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ENTREPRENEURSHIP MODELS IN THE FIELD OF RENEWABLE ENERGY

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МОДЕЛІ ПІДПРИЄМНИЦТВА В СФЕРІ АЛЬТЕРНАТИВНОЇ ЕНЕРГЕТИКИ

The relevance of the research is due to the critical state of energy security in Ukraine, caused by the destruction of infrastructure as a result of Russian aggression and dependence on energy imports. The electricity deficit, supply disruptions, and emergency shutdowns underscore the urgent need for rapid development of alternative energy sources. Considering, that the experience of many countries demonstrates that the development of alternative energy is the key factor in achieving energy independence and stability. Therefore, the research is to identify and describe the entrepreneurship models that can ensure the rapid development of alternative energy, thereby reducing supply disruptions and eliminating the need for emergency shutdowns. Within the research, attention is drawn to the fact that the following entrepreneurship models in the field of alternative energy have already formed and are functioning in Ukraine: electricity production, equipment and components manufacturing, design and construction of facilities, and energy services. However, despite the existing potential, their development is hampered by several factors that require a comprehensive solution with the participation of the state, business, and the public. It has been proven that the process of developing effective measures to stimulate the development of alternative energy should be formed based on the results of analyzing the features and problems of the functioning of each entrepreneurship model in the field of alternative energy. It will allow identifying key barriers and determining priority areas for state support, investment, and regulatory changes. It has been established that for effective measures to stimulate the development of alternative energy, it is necessary to consider the following problematic aspects. In electricity production, there are high

capital costs, dependence on special electricity tariffs, and regulatory instability. In equipment and components manufacturing, there is insufficient development of domestic technologies and production capacities, dependence on imports, and a lack of state support for domestic manufacturers. In the design and construction of alternative energy facilities in Ukraine, there are high risks due to legislative instability, technical and administrative barriers, a growing shortage of qualified personnel, and the lack of a developed market for equipment and components. In energy services, there are legislative restrictions, insufficient staff qualifications, and competition with unscrupulous market participants.

Актуальність дослідження обумовлена критичним станом енергетичної безпеки України, спричиненим руйнуванням інфраструктури внаслідок російської агресії та залежністю від імпорту енергоресурсів. Дефіцит електроенергії, перебої з постачанням та аварійні відключення підкреслюють нагальну потребу у швидкому розвитку альтернативної енергетики. Досвід багатьох країн демонструє, що саме розвиток альтернативної енергетики є ключовим фактором досягнення енергетичної незалежності та стабільності. Відтак, метою дослідження є загальна ідентифікація та опис тих моделей підприємництва, коштом яких можна забезпечити швидкий розвиток альтернативної енергетики, а відтак і зменшити перебої з її постачанням та відмовитися від аварійних відключень. У межах дослідження звернено увагу на той факт, що в Україні сформувалися та вже функціонують такі моделі підприємництва у сфері альтернативної енергетики, як виробництво електроенергії, обладнання та комплектуючих, проєктування та будівництво об'єктів з виробництва електроенергії, а також енергетичний сервіс. Разом з тим, їх розвиток стримується низкою чинників, що потребують комплексного вирішення за участю держави, бізнесу та громадськості. Доведено, що процес розробки ефективних заходів зі стимулювання розвитку альтернативної енергетики необхідно формувати за результатами аналізу особливостей та проблематики функціонування кожної з моделей підприємництва, що належать до цієї сферт. Це дозволить виявити ключові бар'єри та визначити пріоритетні напрямки державної підтримки, інвестицій та регуляторних змін. Констатовано, що для розробки ефективних заходів зі стимулювання розвитку альтернативної енергетики необхідно врахувати всі її проблемні аспекти. По виробництву електроенергії такими проблемними аспектами є високі капітальні витрати, залежність від спеціальних тарифів на електроенергію та нестабільність регуляторного середовища. По виробництву обладнання та комплектуючих — це недостатній розвиток власних технологій та виробничих потужностей, залежність від імпорту, відсутність державної підтримки вітчизняних виробників. По проєктуванню та будівництву об'єктів з виробництва альтернативної енергетики — це високі ризики зумовлені законодавчою нестабільністю, технічні та адміністративні бар'єри, дефіцит кваліфікованих кадрів, відсутність розвиненого ринку обладнання та комплектуючих. По енергетичному сервісу — це законодавча зарегульованість, недостатня кваліфікація кадрів та конкуренція з недобросовісними учасниками ринку.

Key words: entrepreneurship; regulatory environment instability; wind power plants; hydropower plants; solar power plants; entry barriers; dependence on special electricity tariffs.

