

INFLUENCE OF REGIONAL FEATURES ON ECONOMIC DEVELOPMENT IN ALTERNATIVE ENERGY IN UKRAINE

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Abstract. Trends in the development of the energy sector determine the dynamics of pricing policy in the energy market, the level of socio-economic stability and investment attractiveness of both the country as a whole and its individual regions. The study is devoted to the study of regional features of the potential of alternative energy in Ukraine and their impact on economic development. The methodological basis of the article is formed by a number of general theoretical principles, techniques and interdisciplinary methods of scientific research. The article considers the main regional aspects of the impact of the development of renewable energy sources on the socio-economic state of communities: decentralization of energy supply and growth of energy independence, creation of new jobs in the regions and stimulation of local business development, attraction of investments, improvement of environmental safety indicators and decarbonization. Potential challenges for regional economic development caused by the destruction of energy infrastructure during a full-scale war are noted, as well as other problematic aspects, including the need to modernize and expand electricity networks, large losses in electricity networks, problems with resource supply that may limit the development of certain types of alternative energy (for example, bioenergy). The study substantiates the need for the transfer of new technologies and the promotion of "green" initiatives within regional economic development strategies. The main regional advantages and limitations of energy production from various types of renewable energy sources (solar, wind, hydro- and bioenergy, tidal, geothermal energy) are highlighted. Optimization measures are proposed, including diversification of supplies, modernization of the energy system, and updating of legislation. It has been proven that stimulating the regional development of alternative energy in Ukraine will accelerate the overall economic growth of the state, promote investment, stimulate further regional decentralization of energy supply and the introduction of climate-neutral energy capacities.

Keywords: renewable energy sources (RES), sustainable development, regional development, innovation, energy efficiency, diversification, management.

JEL Classification: H56, F52, P11, P13, O13, Q20, Q42

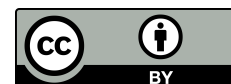
1. Introduction

The large-scale destruction of the energy infrastructure as a result of the Russian aggression led to significant losses: about 78% of the capacity of thermal power plants, 44% of nuclear generation, 75% of wind generation and more than 20% of solar generation were lost in the first year of the invasion. This led to an imbalance in regional economic development, uneven financing, increased social polarization, and intensification of environmental problems. A comprehensive strategy for sustainable economic

growth should take into account increasing the level of energy security of the regions, diversifying sources of generation, stimulating business in the field of alternative energy, and developing public-private partnerships.

The issue of energy independence and sustainable economic growth of regions is one of the current topics of modern scientific discourse. In particular, scientists J. Paravantis, N. Kontoulis (2020), M. Treshchov (2024) explore the relationships between economic growth, social responsibility and energy diversification, and

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O. Shpatakova et al. (2022), S. Khan et al. (2020) form a concept for the development of adaptive and resilient urban systems to the challenges of wartime. The impact of the destruction of regional energy infrastructure on national economic development is highlighted in the publications of V. Mykytenko (2023), O. Kofanov et al. (2023).

General approaches to the development of alternative energy in crisis conditions are given in the works of M. Cantarero (2020), N. Elewa, A. Eldeen (2023), N. Liu et al. (2022), which focuses on the role of institutional support and international cooperation. Ways to increase the investment attractiveness of regions and stimulate local business in the field of renewable energy are disclosed in the publications of F. Taghizadeh-Hesary, N. Yoshino (2020), P. Thaler, B. Hofmann (2022). Scientists argue that the harmonious development of the energy system can be achieved by taking into account the regional specifics of alternative sources: in particular, the potential for the development of bioenergy is in regions with a developed agro-industrial complex, and geothermal energy is in mountainous locations, which requires additional efforts in scientific and theoretical exploration.

Despite the contribution of scientists to the state of research on the issue, aspects of the influence of regional specifics on sustainable socio-economic development in the context of alternative energy remain poorly studied, which makes an expanded analysis of the topic relevant. The problem is becoming particularly urgent against the background of the need to decentralize energy supply as Ukraine moves towards European integration.

The purpose of this article is to analyze the regional specifics of the potential of alternative energy in Ukraine and their impact on economic development.

