and of the Council No. 2018/2001 (2018) and No. 2018/2002 (2018). The former sets a mandatory target of achieving 32% renewable energy sources in the EU's total energy consumption by 2030 and provides legal mechanisms for cooperation between member states, including Joint Projects and the possibility of transferring "surplus" RES generation from one country to another. In addition, the directive obliges the creation of "one-stop-shops" for obtaining permits, which significantly simplifies the process of launching projects in the "green" energy sector. Separate provisions of the directive (Articles 21-22) introduce tools to involve communities in the production of renewable energy, in particular through the promotion of prosumer initiatives and the development of "energy communities," which are guaranteed the right to produce, consume, and sell surplus energy to the grid. Thanks to this combination of legal and financial levers, EU countries receive an effective toolkit for increasing the share of RES, while at the same time promoting investment development in the sector and the creation of local "green" energy markets.

Meanwhile, Directive of the European Parliament and of the Council No. 2018/2002 (2018) sets the goal of increasing energy efficiency indicators by 32.5% by 2030 and obliges member states to approve national action plans for energy efficiency. In particular, Articles 3 and 7 oblige the introduction of standards for the modernisation of buildings and heating systems, and Articles 2a and 4 require the formation of long-term strategies with clearly defined guidelines and interim reports. To stimulate energy-efficient projects, the directive provides for the creation of national funds and the use of preferential financial instruments and tax incentives (Article 20), which motivates both businesses and households to invest in technologies that can reduce energy consumption. In this way, the EU combines regulatory and market mechanisms, enshrining "binding targets" and creating conditions for sustainable development, where renewable energy sources and energy efficiency measures play a leading role in strengthening energy security (International Energy Agency, 2021).

An analysis of the specifics of legal regulation in individual European countries demonstrates a variety of approaches to ensuring energy security, taking into account national characteristics and

priorities. Germany is implementing the Energiewende strategy (n.d.), which provides for a gradual transition from nuclear and fossil energy to RES. The Law of the Federal Republic of Germany "On the Expansion of Renewable Energies" (2014) stimulates the development of RES through fixed tariffs and auctions. At the same time, the updated law "On Electricity and Gas Supply (Energy Industry Act – EnWG)" (2005) provides for the priority connection of "green" generation, and supplements to the Building Code (BauGB) (Buzer.de, 2017) and the Federal Immission Control Act (BImSchG) (Law of the Federal Republic of Germany..., 1974) simplify the receipt of permits and unify environmental requirements. Thanks to such mechanisms, investors receive stable conditions, which accelerates the implementation of new projects and allows for a gradual transition away from fossil fuels and nuclear energy. In France, where nuclear energy has traditionally held a dominant position, the government adopted Law of France No. 2015-992 (2015), which sets goals to reduce the share of nuclear energy to 50% and increase the share of RES to 32% by 2030 (Ministry of Environment, Energy and the Sea, 2016). France is actively developing wind and solar energy and is also implementing energy efficiency programmes in the construction sector. In 2020, the share of RES in France's total energy consumption reached 19.1% (Renewable energies and..., 2021), which indicates gradual progress in achieving the set goals.

Sweden stands out as a leader in renewable energy use, with RES accounting for over 60% of its total energy consumption (Sweden Sverige, 2024). This is a result of a long-term policy focused on developing hydropower, bioenergy, and wind power. The Sweden's Integrated National Energy and Climate Plan (2020) promotes energy efficiency and innovation, and aims for a complete transition to RES in electricity generation by 2040. Sweden is also actively implementing measures to decarbonise transport and industry, which involves reducing carbon dioxide emissions through a transition to environmentally friendly technologies, contributing to an overall reduction in greenhouse gas emissions. In contrast, Poland, which is heavily dependent on coal energy, is working on diversifying its energy mix. The Energy Policy of Poland until 2040 (2021) aims to reduce the share of coal in electricity generation to 56% by 2030 and develop RES, particularly offshore wind energy. Poland plans to increase its installed RES capacity to 23% by 2030, which should help reduce CO_2 emissions and enhance energy security.

An important aspect of European energy policy is the mechanisms for ensuring energy security in crisis conditions. The Directive of the Council of the European Union No. 2009/119/EC (2009) obliges member states to maintain minimum reserves of oil and petroleum products equivalent to 90 days of average daily imports. This prepares EU countries for potential disruptions in energy supply and ensures the stability of the energy market. The Regulation of the European Parliament and of the Council No. (2017) on the security of gas supply establishes mechanisms for cooperation and solidarity among member states to prevent and respond to gas crises. In 2022, the EU adopted the "Save Gas for a Safe Winter" plan (European Commission, 2022a), which aimed to reduce gas consumption by 15% to enhance energy security amid geopolitical instability.

