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## EFFICIENCY OF INSTITUTIONAL REGULATION OF REGIONAL ELECTRICITY MARKETS IN UKRAINE: ANALYSIS OF INTERNATIONAL EXPERIENCE AND MECHANISM OF ENSURING

**Abstract.** *The current state of Ukraine's electricity market is characterized by a contradiction between the state's declared intentions for its development, which stimulated investment activity, in the field of renewable energy sources (RES), and current development trends, which are complicated by the decline in electricity demand due to the pandemic, as well as macroeconomic and political instability. The market is further complicated by imperfect market mechanisms, such as price regulation and lack of competition, and infrastructure problems, including outdated transmission lines and insufficient grid capacity, which impede the balancing of market participants' interests, and the formation of a competitive environment focused on innovative development.*

**Relevance.** *Studying international experience in regulating the electricity market is crucial for Ukraine and its regions, especially those with significant electricity production potential (e.g., the Southeastern region). This study can serve as a catalyst for intensified investment and innovation activities, leading to a brighter future for the country's energy sector.*

**Objective.** *The purpose of the article is to analyze the effectiveness of institutional regulation of regional electricity markets in Ukraine and assess the efficiency of RES use at the regional level.*

**Results.** *It is established that the domestic electricity sector is inferior regarding support for attracting investment and international cooperation in innovation. Despite the EU's increased interest in investing in Ukrainian projects due to integration prospects and the potential for using transit and production capacities, Ukraine needs to increase the attractiveness of investments in the electricity sector, including in innovative projects. It is argued that Ukraine's strengths are its high potential for the development of some regions of electricity (nuclear, hydro, solar, wind), unique transit potential (which, at the same time, creates additional risks due to the country's involvement in international competition for resources) and significant human resources (the possibility of cooperation at the level of scientific schools and research and development institutes). International experience developing the electricity market shows a tendency to liberalize regulatory influences and regionalize regulation.*

**Conclusions.** *Understanding not only the national priorities for regulating investment and innovation processes in the energy sector, but also the peculiarities of alternative energy development in the regional context, is crucial for Ukraine. This comprehensive understanding will enable the optimization of management decisions, considering the specifics of the regional economy, natural ecosystems, and social aspects.*

**Keywords:** *Institutional regulation, institutions, institutional framework, regulatory efficiency, regulation, energy sources, renewable energy sources, electricity, region, regional market.*

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## ЕФЕКТИВНІСТЬ ІНСТИТУЦІЙНОГО РЕГУЛЮВАННЯ РЕГІОНАЛЬНИХ РИНКІВ ЕЛЕКТРОЕНЕРГІЇ В УКРАЇНІ: АНАЛІЗ МІЖНАРОДНОГО ДОСВІДУ ТА МЕХАНІЗМ ЗАБЕЗПЕЧЕННЯ

**Анотація.** Сучасний стан електроенергетичного ринку України характеризується суперечністю між задекларованими державою намірами щодо його становлення, які стимулювали інвестиційну діяльність, зокрема у сфері відновлюваних джерел енергії (ВДЕ), та актуальними тенденціями розвитку, що ускладнюються зниженням попиту на електроенергію внаслідок пандемії, а також макроекономічною та політичною нестабільністю. Недосконалість ринкових механізмів та інфраструктурні проблеми перешкоджають балансуванню інтересів учасників ринку та формуванню конкурентного середовища, орієнтованого на інноваційний розвиток.

**Актуальність.** Для України та її регіонів, особливо тих, що мають значний потенціал виробництва електроенергії (наприклад, Південно-Східний регіон), актуальним є вивчення міжнародного досвіду регулювання електроенергетичного ринку, зокрема в частині активізації інвестиційно-інноваційної діяльності.

**Мета.** Аналіз ефективності інституційного регулювання регіональних електроенергетичних ринків в Україні, а також оцінка ефективності використання ВДЕ на регіональному рівні.