The article was written using the analytical method, synthesis, comparison, generalization and specification. The methodological basis of the article was chosen to identify the main regional advantages and limitations of energy production by various types of renewable energy sources, generalize the obstacles to effective economic development based on regional stimulation of the progress of renewable energy sources in Ukraine.

Limitations of the study relate to potential regional bias.

2. Energy security as the basis for sustainable regional development

Russian military aggression on the territory of Ukraine, the installed capacity of renewable energy sources reached 9.9 GW, of which 6 GW was solar, 2 GW was wind energy, and 0.2 GW was biomass. Despite the crisis conditions of the war, in 2023 about 1,400 new alternative energy facilities were connected to the general energy system. In 2023 alone, more than 150 million US dollars were invested in solar energy by national businesses (UkraineInvest, 2025).

In light of the consequences of the destruction of energy infrastructure as a result of the Russian aggression, the efforts of energy supply companies are focused, first and foremost, on activities to restore regional energy systems in order to guarantee the needs of society and the functioning of businesses, reduce imbalances in the development of communities, and prevent outflow of financial and intellectual capital, increasing social polarization, slowing down of innovation and investment process (Cantarero, 2020; Elewa & Eldeen, 2023).

Energy security has an important function in ensuring the economic stability of regions, which is due to several basic aspects:

- guarantees of reliable energy supply are an indispensable condition for the development of production, minimizing economic losses, preserving jobs, thus maintaining social stability;
- control of price dynamics in the energy sector allows planning investments with greater guarantees, which optimizes the regional investment climate;
- industry sustainability helps ensure competitiveness and adequate pricing policy, promotes modernization, and supports economic activity in regions.

It can be argued that there is a close relationship between energy security and socio-economic sustainability, especially representative in the context of regional development (Liu et al., 2022). A balanced approach requires the formation of effective partnerships between authorities, the public and business within public-private projects, which ensures complementarity to specific regional needs, serves as the basis for inclusive management concepts. In addition, this contributes to the implementation of energy efficiency initiatives and "green" practices in the energy sector.

3. Features of the development of alternative energy in a regional context

The alternative energy market is currently positioned as an equally important factor of production as the markets for capital, labor, and information resources. Its development in Ukraine has significant regional characteristics, determined by natural resources, which makes it possible to distinguish the specialization of regions in certain types of energy: in the Southern regions – solar and wind energy, in the Dnieper – hydropower.

Solar energy is most developed in Dnipropetrovsk, Vinnytsia, Ivano-Frankivsk, Khmelnytskyi and Kyiv regions. As of 2024, solar renewable energy sources accounted for almost 75% of the total volume of "green" energy production (excluding large hydroelectric power plants). As of 2024, about 1,400 solar generation facilities of various capacities were operating within the state (UkraineInvest, 2025).

Despite the increased winds in the Western region of Ukraine, the potential of wind energy has not been fully utilized, which necessitates the need to attract additional investments. At the same time, these regions have significant potential for the development of bioenergy. An example of a bioresource is waste from agricultural enterprises, in particular straw – 2.9 million tons, wood and

firewood waste – 1.6 million tons, peat – 0.6 million tons, solid household waste – 1.1 million tons. (Koshyn, 2017). The potential for biomass production reaches about 34 million tons per year from 94 million tons of agricultural waste, which can contribute to reducing the energy dependence of regions, creating new jobs in rural areas, and increasing the efficiency of the agricultural sector (UkraineInvest, 2025).

The general structure of electricity production sources in Ukraine and Europe for 2023 is shown in Fig. 1.

Increasing the availability of alternative energy for regions can be achieved by reducing the prices of solar panel equipment, inverter software and software control, as well as partial or full reimbursement of the cost of equipment by state or local authorities. The practice of the second option has been tested in the cities of Lviv, Ternopil, Khmelnytskyi regions.