Research on the balance between security and environmental requirements shows that European countries seek to integrate environmental standards into energy policy even during crises. After the 2021 energy crisis, caused by rising gas prices, the EU did not abandon its environmental goals. On the contrary, it emphasised the importance of accelerating the transition to RES to reduce dependence on imported fossil fuels (European Commission, 2022b). An

empirical assessment of the effectiveness of European mechanisms, based on statistical data on RES development and energy efficiency, demonstrates positive trends. According to Eurostat, the share of RES in EU energy consumption grew from 9.6% in 2004 to 22.1% in 2020 (Erin, 2023), which indicates the success of legal mechanisms and policies stimulating the development of "green" energy. To better understand this, Figure 1 shows the historical dynamics of the growth of the share of RES and the target set for 2030. Countries with clear legal mechanisms and strategic planning achieve better results in energy security and environmental sustainability. For example, Sweden, with a high share of RES, has a low dependence on energy imports (32.2%) and one of the lowest per capita CO_2 emissions in the EU (3.8 t/year) (Renewable energy statistics, 2024).

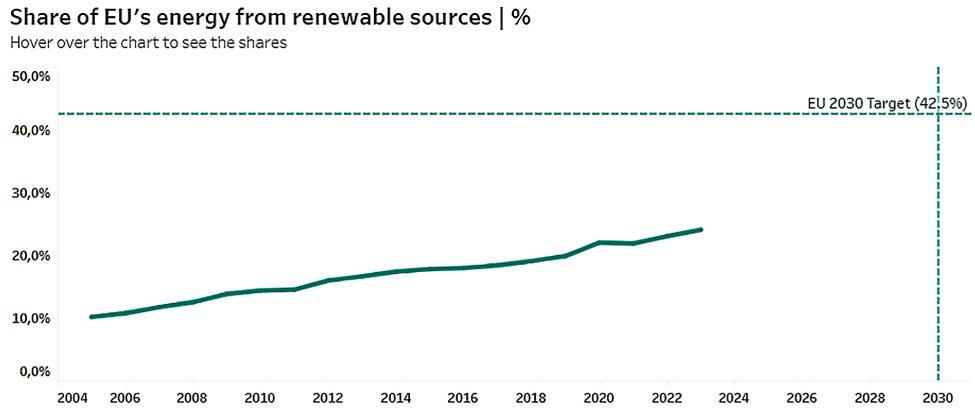

Figure 1. Share of energy from renewable sources in the EU, 2004-2030

Notes: Gross final energy consumption. The solid line represents reported data on the share of energy from renewable sources in the EU. The dotted line – a linear trajectory between the latest reported value and the target

Source: Renewable energy in the EU (n.d.)

Figure 1 shows steady and consistent growth over the last two decades, which is a direct result of the implementation of a comprehensive system of legal regulation and incentives for the development of RES. It is particularly important that even in the face of various economic challenges and crises, the growth trend remains stable, and the target of 42.5% by 2030, although ambitious, appears achievable if the current pace of development in the sector is maintained. This progress clearly illustrates the effectiveness of European energy transformation policy and demonstrates the practical implementation of the goals set out in EU directives and strategic documents.

Along with the growth of the share of renewable energy sources in the EU's energy balance, an important environmental result of this transition is the reduction of greenhouse gas emissions. Avoiding such emissions contributes to the achievement of climate goals and reduces dependence on fossil fuels. Data from Renewable energy in the EU (n.d.) indicate a significant impact of RES on reducing CO_2 emissions in various sectors. Figure 2 shows how renewable energy contributes to reducing emissions in the EU as a whole and in individual member states.

An analysis of the impact of renewable energy sources (RES) on greenhouse gas emission reduction, presented in Figure 2, provides evidence of the effectiveness of European decarbonisation policy. Progress in the electricity sector is particularly significant, showing the

most substantial emission reductions. A comparative analysis of the achievements of EU member states demonstrates the leadership of Germany, Spain, and France in reducing greenhouse gas emissions through the implementation of RES. This confirms the effectiveness of their national strategies and legal mechanisms to incentivise the development of renewable energy. It is important to note that positive trends are observed not only in electricity but also in the heating, cooling, and transport sectors, indicating the comprehensive nature of the energy transition in the EU. This trend not only confirms the correctness of the chosen course towards decarbonising the economy but also creates a strong empirical basis for further improving energy security policy with environmental aspects in mind, which is particularly relevant for Ukraine in the context of its European integration and energy sector reform.

