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ASSESSMENT OF ENERGY SECURITY OF UKRAINE IN THE IMPLEMENTATION OF RENEWABLE ENERGY TECHNOLOGIES

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Introduction. In today's challenges, energy security of the country is a global problem. The implementation of new engineering and design solutions in energy supply systems, which provide for the integrated use of renewable energy sources, will help to solve an important economic, scientific and technical problem of reducing the consumption of traditional fuel and energy resources for Ukraine.

Energy security is closely related to energy independence – it is the degree of independence of the country's leadership in the formation and implementation of policy, independent of external and internal interference and pressure [1].

There is a growing interest in the use of non-conventional renewable energy sources in various sectors of the economy all over the world. The driving force of this process are changes in the energy policy of countries with structural reorganization of the fuel and energy complex in connection with the environmental situation and the transition to energy and resource saving technologies in energy, industry, housing and communal services, etc.

The main directions of improvement of energy efficiency and realization of energy saving potential are not only the mentioned technological modernization of energy supply systems [2]. The use of renewable energy sources under the condition of technological modernization of energy supply implies the elimination of energy inefficient products and the implementation of the latest technologies, equipment, measuring devices and systems. This contributes to the growth of energy efficiency and energy saving.

Review of recent research and publications. General scientific opinions on energy security management among scientists should be divided into three functional parts. These are: approaches to defining the concept of energy security, approaches to defining its components, and approaches to energy security management at the theoretical level and in real practice.

As for the scientific approaches of the first group, it should be noted that there is quite a wide range of views among them. However, in most cases this group of scientific approaches defines the concept of energy security management in one way or another, defining and describing the components of this system [3].

At the same time, there are three such groups of components:

- Energy security management – as a combination of interrelated measures [4];
- energy security management – as a combination of functional components [5];
- energy security management – as a combination of security subjects and instruments of their activity [6].

In general, it should be noted that these scientists and researchers unjustifiably use the semanteme "system" in their definitions. The use of "system" gives the impression that the definitions have comprehensiveness, complexity and a certain integrity [7].

This allows to some extent to make the definitions shorter and more meaningful, but on the other hand this approach generates ambiguity of concepts and their conceptual generic relations. In most cases, such definitions cannot be fully and consistently understood without additional interpretation of the context in which these definitions are given [8]. Thus, from the semantic point of view, the definitions included in the definitions of the first approach cannot serve as a basis for understanding the principles of the structure and functioning of the energy security system.

In contrast to the first group of approaches to the definition of "energy security", the second group consists of definitions based on the semantics of "system" in the interpretation of the essence of energy security management.

In order to define the concept of "energy security", representatives of the second group use, in particular, general system principles and characteristics [9]. However, it should be noted that most of the definitions of this group are based on stereotypical systemic formulations.

This means that the definition is based on one of the classical definitions of the system and the predicate of the system is changed to energy security [10]. In general, this should not be considered incorrect, but in this case, the peculiarities of the energy security system as a kind of social system may not be fully taken into account.

The third group of approaches to interpreting the nature of the energy security system is the most difficult to study. The third group includes studies in which the energy security system is not a direct object of research, but is analyzed as a certain component of the general concept of security [11]. In this case, the system building in the field of energy security is considered through the prism of the results of the system building of other levels of security [12]. These areas of scientific research include the theory of security of social systems [13], the theory of security of people, society, civilization [14], and a synergistic approach to the creation and functioning of security systems [15].

Problem statement. The purpose of the article is to determine the indicators of effective assessment of energy security in the implementation of renewable energy technologies based on SWOT analysis.

Main material and results. High technical and economic performance and stable operating parameters of power equipment can be achieved by integrated use of solar and wind energy for combined generation of heat and electricity with their accumulation. One of the factors that impede the widespread use of renewable energy sources is the lack of technical solutions and technological schemes for their implementation, economically acceptable for the middle band. Considering the significant financial costs for the construction of a power supply system with the combined use of renewable energy sources, it is very important to develop correct methods for their calculation, taking into account the initial data of a particular user, which will help to minimize the total cost. Otherwise, there is a high probability of unsatisfactory operation of the energy supply system, which will result in additional costs for its re-equipment.

A common point that unites different approaches to the construction of indicators is a set of certain threats to the energy supply of the enterprise. At the same time, it is necessary, according to the authors, to examine the influence of the external and internal business environment on the determination of energy security by means of SWOT analysis.

The architecture of the created model includes the following levels: data loading and processing; data analysis; SWOT modeling; forecasting.