**Результати.** Встановлено, що вітчизняна електроенергетика поступається за рівнем підтримки залучення інвестицій та міжнародного співробітництва у сфері інноваційної діяльності. Незважаючи на підвищений інтерес ЄС до інвестування в українські проекти, зумовлений перспективами інтеграції та потенціалом використання транзитних і виробничих потужностей, Україні необхідно посилювати привабливість інвестицій в електроенергетичну галузь, у тому числі в інноваційні проекти. Аргументовано, що сильними сторонами України є високий потенціал розвитку окремих напрямів електроенергетики (ядерної, гідро-, сонячної, вітрової), унікальний транзитний потенціал (який, водночас, створює додаткові ризики через залучення країни до міжнародної конкуренції за ресурси) та значний кадровий потенціал (можливість співпраці на рівні наукових шкіл та дослідно-конструкторських інститутів). Виявлено, що міжнародний досвід розвитку електроенергетичного ринку демонструє тенденцію до лібералізації регуляторних впливів та регіоналізації регулювання.

**Висновки.** З огляду на пріоритетність розвитку ВДЕ у провідних країнах світу, для України важливим є розуміння не лише загальнодержавних пріоритетів регулювання інвестиційно-інноваційних процесів у цій сфері, а й особливостей розвитку альтернативної енергетики в регіональному контексті. Це дозволить оптимізувати управлінські рішення з урахуванням специфіки регіональної економіки, природних екосистем та соціальних аспектів.

**Ключові слова:** Інституційне регулювання, інституції, інституційні засади, ефективність регулювання, регулювання, джерела енергії, відновлювальні джерела енергії, електроенергія, регіон, регіональний ринок.

**Formulation of a scientific problem and its significance.** The electricity sector is characterized by a significant degree of natural monopoly. This imperative is enshrined in Ukraine's current legislation: transportation and distribution of

electricity (including electricity generated from renewable energy sources) and transportation of heat are classified as natural monopolies.

Amidst persistent problems related to infrastructure provision, the electricity sector of Ukraine is hindered by market imperfections. These impede the balance of stakeholder interests and the formation of a competitive, innovative-oriented environment. There is a dissonance between the official declarations on the implementation of market mechanisms and current market trends, characterized by a decline in electricity demand due to the COVID-19 pandemic, as well as macroeconomic and political instability.

The above justifies the need for the audience to actively study and understand international experiences in regulating the electricity market. This understanding is particularly crucial in stimulating investment and innovation for Ukraine and its regions, especially those that are significant electricity producers. As academics, policymakers, and industry professionals, your role in this process is vital, and your actions can make a significant difference in the future of the Ukrainian electricity sector.

The objective of this article is significant. It aims to analyze the effectiveness of institutional regulation of regional electricity markets in Ukraine and assess the efficiency of RES use at the regional level.

**Analysis of recent research on this issue.** At the current stage of development of scientific thought, the problems of the electric power industry are reflected in a significant number of studies conducted by a wide range of scholars, in particular, in the works of V. Kupchak [11], V. Lagodienko, B. Osvitsynskyi [9], K. Pavlov [8-11, 19], O. Pavlova [8-11, 19], O. Romanyuk [19], A. Tymchyshak [9] and others.

At the same time, the scientific literature insufficiently covers issues related to identifying and developing mechanisms for adapting international experience in regulating the electricity market to the conditions of Ukraine and its regions.

**Presentation of the main material and justification of the research results obtained.** Ukraine faces a set of interrelated challenges:

1. Internal aspect: maximizing the efficient use of the existing natural potential, revitalizing and modernizing the infrastructure and human resources of the electricity sector in the context of implementing competitive market relations in the areas of electricity generation, distribution, and consumption. This, in turn, should stimulate the inflow of investments and the introduction of innovations on a continuous basis.

2. External aspect: Integrating regional electricity markets with international, primarily European, energy systems would be economically feasible and environmentally safe.

For Ukraine, it is relevant to analyze the international experience of both countries that have already transformed their electricity sector into a market model and key strategic partners and opponents in foreign relations. At the same time, the significant potential of nuclear and hydropower, as well as transit opportunities, impose additional requirements for developing the industry and identifying priority areas for attracting investments to stimulate its innovative development.

In scientific literature and in practice, there are the main models of electricity market organization typical for many countries of the world: regulated natural monopoly, single buyer (regulated markets), competitive wholesale electricity market, and competitive wholesale and retail electricity markets (competitive markets) [7].

These models may vary depending on the specifics of individual segments and areas of the electricity market. General approaches to antitrust regulation determine a country's choice of a regulated natural monopoly model. For example, in the United States, the threshold for market monopolization is a concentration of 6% in the hands of one participant, while in Europe, the permissible values range from 25-50%. In Ukraine, despite the declarative nature of market principles, hidden monopolism and cartel agreements distort the competitive environment and suppress investment and innovation activities [4].