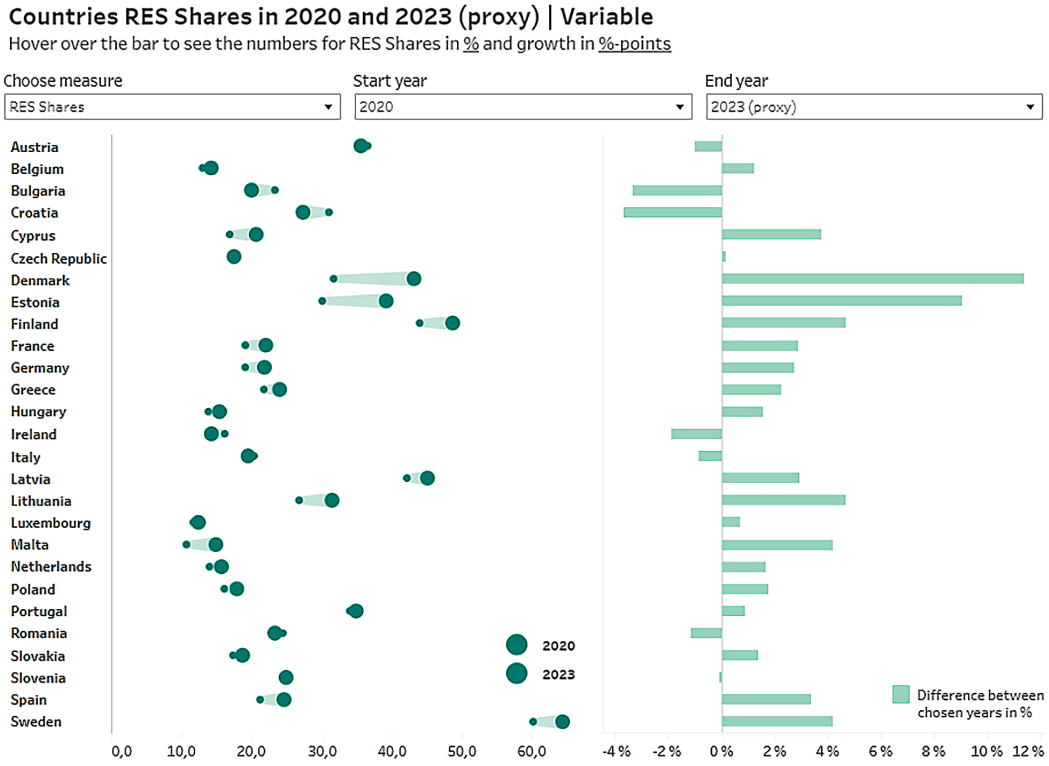

Figure 2. Environmental effects of RES use: greenhouse gas emissions reduction, 2005-2023
Source: Renewable energy in the EU (n.d.)

An analysis by the IEA (2020) shows that the implementation of energy-efficient technologies in EU countries has led to a 1.5% annual reduction in energy consumption over the last decade, which is equivalent to a saving of EUR 15 billion per year. This highlights the economic benefits of implementing energy efficiency policies and confirms their role in ensuring energy security. Identifying promising directions for Ukraine involves adapting European experience while considering national specifics. First, it is necessary to develop a long-term strategy for the development of

RES and energy efficiency with clear targets. This should include legislative consolidation of goals for increasing the share of RES in the energy balance, improving energy efficiency in all sectors of the economy, and reducing greenhouse gas emissions in line with Ukraine's international obligations. It is important to implement legal mechanisms that will incentivise investment in "green" energy through fixed tariffs, auctions, and tax benefits, which will create favourable conditions for attracting private capital and international investments in the development of the RES sector.

The development of infrastructure to integrate RES into the energy system, including energy storage systems and "smart" grids, will contribute to the stability of the energy supply and the efficient use of renewable resources. In 2022, Ukraine joined the European energy network ENTSO-E (2023), which is an association of European electricity transmission system operators. This increases the stability of the energy system and promotes market integration, opening up new opportunities for technical cooperation and the exchange of experience in the field of energy system management. The integration of EU environmental standards into national legislation, in particular through the implementation of EU directives within the Association Agreement (2014), will contribute to the harmonisation of the legal field and the improvement of environmental standards. This will also open up new opportunities for cooperation and access to European financial instruments, such as the programmes of the European Investment Bank and the European Bank for Reconstruction and Development, which support projects in the RES and energy efficiency sectors.