The first level provides the ability to load data by manual input, then edit it to eliminate data redundancy or add new data. The next step is to prepare the data for analysis. Various software products can be used at this stage. According to the authors, the most convenient and inexpensive is MS Excel.

The second level provides the possibility of mutual analysis of pairs of such indicators: Strengths – Opportunities (S-O); Strengths – Threats (S-T); Weaknesses – Opportunities (W-O); Weaknesses – Threats (W-T).

The third level provides tools for building a SWOT analysis model.

The fourth level implements predictions based on the created SWOT model.

This model fulfills the main characteristics of the model, which is designed to help the decision maker to identify critical technologies of the studied industry. The main goal of the created model is the efficiency of identification of justified critical technologies.

The most important characteristics, according to the research, were identified (Table 1).

Table 1

Identification of strong characteristics in the innovative development of Ukraine in the energy security system

STRENGTHS	
S1	Level of provision of the enterprise with own energy resources
S2	Building a solid foundation for a competitive economy
S3	Achieving the level of energy self-sufficiency
S4	Developed NPP network
S5	Promoting internal reforms in the context of grid integration with the EU
S6	Change of energy type (alternative) and supplier
S7	Creating an energy efficient society
S8	Creating opportunities for re-equipment of both the energy industry and the country's industry in general
S9	Improving the security dimension of the economy, energy and environment
S10	Development of scientific potential
S11	Creation of workplaces
S12	Convenient geographical location for the development of the electric power industry
S13	Large stock of natural resources for various industries
S14	Favorable trade geographical location

Source: developed by the authors

However, the weaknesses of the modern economy as a whole and of its individual sectors have been identified even more clearly (Table 2).

Table 2

Identification of weaknesses in the innovative development of Ukraine in the energy security system

WEAKNESS	
W1	Monopoly dependence on one supplier or energy supply route
W2	Underfunding of works on the search for alternative sources of electricity, reduction of their volumes
W3	High dependence on natural gas and oil imports
W4	Obsolete production facilities and a significant share of unusable fixed assets of enterprises
W5	Setting appropriate tariffs, coefficients for enterprises
W6	Low level of investment and innovation activity in the fuel and energy complex of enterprises
W7	The need for modernization, re-equipment and industrial restructuring with the extension of the technological resource of production facilities at enterprises
W8	Low qualification of most of the workforce
W9	High level of corruption
W10	Political and social instability
W11	Raising tariffs for the development of gas fields up to 5 km deep
W12	Migration of labor resources for permanent residence abroad
W13	Difficult implementation of EU standards in the energy sector
W14	Difficulty of achieving strategic goals in the energy sector in Ukraine
W15	Non-closed production cycles of most industries
W16	Irrational use of natural resources
W17	Irrational privatization
W18	The de-professionalization of the energy sector
W19	Low orientation of education to industry
W20	Falsity of a number of normative legal acts
W21	The complexity of economic transformation
W22	Increase in the cost of energy resources

Source: developed by the authors

It is known that Ukraine is one of the world's leading countries in mineral resources, is one of the richest in terms of quality composition and productivity of agricultural land, occupies a leading position in nuclear energy, is among the top five countries – software developers under outsourcing schemes, etc.

It is possible to get rid of these characteristics. If the strong features are used wisely and all opportunities for the country are realized (Table 3), then it is possible not only to compensate for the weaknesses, but also to turn them from disadvantages into advantages. Ukraine is one of the few countries that has many opportunities for its development under favorable conditions.

Table 3

Identification of opportunities for innovative development of Ukraine in the energy security system

OPPORTUNITIES	
O1	Significant potential of unconventional natural gas reserves (coalbed methane, shale gas, biogas from solid waste landfills, etc.)
O2	Extensive and developed oil and gas transportation pipeline systems
O3	System of oil, condensate and liquefied gas auctions
O4	Integration into the European energy system
O5	Significant potential to reduce greenhouse gas emissions
O6	An extensive district heating system
O7	Auctions of permits and licenses for the development of hydrocarbon deposits
O8	Development of renewable energy sources
O9	High quality and compliance with international standards of Ukrainian developments in the progressive field of alternative energy
O10	Implementation of incentive taxes
O11	Significant energy saving potential in industry, transport, public and domestic sectors
O12	Strengthening global connectivity
O13	Strengthening energy saving and energy efficiency
O14	Diversification of energy imports
O15	Creation of strategic reserves of fuel and energy resources
O16	Reformation of the energy system
O17	Innovative renovation in accordance with world standards
O18	Attracting investments and business development with foreign capital
O19	Reducing administrative barriers to market entry and free investment
O20	Reorientation of old enterprises, modernization of technological processes
O21	Expansion of international relations
O22	Development of mechanisms to combat corruption
O23	Possibility of diversification of nuclear fuel supplies

Source: developed by the authors

The formation of a group of experts on the basis of a competency-based approach, taking into account the rank of positions, allows to form a group that, according to its official duties, has the opportunity to build a personnel evaluation system in accordance with the goals of the company. Specific requirements to the members of the expert group leave their mark on the principles of their selection. The staff of the expert group consists of the total number of applicants and is formed from the most competent specialists who can demonstrate the ability to predict and identify patterns.