The model of a regulated natural monopoly is typical for the Scandinavian countries. In addition to the Scandinavian countries, the centralization of electricity

distribution powers in the hands of a single transportation company, a sign of a natural monopoly, is also typical for France.

As a rule, the regulatory authority responsible for tariff setting has the authority to grant natural monopoly status in the electricity sector. Only countries with a high level of economic development and social protection of the population can afford a complete transition to market-based electricity pricing mechanisms.

The single-buyer model has been implemented in China, where five large companies generate electricity, although private and municipal (communal) enterprises are allowed to enter the market.

The model of a competitive wholesale market is characterized by a relatively high degree of competition in the industry. There are two main types of this model: 1) the model of a mandatory pool (exchange), where the entire volume of electricity produced is sold; 2) the model of a residual pool, where electricity is traded mainly after bilateral contracts outside the pool are concluded [4]. This competitive model is used in most EU member states (Fig. 1).

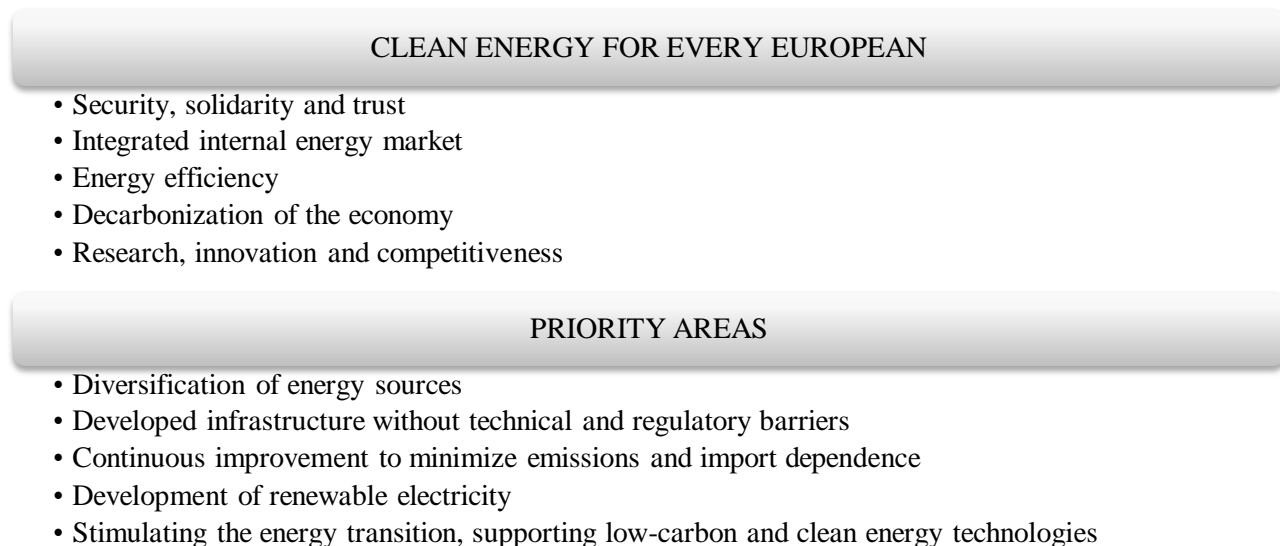


Figure 1 – Directions of formation of electricity markets in the European Union [30].

The model of competitive retail and wholesale markets is typical for the United States and Japan, where most of the generating, distributing, and marketing companies in the electricity sector are privately owned [4].

Thus, the above models indicate the progress of reforms in the electricity sector aimed at implementing market relations, which is key to stimulating investment and innovation processes. Since the late 1990s, many developed countries have been moving away from vertically integrated structures with state regulation of all electricity generation, distribution, and consumption processes in favor of transforming the energy sector from a natural monopoly to a market-type structure, which is declared by Ukraine [6].

However, this process should take place gradually, under the control of regulatory authorities. It should not be accompanied by the hidden monopolization of specific segments of the electricity sector, which is currently observed in Ukraine about RES. In contrast, the monopoly position in other sectors is preserved.