Improving legal regulation of energy security in Ukraine. Improving the legal regulation of Ukraine's energy security requires a comprehensive approach, especially during martial law and growing environmental challenges. An analysis of current legislation and its application has revealed a number of systemic problems that significantly limit the state's ability to ensure the stable functioning of the energy sector and the proper protection of natural resources. In particular, the Law of Ukraine No. 389-VIII (2015) lacks detailed provisions on the specifics of managing the energy sector and environmental protection during martial law, which creates legal uncertainty and complicates the process of making operational decisions in crisis situations. At the same time, the Law of Ukraine No. 2019-VIII (2017) does not take into account the specifics of the energy market in emergency situations, which significantly limits the possibilities of state regulation to ensure an uninterrupted energy supply. In addition, the lack of specialised regulatory acts that would regulate the processes of restoring energy infrastructure while taking into account modern environmental standards creates significant obstacles to the effective reconstruction of the industry and the minimisation of negative environmental impact.

Military actions on the territory of Ukraine have caused large-scale damage to energy infrastructure and led to serious environmental consequences. According to official data from the Ministry of Energy of Ukraine, as of December 2022, over 50% of energy facilities were damaged to varying degrees (50% of Ukraine's energy..., 2023). Such damage has caused massive interruptions in the supply of electricity and heat, which has negatively affected the livelihoods of the population and the country's economy. It is especially critical that the damage to oil depots, gas pipelines, and other energy facilities has led to large-scale pollution of soils, water resources, and atmospheric air, creating long-term environmental problems. The pollution of land and water resources, in particular with heavy metals and petroleum products, can have serious consequences for the health of the population and the biodiversity of the regions affected by the fighting.

To overcome these challenges, it is necessary to develop and implement a set of concrete proposals to improve legal mechanisms. First, it is proposed to supplement the Law of Ukraine No. 389-VIII (2015) with a separate section that will detail the specifics of managing the energy sector during martial law. This section should provide for clear mechanisms for rapid response to threats to energy security, including procedures for emergency repair and restoration of damaged infrastructure using modern technologies and taking into account environmental standards. This will ensure a quick restoration of energy supply and minimise negative environmental impact. An important element is the introduction of a special operating regime for energy enterprises, which will ensure an uninterrupted energy supply to critical facilities such as hospitals, water supply stations, and other infrastructure, including mechanisms for flexible regulation of tariffs and energy supply conditions. In addition, it is necessary to establish a clear procedure for mobilising resources for the restoration of energy infrastructure, including procedures for attracting material and human resources, as well as mechanisms for international assistance and cooperation with international organisations and partners.

The next important step should be the development and adoption of a special Law of Ukraine "On Energy Security," which will define the general principles of state policy in this area, establishing the priority of ensuring energy independence, diversifying energy sources, and developing its own energy capacities, in particular by stimulating the use of renewable energy sources. This legislative act should clearly define the competence of state authorities in the field of energy security, ensuring an effective distribution of powers between central and local authorities, as well as between various departments such as the Ministry of Energy, the Ministry of Environmental Protection and Natural Resources, and the State Emergency Service. Special attention should be paid to the mechanisms for coordinating actions between various departments and agencies for an effective response to crisis situations, which may include the creation of a single coordination centre for energy security and environmental protection under martial law on the basis of the National Security and Defence Council (NSDC) of Ukraine with the involvement of representatives of relevant ministries and departments.

Improving environmental legislation to account for the specifics of martial law is an integral part of a comprehensive approach to solving the problem. It wasU proposed to amend the Law of Ukraine No. 1264-XII (1991) to establish a special environmental control regime during martial law, which will allow for prompt detection and response to environmental threats caused by military actions. This can be achieved by strengthening monitoring, using modern remote sensing technologies, and attracting additional resources. A crucial aspect is making Environmental Impact Assessments (EIA) mandatory for the reconstruction and construction of energy facilities, even in emergency conditions. This will help minimise the negative impact on ecosystems and ensure the sustainable use of natural resources. Additionally, it is necessary to establish clear responsibility for environmental offenses under martial law, particularly for the deliberate damage to environmental objects or negligence leading to ecological disasters.