At the same time, there are certain organizational contradictions between innovative projects using renewable energy sources and the traditional energy system. The lack of information support for potential investors is also characteristic. Alternative energy incentive programs initiated by local governments and territorial communities will allow owners to be compensated, and financial

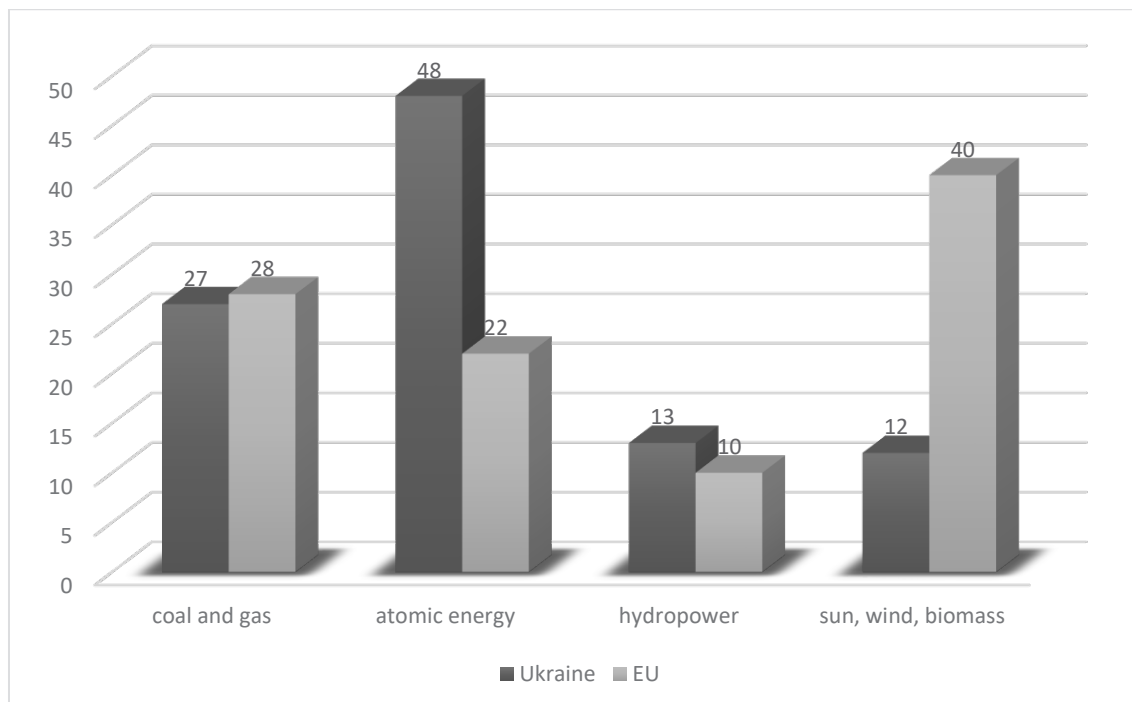


Figure 1. Structure of electricity production sources in Ukraine and Europe as of 2023.

Source: systematized by the author based on (State Statistics Service of Ukraine, 2024; Eurostat, 2024)

assistance from European institutions will contribute to accelerating the growth of the share of alternative energy in the overall energy balance.

4. The impact of regional development of renewable energy sources on the economic situation

The development of renewable energy at the regional level stimulates economic development by reducing energy costs for businesses and the population, reducing dependence on imported energy resources to ensure resilience to price fluctuations on world markets, and creating new jobs (for example, in the areas of construction and operation, maintenance of solar, wind and other power plants). and other areas), diversification of income sources. This creates new areas for investment and innovation, increases the competitiveness of the industry, stimulates the development of local business and restrains the outflow of finances from the region (Paravantis & Kontoulis, 2020; Treshchov, 2024).

In times of war, massive damage to energy infrastructure and the decommissioning of significant wind and solar power plants, as well as an unstable political situation, create significant investment risks, which has a destructive effect on alternative energy development projects. To fully utilize their potential, it is necessary to use targeted economic instruments.

Among the main stimulation methods:

1) feed – in tariffs that increase the investment attractiveness of the industry by providing for the establishment of guaranteed prices for electricity produced from renewable sources;

2) "green" certificates, which are securities that confirm the use of alternative energy and serve as an image-forming and stimulating factor for industry investment;

3) preferential fiscal policy and targeted subsidies for businesses investing in alternative energy sources;

4) holding auctions that stimulate competition in the industry market and the formation of an objective price for renewable energy resources;

5) simplification of permitting procedures and bureaucracy;

6) special credit lines providing financial support for renewable energy projects (Taghizadeh-Hesary & Yoshino, 2020; Thaler & Hofmann, 2022).