For Ukraine, the experience of the European Union (EU) countries in developing the electricity market, which has achieved significant success and, thanks to basic competitive conditions, is actively generating innovations to achieve the status of climate-neutral countries, is of paramount importance. The EU-Ukraine Association Agreement has a separate section on economic and sectoral cooperation, and the chapter "Economic and Sectoral Cooperation" defines priority cooperation areas.

Electricity trade issues, including pricing aspects, are also regulated, but the section on cooperation reveals the broadest range of interactions.

The identified areas outline potential opportunities for developing Ukraine's electricity market, especially those regions with significant production and transit potential. These areas are important for investment and innovation processes in the industry. They form the institutional, organizational, legal, infrastructural, and logistical basis for integrating Ukraine's electricity market with the EU while preserving the specifics of the domestic market and ensuring a balance of its participants' interests, considering national priorities.

The investment and innovation sectors are particularly interested in cooperation. The existing European Institute of Innovation and Technology implements several research programs that help mobilize domestic intellectual

potential to generate new ideas in the electricity sector. This is one of Ukraine's competitive advantages in cooperation with the EU.

Despite the priority of European integration processes, when unifying Ukraine's domestic market with the European one, it is necessary to develop its model of the national electricity market regulator, which would justify (Figure 2):

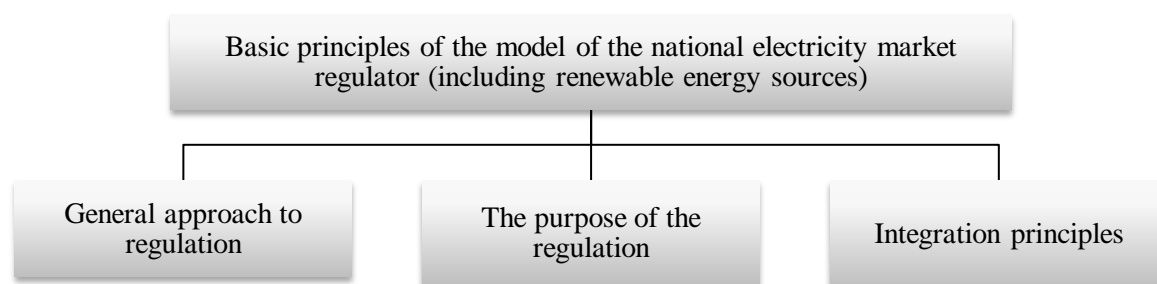


Figure 2 – Basic principles of the model of the national electricity market regulator (including renewable energy sources)

1. General approach to regulation: “Competitive wholesale and retail electricity markets.”

2. Regulatory objective: To stimulate investment and innovation to improve energy use efficiency and management of energy systems.

3. Integration principles: Harmonization with the approaches adopted in the EU while protecting domestic interests regarding natural, transit, and infrastructure potential and developing appropriate institutional and organizational support.

The formation of its model of national electricity market regulation is observed in EU countries, which coordinate their policies in the field through complex schemes, focusing on the activities of the Energy Community and adopting a series of energy packages [3].

The latest, fourth EU energy package, adopted in 2019, is focused on innovative goals for the development of the industry. Its key idea is 'Clean Energy for Every European,' a comprehensive initiative to promote the use of renewable energy sources, reduce energy consumption, and foster innovation in the energy sector. Therefore, having begun its implementation, Ukraine undertakes obligations to

increase the share of renewable energy sources, reduce consumption, and rationalize the economical use of energy resources, thus ensuring the innovative development of the industry [16].

A separate direction for developing the electric power industry, and energy in general for EU countries, is "research, innovation and competitiveness." Given the EU's increased interest in Ukraine's integration into the electricity sector, this priority allows the use of experience from developed countries regarding innovation and attracting their funds within the framework of international cooperation programs. As a rule, domestic experts consider the advantages of integrating Ukraine's energy system into the European one as the key to the security paradigm, promoting the liberalization of the electricity market, which is happening today under pressure from EU authorities [15].

However, the main argument should be innovative. Significant differentiation of investment sources in the electricity industry could be possible, including using resources from numerous regional development financial programs.