The implementation of European experience in energy security and environmental protection involves adapting the best practices and standards of the EU to Ukrainian national legislation. Specifically, it is necessary to implement the provisions of the Directive of the European Parliament and of the Council No. 2018/2001 (2018) on the promotion of the use of energy from renewable sources by introducing effective mechanisms to stimulate the development of renewable energy

sources (RES), such as the "green" tariff system and holding auctions to attract new investors. A telling example of the successful implementation of such mechanisms is the experience of Spain, where the auction system for supporting RES has significantly increased the installed capacity of solar and wind energy (Rosales-Asensio *et al*., 2024). An important element is the simplification of administrative procedures for the construction and connection of RES facilities, which will reduce bureaucratic barriers and accelerate the development of the sector. For example, in Germany, legislation provides for simplified procedures for small and medium-sized RES projects, which encourages the active participation of local communities and entrepreneurs in the development of renewable energy.

The implementation of the provisions of the Directive of the European Parliament and of the Council No. 2012/27/EU (2012) on energy efficiency will contribute to the establishment of national energy efficiency targets and the improvement of building energy efficiency through the introduction of minimum energy standards for new and reconstructed buildings. A successful example of such a strategy is the experience of Denmark, which has introduced high energy efficiency standards and financial incentives for building modernisation, leading to a significant reduction in energy consumption (Danes embrace energy..., 2024). The integration of EU environmental standards, particularly the provisions of the Directive of the European Parliament and of the Council No. 2011/92/EU (2011) on the assessment of the environmental impact of certain public and private projects, will ensure that EIA is mandatory for all significant energy projects and that the public is involved in this process. A striking example is the experience of Finland, where public participation in the EIA process is mandatory, which helps in making more balanced decisions and increases public trust in the authorities (OECD, 2021).

The mechanisms for implementing the proposed changes must be practical and effective, which involves holding broad consultations with all interested parties, including representatives of the energy sector, environmental organisations, and local communities. An important aspect is ensuring proper training and capacity building for the staff of state bodies and energy enterprises, which may include cooperation with European partners and international organisations. At the same time, it is necessary to take into account possible obstacles to the implementation of the proposed changes, such as resistance from certain interested parties, insufficient funding, and a lack of qualified personnel. To overcome these obstacles, it is necessary to provide for a system of financial incentives and benefits, mechanisms for attracting international aid and investment, and training and capacity-building programmes.

An assessment of the potential impact of the proposed measures on various sectors of the economy and society indicates their positive effect. The energy sector will have the opportunity to modernise its infrastructure and increase its resilience and efficiency. The economy as a whole will receive an additional impetus through attracting investment, creating new jobs, and developing innovative technologies. The social sphere will benefit from increased reliability of energy supply and an improved environmental situation, which will have a positive impact on public health and the quality of life of citizens.

Practical experience in European countries confirms the effectiveness of the proposed measures. In particular, Germany's Energiewende programme envisaged a gradual shift away from nuclear and coal-fired power in favour of RES, accompanied by the creation of an appropriate legal framework and system of financial incentives. As a result, the share of RES in the country's electricity sector increased to 42.6% in 2019 (Agora Energiewende, n.d.), contributing to a reduction

in CO_2 emissions by more than 50 million tonnes and the creation of new jobs. In Denmark, setting ambitious targets for a complete phase-out of fossil fuels by 2050 and introducing effective legal mechanisms and state support has enabled the country to become a leader in wind energy, generating more than 50% of its electricity from wind and solar power in 2020. This success was made possible by consistent government policy, which included a ban on the construction of new coal-fired power plants since 1997, the introduction of a "single window" system for obtaining permits, the implementation of demonstration projects through public-private partnerships, and the creation of favourable economic incentives for the development of renewable energy (State of Green, 2021). In France, the adoption of Law of France No. 2015-992 (2015) set targets for reducing the share of nuclear energy and increasing RES, accompanied by the introduction of support mechanisms for the development of solar and wind energy, as well as energy efficiency programmes.

The expected results of the proposed measures include a significant increase in Ukraine's energy security, which will be achieved by reducing dependence on energy imports, diversifying supply sources and actively developing domestic energy capacities, particularly in the field of renewable energy sources. An important aspect is the expected improvement in the environmental situation, which will reduce the negative impact on the environment and preserve biodiversity and natural resources through the integration of modern environmental standards into the processes of restoration and development of energy infrastructure. Improvements in the efficiency of public administration will be achieved through the introduction of a clear division of powers between authorities, the improvement of mechanisms for coordinating their activities, ensuring transparency in decision-making processes, and the active involvement of the public in discussions on important issues relating to the development of the energy sector.