Ключові слова: підприємництво; нестабільність регуляторного середовища; вітрові електростанції; гідроелектростанції; сонячні електростанції; вхідні бар'єри; залежність від спеціальних тарифів на електроенергію.

PROBLEM STATEMENT

The relevance of the research is due to the critical state of energy security in Ukraine, caused by the destruction of infrastructure as a result of Russian aggression and dependence on energy imports. The electricity deficit, supply disruptions, and emergency shutdowns, especially exacerbated in the summer of 2024, underscore the urgent need for rapid development of alternative energy sources. Considering that the experience of many countries demonstrates that the development of alternative energy is the key factor in achieving energy independence and stability. Denmark, Iceland, Norway, and Portugal serve as prime examples of successful transitions to renewable energy sources, providing a significant share of their

Table 1. The characteristics of basic types and features of entrepreneurship associated with the production of different types of alternative energy

Object types	The basis for entrepreneurship by object subtypes	Features of entrepreneurial activity	Specificity of entrepreneurship
solar power plants	Ground-mounted solar power plants (utility-scale), rooftop solar power plants, ground-mounted solar power plants with trackers, grid-connected, off-grid, hybrid	High initial investment costs Legislative instability Technical challenges Seasonality of production	The investor finances the construction of the power plant and receives a profit from the sale of electricity at a «green» tariff, through a net billing mechanism, or through other mechanisms
wind power plants	Onshore wind farms, distributed wind farms	High initial investment costs, complexity of obtaining permits and grid connection, dependence on wind potential, need to consider environmental impact (noise, impact on birds), legislative instability	
hydroelectric power plants	Large-scale hydroelectric power plants, medium-scale hydroelectric power plants, small-scale hydroelectric power plants	Significant capital investments, complexity of construction and long payback period, dependence on the water regime of rivers, the need to comply with environmental standards and take into account the impact on aquatic ecosystems, legislative instability	
biogas plants	Agricultural biogas plants, industrial biogas plants	The need for a stable supply of organic raw materials, the complexity of the technological process, the need to comply with environmental standards for waste treatment, a limited market for biogas and heat, and legislative instability.	

Source: formulated by the author based on [1; 4—5].

energy consumption through wind, water, geothermal, and solar power. Ukraine, possessing significant potential in the field of renewable energy, has a unique opportunity to use the current crisis as a catalyst for the accelerated development of this sector. Stimulating various entrepreneurship models in alternative energy could quickly reduce supply disruptions and eliminate the need for emergency shutdowns.

THE ANALYSIS OF RECENT RESEARCHES AND PUBLICATIONS

Significant contributions to the research of entrepreneurship problems in the field of alternative energy as a promising direction for strengthening the economic independence of the state have been made by scientists such as Perevozova I.V., Morozova O.S., Nemish Yu.V., Lysenko-Helembyuk K.M., Kudrya S.O., Melnyk L.H., Khrystenko H.M., and Hurska I.S.

GOAL SETTING (FORMULATION OF GOALS OF THE ARTICLE)

The goal of the research is to identify and describe the entrepreneurship models that can ensure the rapid development of alternative energy, thereby reducing supply disruptions and eliminating the need for emergency shutdowns.

THE PAPER MAIN BODY WITH FULL REASONING OF ACADEMIC RESULTS

Basic models of entrepreneurship in the field of alternative energy have been formed in Ukraine, such as electricity production, equipment and component manufacturing, design and construction of facilities, and energy services. However, despite the existing potential, their development is hampered by several factors that require a comprehensive solution with the participation of the state, business, and the public.

The content of these measures can be specified only based on the characteristics of the basic types and features of existing business models, to the extent that will allow us to outline the problems of their functioning and development. To develop effective measures to stimulate the development of alternative energy, it is necessary to analyze in detail the features and problems of the functioning of each of these entrepreneurship models. This will allow identifying key barriers and determining priority areas for state support, investment, and regulatory changes.

So, regarding the models of alternative electricity production in Ukraine, they are mainly implemented by an investor (owner) who finances the construction or acquisition of a power plant. The investor profits from selling electricity at the "green" tariff, through the self-production mechanism (net billing), and several other mechanisms (the nature and content of which are not stable due to legislative instability). At the same time, the basis of the profit function can be a wide variety of energy production facilities, including [1; 4—5]:

— solar power plants (SPP). Specifically, for production purposes, large (industrial) SPPs are used (large complexes of solar panels located on a significant area, with a capacity of over 1 MW), commercial SPPs (complexes of solar panels with a capacity from 100 kW

Table 2. Characteristics of basic types and features of entrepreneurship related to the production of equipment and components for renewable energy in Ukraine