Significant attention is paid to the electricity infrastructure in Europe. For this purpose, since 2009, the European Network of Transmission System Operators for Electricity (ENTSO-E) has been operating. Its scale and comprehensive nature are oriented towards the fundamental goals of developing the EU countries' industry – sustainable access to electricity. Since 2019, Ukraine has intensified cooperation with ENTSO-E through the mediation of NEC "Ukrenergo". Currently, a multi-year integration algorithm has been developed, covering the period 2006-2023: In 2006, the Romanian transmission system operator "Transelectrica" applied for the expansion of the ENTSO-E synchronous zone by connecting the IPS of Ukraine and the EU of Moldova; in the intervening years, various measures were implemented to synchronize the operation of electric power facilities, introduce automated systems for regulating, controlling the production and distribution of electricity; in 2021-2022, the synchronous connection of the power systems of continental Europe and Ukraine and Moldova, test work in isolated mode (from the power systems of Russia and Belarus) are planned; 2023 – the beginning of the operation of the united energy



system of Ukraine, including the electric power industry, in synchronous mode with ENTSO-E [5].

Envision a promising future with the integration of the United Power System of Ukraine into the European energy system ENTSO-E. This strategic move is anticipated to significantly bolster the stability and security of energy supply in Central and Eastern Europe, paving the way for increased investment and innovation. The gradual accumulation of additional financial resources with stable demand will create favorable conditions for the industry's growth, instilling a sense of optimism about the potential of this integration [1].

One of the strengths of EU countries is the formation of interstate institutional and exchange entities to consolidate efforts in the industry and satisfy their interests. For example, the Spanish market is combined with Portugal and is called the Iberian Electricity Market (MIBEL), and the Nord Pool exchange (and its web system Nord Pool Spot) unites Norway, Sweden, and the eastern part of Denmark [9]. For Ukraine, the formation of such "local" interstate markets is complicated due to current geopolitical conflicts, but it is promising in the context of further integration with Europe. Given external initiatives and geopolitical interests, the creation of an exchange-based electricity market of Ukraine with Romania (initiator of joining ENTSO-E), Moldova (prospects for joining ENTSO-E), Hungary (intensification of cooperation since 2019 with the agreement of parallel operation of energy systems), Slovakia and the Czech Republic (countries that work on the same IT platform as the State Enterprise "Market Operator" of Ukraine [12]) is promising.

The practical establishment of a common electricity market with neighboring European countries is a significant boon for border regions and a crucial step for the entire industry. This market will enable the optimization of production capacities, particularly benefiting electricity-producing regions in Ukraine. The South-Eastern region stands to gain significantly from this optimization, providing reassurance about the industry's future [7].

Special attention should be paid to studying international experience in the "Smart Grid" programs and the transition to digital technologies in the electric power

industry. They are currently gaining particular popularity for electricity metering. The USA, EU countries, and China are conducting thorough developments in these areas. Significant opportunities are opening up for Ukraine since the IT sector is one of the leading ones in the national economy. Systematic cooperation between leading energy companies and IT with the formation of information and analytical clusters will be an impetus for improving the efficiency of energy system management. In those regions where IT is actively developing, such as Dnipropetrovsk and Kharkiv, establishing such cooperation should be among the priorities of regional development strategies.

The 'Smart Grid' programs in Ukraine, which began to be actively discussed only in 2020, are a result of the implementation of the IBRD Electricity Transmission Project-2 with the assistance of the Clean Technology Fund (the project is being implemented by NEC 'Ukrenergo') [14].

These programs, which focus on integrating digital technologies in the electric power industry, have the potential to revolutionize energy management in the country, leading to improved efficiency and sustainability. This progress underscores Ukraine's commitment to technological advancement in the energy sector [14].

At the same time, some experience with smart grids has already been formed in Europe, starting in 2010. Cooperation with European partners in this area will make it possible to transition to fundamentally new approaches in energy system management based on transparency, innovation, and objective energy efficiency assessment.

Significant efforts are being made by developed countries, particularly in the EU, to implement energy efficiency and energy-saving technologies. In this context, close cooperation has been established with construction institutes (utilizing appropriate technologies with their planning already at the design stage of facilities and the possibilities of further operation), industry (transitioning to low-carbon production), and transport (with minimal carbon emissions). If Ukraine initiates systematic work on energy efficiency and saving on platforms of intersectoral cooperation, regional authorities and local self-government will attract a much larger

scale of foreign investment. This underscores the importance of international cooperation in achieving energy efficiency goals [11].