Particular attention should be paid to the economic aspects of the proposed changes, in particular the creation of favourable conditions for attracting investment in the renewable energy and energy efficiency sectors, which will contribute to overall economic development, the creation of new jobs and the strengthening of the country's scientific and technical potential. An important element is the strengthening of international cooperation and the deepening of Ukraine's integration into the European energy space, which will strengthen the country's position in the international arena, ensure the fulfilment of international obligations and obtain the necessary financial and technical assistance for the modernisation of the energy sector. Comprehensive improvement of the legal mechanisms for ensuring Ukraine's energy security in a state of martial law, taking into account the requirements for the conservation of natural resources and environmental protection, is a necessary prerequisite for achieving sustainable development of the state. The proposed practical and specific recommendations, based on an analysis of current legislation and successful European experience, can create a solid foundation for effectively responding to contemporary challenges and ensuring the stable and environmentally safe functioning of the energy sector. The implementation of these recommendations will not only contribute to ensuring internal stability and economic growth, but also to enhancing Ukraine's international authority as a reliable partner that consistently adheres to high standards in the field of energy and ecology.

Discussion

The study revealed fundamental problems in the legal regulation of Ukraine's energy security under martial law, which require a systematic solution that takes into account environmental

imperatives and the country's European integration aspirations. Based on the results of a comprehensive analysis of the regulatory framework and law enforcement practices, critical shortcomings were identified in three key areas: coordination of government agencies, mechanisms for assessing and compensating for environmental damage, and procedures for restoring damaged energy infrastructure. In particular, the lack of clearly regulated procedures for interaction between different agencies leads to duplication of functions and inefficient use of resources in critical situations. There was a lack of effective balance between energy security objectives and environmental protection requirements, leading to significant economic losses and environmental risks in both the short and long term. These conclusions are strongly supported by the study by J.D. Colgan *et al*. (2023), who, based on empirical data, estimated the scale of Europe's economic losses due to energy dependence on Russian energy carriers at EUR 517-831 billion and justified the urgent need to diversify energy supply sources. M. Al-Saidi (2023) develops this thesis, proposing specific promising areas of cooperation with Middle Eastern countries to strengthen energy security and emphasising the importance of long-term strategic partnerships in the energy sector.

The study developed a comprehensive methodology for assessing the effectiveness of legal mechanisms for ensuring energy security, which, unlike existing approaches, integrates economic, environmental and security aspects into a single assessment system. The proposed methodology is based on a multi-level system of indicators, which allows not only to assess the current state of energy security, but also to predict potential risks and threats. Particular attention is paid to the possibility of assessing both the direct and indirect consequences of military actions for the energy sector, which is of exceptional relevance in the context of ongoing aggression. The developed methodological toolkit includes a system of quantitative and qualitative indicators that allow for a comprehensive assessment of the effectiveness of legal mechanisms at various levels of public administration. This correlates with the conclusions of A.B. Ige *et al*. (2024) regarding the need for a comprehensive approach to protecting energy infrastructure from modern threats, including cyberattacks and other forms of hybrid influence. C. Samaras *et al.* (2019) and D. Mara *et al*. (2022) confirm in their studies the conclusions about the strategic importance of energy security for the defence sector, emphasising the need to integrate energy issues into military planning. At the same time, a thorough study by M. Rajavuori and K. Huhta (2020) significantly complements the understanding of the role of investment screening in the protection of critical infrastructure, proposing additional mechanisms for assessing security risks when attracting foreign investment in the energy sector.

A significant result of the study was the development of a conceptual model for the transformation of Ukraine's energy sector in the context of European integration, based on a systematic analysis of existing legal mechanisms and an assessment of their compliance with European standards. It has been established that the current energy market model is characterised by significant structural shortcomings and requires fundamental changes to ensure compliance with the requirements of sustainable development and energy security. In particular, insufficient integration of environmental requirements into the processes of planning and implementing energy policy, the lack of effective mechanisms to stimulate the development of renewable energy sources, and the low efficiency of the state regulation system for the energy sector in crisis conditions have been identified. These findings are confirmed by the study by C. Kuzemko *et al*. (2022), which emphasises the critical

importance of accelerating the energy transition in the context of Russian aggression and stresses the need for a systemic transformation of the energy sector. L. Rodríguez-Fernández *et al.* (2020) provide strong empirical evidence in favour of the recommendation to diversify gas supply sources, demonstrating the positive impact of such a policy on energy security using the example of EU countries. An important contribution to understanding the issue is made by B. Zakeri *et al*. (2022), who develop the thesis on the need to build resilient energy systems in the context of multiple crises and propose specific mechanisms to increase their reliability.