Object Types	The basis for entrepreneurship by object subtypes	Features of entrepreneurial activity	Specifics of entrepreneurship
Solar panel production Wind turbine manufacturing	Production facilities for assembly of solar panels and wind turbines, both for the domestic market. Service centers for equipment maintenance and repair.	High-tech production requiring skilled personnel and modern equipment Need for cooperation with research institutions and component manufacturers Focus on the domestic market	Competition with imported manufacturers, which requires constant improvement of product quality and cost reduction (which is not always possible from an economic point of view) The need for constant adaptation to changes in legislation and technical standards. Lack of government support and benefits.
Production of inverters, controllers, and other equipment	Production facilities for the assembly of inverters, controllers, control and monitoring systems, cables, and other components. Service centers for equipment maintenance and repair		

Source: formulated by the author based on [3—4].

to 1 MW, suitable for providing electricity to businesses, shopping centers, hotels, etc.), and small (home, household) SPPs (special installations with a capacity of up to 100 kW, used to provide electricity to individual households);

— wind power plants (WPP). Specifically, for production purposes, large or medium-sized onshore wind farms are used (consisting of hundreds of wind turbines and having a capacity of over 100 MW), medium-sized wind farms (consisting of dozens of wind turbines and having a capacity from 10 to 100 MW), and parks of one or several wind turbines for individual households, farms, and small businesses (up to 10 MW). These structures can also exist as distributed or hybrid wind power plants;

— hydroelectric power plants (HPP). Specifically, for production purposes, large HPPs with a capacity of over 100 MW are used (these are complex structures that include a dam, reservoir, engine room, and other facilities), medium HPPs with a capacity from 10 to 100 MW (which can be either separate structures or part of a cascade of HPPs), and small HPPs with a capacity of up to 10 MW (built on small rivers and do not require the creation of large reservoirs);

— biogas plants. Specifically, for production purposes, special installations are used that process organic waste into biogas, electricity, and heat. There are large plants (with a capacity of over 1 MW, used for processing large volumes of waste), medium-sized plants (with a capacity of 0.5—1 MW, suitable for agricultural enterprises), and small plants (with a capacity of up to 0.5 MW, which can be used in farms and private homes).

The characteristics of basic types and features of entrepreneurship associated with the production of different types of alternative energy are shown in Table 1.

Therefore, to develop such a business model, it is necessary to overcome problems such as entry barriers, dependence on special electricity tariffs (which are set by the state above the market level for producers of electricity from renewable sources), and the instability of the regulatory environment. So, the construction of power plants or other facilities for the production of alternative energy requires significant capital investments, which is a barrier for many investors, especially small and medium-sized businesses. In addition, frequent changes in legislation in the field of renewable energy, particularly regarding the "green" tariff and other support mechanisms, create uncertainty and risks for investors.

A characteristic example is the Law of Ukraine No. 3220-IX "On Amendments to Certain Laws of Ukraine on the Restoration and Green Transformation of the Energy System of Ukraine" (dated July 27, 2023), which not only introduced new mechanisms to support the production of electricity from renewable sources, such as auctions and contracts for difference (CfD), but also initiated a gradual reduction of the "green" tariff. In addition to the above, there have been other changes in legislation that have affected the conditions for doing business in the field of renewable energy. For example, the rules for connecting power plants to the grid, equipment requirements, and permit procedures have changed. In particular, requirements have been introduced to ensure frequency and voltage stability in the grid, as well as the ability to remotely control the power plant. In addition, investors are now required to provide financial guarantees for the fulfillment of technical connection conditions and ensure the stable operation of the power plant. Business models focused on the production of equipment and components for renewable energy in Ukraine are currently characterized by a significant dependence on imports. Although there are enterprises in the country that assemble solar panels, wind turbines, inverters, and other equipment, they mainly use imported components.

Therefore, to develop such a business model, it is necessary to overcome problems such as insufficient development of own technologies and production facilities (due to the underdevelopment of high-tech industries, insufficient investment and qualified personnel), dependence on imports (importing ready-made components

Table 3. Characteristics of basic types and features of entrepreneurship associated with the design and construction of alternative energy facilities in Ukraine

Object types	The basis for entrepreneurship by object subtypes	Features of entrepreneurial activity	Specifics of entrepreneurship
EPC contractors (Engineering, Procurement, and Construction)	A comprehensive range of services for the design, supply of equipment, and turnkey construction of solar, wind, and other alternative power plants	Providing a full cycle of work from project development to commissioning of the facility. Coordination of work of various subcontractors and suppliers. Responsibility for adhering to the project budget and deadlines	The need for highly qualified specialists (such as engineers, designers, builders, project managers). Competition with international companies (necessity for continuous improvement of service quality and cost optimization). The need to adapt to changes in legislation and technical standards
Engineering activities	A comprehensive range of services for the design and development of technical solutions for alternative energy	Designing solar, wind, biogas, and other power plants. Providing consultations on equipment selection, technologies, and project optimization. Developing new technologies and solutions in the field of renewable energy	High intellectual component (need for highly qualified engineers and scientists). Competition with international companies (which necessitates continuous improvement of knowledge and skills). The need for constant monitoring of new trends and developments in the industry

Source: formulated by the author based on [2; 4].

more economically viable than producing them in Ukraine due to the lack of production scale and shortage of personnel), lack of government support (lack of government support for domestic manufacturers complicates the development of their production of components for renewable energy) [3—4].