In addition, an important strategic step is the diversification of energy supply, which allows reducing dependence on monopolists and contributes to sustainable socio-economic growth of both the country as a whole and its individual regions. For successful integration into a single European energy space, it is considered appropriate to implement standards and norms complementary to European norms, in particular, in the context of energy efficiency, competitiveness and transparency of the industry market.

At the same time, in the national field there are a number of challenges related to the process of diversification of energy supply (Table 1).

Thermal modernization of budget buildings and the introduction of energy management systems for the use of renewable energy resources will reduce the cost of budget funds for paying for energy carriers. A practical successful example of regional programs is the Czech Republic's project

Table 1
Challenges of the diversification process

Destabilizing factor	Specificity of impact
Infrastructure challenges	The need to invest in the development of logistics routes and infrastructure modernization.
Energy efficiency and development of renewable energy	The intensification of the role of energy efficiency and alternative energy sources is seen as important for ensuring sustainable development. Investments and implementation of energy efficient technologies actively contribute to ensuring energy security and independence.
Financial sustainability	Diversification requires significant investments, both in the context of infrastructure development and the development of new sources of renewable energy, and for the modernization of existing systems.
Regulatory environment	The creation of an effective and transparent sectoral regulatory framework is an important factor in stimulating investment attraction, business integration, development of public-private partnerships and promotion of diversification. It is advisable to develop and implement sustainable and predictable requirements and standards in regional differentiation that will stimulate innovation and ensure sustainable economic growth.

Source: systematized by the author

"Green Savings", which is aimed at financially supporting the insulation of existing housing stock, the use of renewable energy sources in heating and the implementation of passive house standards (De Rose et al., 2022).

To effectively stimulate the regional development of alternative energy, it is necessary to provide in the legislative framework flexible depreciation of investments in renewable energy, tax breaks for investors in renewable energy, subsidy conditions for the creation of new facilities, and financial incentives for consumers to purchase equipment and services in renewable energy.

Among the financial methods for stimulating the regional development of renewable energy sources that are successfully operating in European countries:

- "green" funds addressed to long-term debt capital markets, financed by private banks at lower interest rates;
- state renewable energy funds managed by relevant agencies; soft loans and special loans from institutional banks;
- financing of research and development work on the development of renewable energy facilities;
- subsidizing new equipment models based on renewable energy sources through tax reductions for manufacturers.

To promote the increase of potential consumers of renewable energy sources in the regional context, it is necessary to conduct effective communication work with local self-government bodies to provide advantages to renewable energy projects. It is necessary to provide state policy in the field of renewable energy with greater predictability by creating long-term strategic plans aimed at achieving zero carbon emissions, with appropriate content regarding incentives, guarantees and financial credit support for projects and programs to involve local communities in the implementation of projects based on renewable energy sources.

5. Conclusions

Ukraine's European integration development strategy envisages active regional progress based on sustainable economic growth, which includes integration into global economic networks, transfer of the latest technologies, implementation of "green" initiatives, interaction between the state, the public and business in public-private partnership projects to stimulate the development of renewable energy.

To increase the share of renewable resources, it is necessary to use the potential of the system of economic incentives and motivation of the business sector, which is successfully used by developed European countries: tax breaks and subsidies for investors, financial incentives for producers and the establishment of "green" funds addressed to long-term debt capital markets, special credit lines, financing of research and development work on the development of renewable energy facilities. The use of these economic instruments in Ukraine will allow developing an energy-independent economy in a regional context and will accelerate the implementation of international obligations under the Paris Climate Agreement and the Association Agreement with the European Union.

Given the current state of Ukraine's energy system, the development of renewable energy can become the basis for the restoration and modernization of territories, especially in remote communities that have suffered the most from military operations. In particular, the construction and operation of small solar power plants in rural regions will not only ensure local energy supply, but also reduce the load on the national energy system. Such initiatives will stimulate the development of local entrepreneurship and contribute to social stability.

A promising direction for future research is seen as the development of a system of economic incentives for small and medium-sized businesses to introduce renewable energy sources for sustainable economic regional development.

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