A key element of the study was the development of comprehensive proposals for improving legal mechanisms to ensure energy security, taking into account both the specifics of martial law and the long-term goals of sustainable development of the state. Based on the analysis, amendments to a number of legislative acts were proposed, aimed at strengthening environmental protection mechanisms in the energy sector and implementing European environmental standards. In particular, proposals have been developed to improve the environmental monitoring system, introduce economic incentives for environmentally friendly technologies, and strengthen liability for violations of environmental legislation in the energy sector. The proposals find substantial support in the research of Yu. Kharazishvili *et al*. (2021), which offers additional methodological tools for assessing the effectiveness of such mechanisms and emphasises the need to adapt them to the specifics of martial law. Fundamental research by J.E. Payne *et al*. (2023) provides convincing evidence of the need to take into account global trends in the transformation of energy markets when formulating national policy, in particular regarding the development of renewable energy sources and the introduction of energy-efficient technologies.

The study pays particular attention to the analysis of the specifics of legal regulation in conditions of martial law, which revealed the need to develop special mechanisms for assessing and compensating for environmental damage caused by military actions. Based on a systematic analysis of international experience and national practice, innovative approaches to determining the amount of damage and mechanisms for its compensation are proposed, taking into account both the direct and long-term environmental consequences of military actions. A methodology has been developed to assess the cumulative impact of military actions on the environment and energy infrastructure, which allows for a more accurate determination of the amount of compensation required. An important contribution to understanding the issue is made by T.L. Shaar and R. Leal-Arcas (2024), who develop conclusions on the need to accelerate the decarbonisation of the energy sector, demonstrating its key role in ensuring long-term energy security and environmental sustainability.

A significant scientific contribution of this study is the development of comprehensive methodological principles for assessing the long-term environmental consequences of military actions for the energy sector and mechanisms for compensating for them. Based on the analysis, an integrated system of indicators for monitoring and assessing environmental damage has been proposed, taking into account both direct losses from infrastructure destruction and long-term consequences for ecosystems. Mechanisms for determining the cause-and-effect relationships between military actions and environmental damage have been developed, creating a legal basis for substantiating claims for compensation for damage caused. M. Dolynska *et al*. (2023) confirm the relevance of this approach, focusing on the specific problems of legal regulation of land relations in wartime and the need to develop special

mechanisms for the protection of environmental rights. N. Trotsiuk and H. Hrabovsky (2023) significantly develop recommendations for improving the environmental control and monitoring system, proposing specific tools to increase the effectiveness of state supervision in the environmental sphere.

Unlike previous studies, the proposed comprehensive approach to addressing energy security issues takes into account both the specifics of martial law and the long-term goals of sustainable development and European integration. This creates a reliable methodological and legal basis for the formation of effective state policy in the field of energy security and environmental protection. The results of the study are of direct practical importance for improving the system of state management in the energy sector and can be used in the development of strategic documents for the post-war reconstruction of Ukraine. In conclusion, it should be emphasised that ensuring Ukraine's energy security in a state of martial law requires a systemic transformation of the legal mechanisms for regulating the energy sector. The proposed changes to the legislation, the methodological approaches developed and the practical recommendations create a comprehensive basis for solving the identified problems, taking into account environmental requirements, EU standards and the specifics of martial law. A comparative analysis with the results of leading international studies confirms the relevance and validity of the proposed solutions aimed at strengthening energy independence, protecting critical infrastructure and ensuring the environmental security of the state.

Conclusions

The study demonstrated a systematic approach to improving the legal mechanisms for ensuring Ukraine's energy security during martial law. An analysis of the current legislation revealed critical shortcomings in the legal framework, in particular, the lack of specialised regulatory acts for restoring energy infrastructure while taking into account environmental standards, inconsistencies between the provisions of the Law of Ukraine "On the Legal Regime of Martial Law" and sectoral laws in the field of energy and environmental protection, and insufficient integration of European environmental standards into national legislation. The lack of clear mechanisms for coordinating between authorities when responding to damage to critical energy infrastructure and mechanisms for assessing the environmental impact of restoration work is a particularly acute problem.