Entrepreneurship models focused on the design and construction of alternative energy facilities. It is important to develop EPC contractors and engineering activities in this regard [2; 4]. The characteristics of basic types and features of entrepreneurship associated with the design and construction of alternative energy facilities in Ukraine are presented in Table 3.

Therefore, to develop such a business model, it is necessary to overcome problems such as legislative instability, technical and administrative barriers, shortage of qualified personnel, and lack of a developed market for equipment and components [2; 4]. So, the main problem is that most of the components for building power plants have to be imported, which increases the cost of projects, creates dependency on external suppliers, and generally complicates the processes of designing, supplying equipment, and turnkey construction of solar, wind, and other alternative power plants.

At the same time, it is important to develop energy audits and energy monitoring and to implement energy-efficient solutions. The characteristics of the basic types and features of entrepreneurship related to energy services in Ukraine are presented in Table 4.

Therefore, to develop such a business model, challenges such as legislative regulation, insufficient qualifications of personnel, and competition from dishonest market participants need to be overcome. The main problem is that in energy services market, companies are offering low-quality services at inflated prices. It undermines consumer trust in energy services and complicates the work for honest entrepreneurs.

CONCLUSIONS FROM THIS STUDY AND PROSPECTS FOR FURTHER EXPLORATION IN THIS DIRECTION

Within the study, attention is drawn to the fact that in Ukraine, models of entrepreneurship in the field of alternative energy have formed and are already functioning. These include electricity generation, equipment, and components manufacturing, project design and construction, as well as energy services. However, despite the existing potential, their development is hindered by several factors that require comprehensive solutions involving the state, business, and the public. In this regard, the following conclusions have been drawn:

1. The process of developing effective measures to stimulate the development of alternative energy should be based on an analysis of the specific characteristics and issues of each entrepreneurship model in the alternative energy sector. It will allow identifying key barriers and determining priority directions for state support, investments, and regulatory changes

2. In particular, to develop effective measures to stimulate the development of alternative energy, it is necessary to consider the following problematic aspects. In electricity production, there are high capital costs,

Table 4. Characteristics of the basic types and features of entrepreneurship related to energy services in Ukraine

Object types	The basis for entrepreneurship by object subtypes	Features of entrepreneurial activity	Specifics of entrepreneurship
Energy audit and energy monitoring	Services for assisting in the identification of energy-saving potential and the implementation of corresponding measures	Comprehensive assessment of facilities to identify inefficient energy use. Installation and maintenance of energy consumption monitoring systems. Providing recommendations for improving energy efficiency and developing implementation plans for measures.	Demand for energy engineers, auditors, and analysts. Legislative regulation and the associated complexity of licensing and certification. A large number of companies in the market requiring continuous improvement in service quality and innovative approaches
Implementation of energy-efficient solutions	Services for upgrading lighting, heating, ventilation, and air conditioning systems to reduce energy consumption	Development and implementation of energy-efficient projects. Sale and installation of energy-saving technologies. Technical support and maintenance of installed equipment.	Need for financing to purchase equipment and materials. Need to establish long-term contracts with clients based on energy service agreements. Impact of changes in legislation and energy efficiency support programs

Source: formulated by the author based on [1—3].

dependence on special electricity tariffs (set by the state above market levels for renewable energy producers), and regulatory environment instability. In equipment and component production, there is insufficient development of proprietary technologies and manufacturing capacities, dependence on imports, and a lack of state support for domestic manufacturers. In the design and construction of facilities for alternative energy production in Ukraine, there are high risks due to legislative instability, technical and administrative barriers, a growing shortage of skilled personnel, and the absence of a developed market for equipment and components. In energy services, there are legislative regulations, insufficient qualifications of personnel, and competition from dishonest market participants.

These provisions underline the necessity of a comprehensive approach to developing alternative energy in Ukraine and allow for identifying the development of such an approach as a perspective for further research. It is crucial to develop an approach that takes into account the specifics of each business model and focuses on overcoming current barriers.

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