When studying international experience in the electricity market development, Ukraine must understand effective instruments for regulating investment and innovation processes in the context of individual areas. Expecting an increase in demand for electricity resources, developed EU countries plan to meet it through nuclear and renewable energy [4].

In Ukraine, the RES sector is actively and somewhat spontaneously developing, and nuclear power is forced to decline. The problem lies in the depreciation of nuclear power plant equipment and the prevalence of forced measures to extend their operation. Instead, investments for innovative purposes in the nuclear power industry are meager.

In the world, the development of nuclear power, despite large-scale tragedies, remains a priority. Nuclear energy accounts for about 12 % of global electricity production, and its share in electricity production is projected to increase steadily; in fact, nuclear energy on modern nuclear power units is considered an environmentally friendly energy source along with RES [19]. Therefore, this sector's investment attractiveness is also high for Ukraine. This segment of the electricity market is up-and-coming and requires the intensification of international investment activities through the mediation of NNEGC "Energoatom."

Investment initiatives in Ukraine's nuclear power industry are currently weak. The issue of building two power units at the Khmelnytskyi NPP is periodically raised. However, market confrontations with the RES segment are currently subjectively hindering the nuclear power industry, which is unacceptable for the competitive development of the market when progressive countries of the world, on the contrary, follow the ideology of integrating different sources of electricity.

The development of nuclear power plants should be innovative. The growth of nuclear energy is possible due to the accelerated transition to standard III and IV generation reactors, as well as fast neutron reactors; this will solve the problems of

providing countries with uranium ore and spent nuclear fuel and increase the economic performance and safety of nuclear power plants [18].

Hydropower remains a promising sector of the electricity market. In developed countries with appropriate natural conditions, hydroelectric power plants are considered a substitute for polluting thermal power plants. In particular, in Europe, there is a process of their closure. In 2020, the largest electricity company in Austria closed the last coal-fired thermal power plant in the country (the power plant will be converted to gas and kept in reserve); France and Sweden (by 2022), Great Britain (by 2025), Greece (by 2028), Hungary (by 2030) and several other countries have announced their intentions to completely abandon coal in electricity generation within the next decade [17].

Even though the leading countries of the world are focused on abandoning thermal power plants, new technologies for coal-fired power plants are simultaneously being developed – those operating at super- (standard in China, India) and ultra-supercritical (China, USA, Germany, Denmark, South Korea) steam parameters, circulating fluidized bed combustion technologies (China, USA), CCGT with integrated gasification combined cycle (China, USA), pressurized fluidized bed combustion (Japan) and other effective technologies [13].

For Ukraine, it is relevant to be involved in developing and implementing these technologies, although the primary problem remains the modernization of existing thermal power plants. To accomplish this task with the involvement of investments, it is advisable to study China's experience as the largest electricity consumer in the world due to demographic characteristics. Since 2010, this country has been taking active measures to attract investment in modernizing existing thermal power plants and constructing new ones. This allowed it to increase the energy efficiency of these facilities significantly.

Wind power has significant development potential in Ukraine, particularly in the South-Eastern region. In developed countries, its spread is based on appropriate economic and environmental justifications, considering the interests of local authorities and the public (the issue of proximity to residential buildings) [20].

According to Bloomberg New Energy Finance's forecast, the cost of operating wind power plants will fall by 41 % by 2040, and in 25 years, they will become the cheapest way to produce electricity [2].

Such forecasts make this segment of the electricity market attractive to investors. Due to its natural conditions, Ukraine attracts increased investment interest in developing wind power plants, particularly from China. For geographical differentiation, it is advisable to consider the USA's experience with tax incentives and government subsidies.

**Висновки.** At this stage, Ukraine needs to choose strategic partners and, first of all, integrate their practices into the domestic environment. The domestic electric power industry's losing positions are in supporting investment attraction and international cooperation for innovation. The EU maintains an increased interest in investing in projects in Ukraine, given the prospects for its integration and the need to use its transit and production potential international confrontations in the struggle for "resources" also significantly impact this.

International experience developing the electricity market indicates a trend toward liberalizing managerial influences. Another indicative trend is the regionalization of regulation. Given the leading interest of developed countries in RES, Ukraine needs to understand, in addition to the nationwide priorities for regulating investment and innovation processes in this area, the specifics of the development of alternative energy in the region. This will make it possible to optimize management decisions according to the specifics of the regional economy, natural ecosystems, and society.

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