The study of the European experience in the legal regulation of energy security made it possible to identify effective mechanisms for ensuring a balance between energy and environmental interests. The successful practices of five EU countries were analysed, demonstrating different approaches to the transformation of the energy sector: the use of a system of "green" tariffs and auctions, energy certificate and investment grant systems, incentive systems for the development of offshore wind power and energy cooperatives, and mechanisms for simplifying administrative procedures.

Based on the analysis, a set of concrete proposals was developed to improve the legal regulation of Ukraine's energy security. It is proposed to amend the Law "On the Legal Regime of Martial Law," supplementing it with provisions on special procedures for restoring damaged energy infrastructure and mechanisms for assessing the environmental impact under martial law. The necessity of adopting a special Law "On Energy Security" was justified, which will define the principles of state policy in this area and establish mechanisms for coordinating the actions of authorities. It is recommended to create a single coordination centre under the National Security and Defence Council of Ukraine to manage the processes of restoring the energy sector and to introduce

a system for stimulating the development of renewable energy sources through "green" tariffs and simplified administrative procedures, following the example of European countries. The implementation of these proposals is expected to: reduce dependence on imported energy sources by 30-40% by 2030; increase the share of renewable energy sources in the energy balance to 25% by 2030; reduce greenhouse gas emissions by 40% compared to the 1990 level; create over 50,000 new jobs in the "green" energy sector; and attract at least 5 billion euros of foreign investment in the modernisation of energy infrastructure.

Further research should be focused on several key areas: the development of mechanisms for the financial support of the proposed changes, including the creation of a special energy reconstruction fund and a system of state guarantees for investors; the study of opportunities for attracting international investments for the restoration of energy infrastructure through mechanisms of "green" bonds and climate funds; the study of the specifics of implementing European standards in the post-war reconstruction of Ukraine, in particular regarding the implementation of the Emissions Trading System and Cross-Border Carbon Adjustment Mechanisms; and the development of a methodology for assessing the effectiveness of the implemented legal mechanisms based on a system of quantitative and qualitative indicators that will allow for monitoring progress in achieving the set goals and timely adjusting state policy in the field of energy security.

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Conflict of Interest

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Правові механізми забезпечення енергетичної безпеки України під час воєнного стану в контексті охорони природних ресурсів і захисту довкілля

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Анотація

Метою дослідження було формування системного підходу до вдосконалення правових механізмів забезпечення енергетичної безпеки України в умовах воєнного стану на основі балансу безпекових та екологічних інтересів держави. Методологічну основу дослідження склали системно-структурний, порівняльно-правовий та формально-юридичний методи, використані для вивчення національного законодавства, міжнародних нормативно-правових актів та практичного досвіду європейських країн. Встановлено основні недоліки правового регулювання: відсутність спеціалізованих нормативно-правових актів щодо відновлення енергетичної інфраструктури з урахуванням екологічних стандартів, недостатня координація між органами влади та неповна імплементація європейських екологічних норм. Проаналізовано законодавчі засади успішного досвіду європейських країн: досягнення Німеччиною 45,4 % частки відновлюваних джерел енергії в електроенергетиці, впровадження Францією програми скорочення частки ядерної енергетики до 50 %, реалізація Швецією стратегії повного переходу на відновлювані джерела енергії до 2040 року, досягнення Данією показника генерації понад 50 % електроенергії з вітру та сонця, та впровадження Польщею програми диверсифікації енергетичного балансу із планом збільшення частки відновлюваних джерел енергії до 23 % до 2030 року. На основі європейських практик розроблено комплексні пропозиції щодо вдосконалення законодавства України: доповнення до Закону «Про правовий режим воєнного стану», створення спеціального Закону «Про енергетичну безпеку», формування єдиного координаційного центру при Раді національної безпеки та оборони України та впровадження механізмів стимулювання відновлюваної енергетики через систему «зелених» тарифів і спрощених адміністративних процедур. Результати дослідження створюють теоретичне та практичне підґрунтя для вдосконалення державної політики у сфері енергетичної безпеки та охорони довкілля в умовах воєнного стану та післявоєнної відбудови України

Ключові слова: відновлювана енергетика; екологічні стандарти; координаційний центр; зелені тарифи; Європейська інтеграція