As experts were selected 10 officials from different management levels of 7 Ukrainian industrial enterprises. The consistency of experts' opinions was calculated by Kendall's rank correlation coefficient, which is 0.67.

With the help of fractal analysis a graphical interpretation of the comparative matrix of SWOT analysis components in the innovative development of Ukraine in the system of energy security was built (Figure 1).

The following five strong characteristics are of the highest importance: S5 "Facilitation of internal reforms related to network integration with the EU"; S6 "Change of energy type (alternative) and supplier"; S12 "Favorable geographical location for the development of the electricity industry"; S13 "Large stock of natural resources for various industries"; S14 "Favorable geographical location for trade".

Undoubtedly, there are a number of factors that hinder the country's economic development, and some even cause its decline. Consider the threats (Table 4) that seem to be the most pressing today.

Table 4

Identification of threats in the innovative development of Ukraine in the energy security system

THREATS	
T1	Outflow of investment capital from Ukraine
T2	Threat of terrorist attacks on energy facilities, on the territories of countries engaged in transit transportation of energy resources
T3	Environmental (large-scale accidents, greenhouse gas emissions that threaten the entire planet)
T4	Speculation in the media, which is a negative manifestation of the modern globalized world (artificial creation of panic, which leads to destabilization of energy markets)
T5	Social threat (high production accidents, strikes and other possible protests, etc.)
T6	Threats of nuclear terrorism, problem of non-proliferation of nuclear materials
T7	Energy poverty (lack of access to sufficient quantities)
T8	External aggression of the energy supplier
T9	Neglect of the "decarbonization" rule
T10	It is difficult to ensure the stability of energy transportation
T11	Dependence on foreign energy resources
T12	Possible loss of transit status
T13	Self-isolation after non-compliance with EU rules or their inadequate implementation
T14	Presence of seismically active geological zones in the Carpathian region

Source: developed by the authors

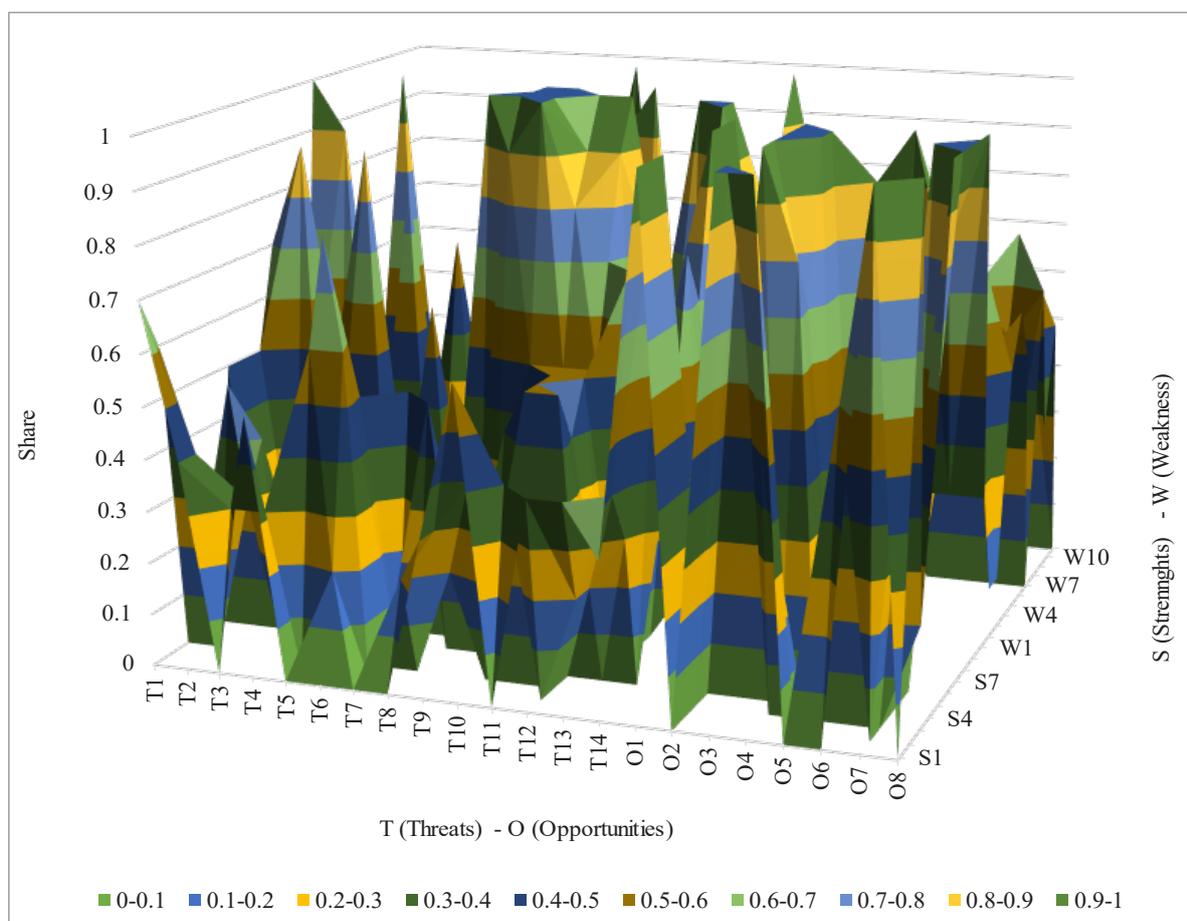


Figure 1. Graphical interpretation of the matrix of comparison of SWOT analysis components in the innovative development of Ukraine in the system of energy security

Source: developed by the authors

The weakest features. Thus, the weakest characteristics are the following: W5 "Establishment of appropriate tariffs, coefficients for enterprises"; W9 "High level of corruption"; W10 "Political and social instability"; W12 "Migration of labor resources for permanent residence abroad"; W22 "Increase in the cost of energy resources".

The most likely opportunities for implementation. Therefore, the most likely opportunities are the following: O1 "Significant potential of unconventional natural gas reserves (coal bed methane, shale gas, biogas from landfills, etc.)"; O8 "Development of renewable energy sources"; O10 "Implementation of incentive taxes"; O17 "Innovative renovation according to world standards".

The most dangerous threats. Thus, the most dangerous threats are as follows: T1 "Outflow of investment capital from Ukraine"; T5 "Social threat (high rate of production accidents, strikes and other possible protests, etc.)"; T8 "External aggression of the energy supplier".

Priorities in the development and implementation of new technologies in Ukraine are within the traditional technological areas: metallurgy, energy, chemistry, agriculture and new high-tech industries: national programs and projects for space exploration, aviation, biotechnology, telecommunications.

Industrial development relies heavily on the introduction of high-priority energy-saving technologies, which are the key to creating world-class and above products. The application of key technologies should help meet the country's priority needs in social, military, economic and other fields. The economic analysis of the factors influencing the determination of priorities of technological development shows that the indicators of the implementation of key technologies in the Ukrainian industry can be the following: the volume of budget financing of scientific and technical works on the development of advanced technologies and determination of priority directions of scientific and technological development; the volume of innovation costs; introduction of new technological processes; mastering the production of new types of products; specific volumes of innovation costs for the introduction of new technological processes.

Conclusions. Ukraine has the potential to accelerate economic growth and improve energy security. Energy security is a key element of national security. Therefore, the Government of Ukraine is implementing strategic reforms in the field of energy supply and strengthening energy security through the implementation of energy strategies. Ukraine is expanding cooperation with the European Union, which will ensure the protection of our country and create a competitive energy market and sustainable socio-economic development.

A key element of the modern economy is a powerful energy sector, the development of which is closely linked to the progress of science and technology. Energy resources in combination with mechanical systems provide technological innovation in all spheres of production, communication and society, which leads to dominant economic growth and national security.

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Tetiana Hilorme, Doctor of Economics, Associate Professor, Leading Researcher, Oles Honchar Dnipro National University. **Lilia Nakashidze**, Doctor of Technical Sciences, Senior Researcher, Leading Researcher, Oles Honchar Dnipro National University. **Iryna Liashenko**, Candidate of Philology, Associate Professor, Ukrainian State University of Science and Technologies. **Assessment of energy security of Ukraine in the implementation of renewable energy technologies.**

The article investigates the definition of indicators of effective assessment of energy security of Ukraine in the implementation of renewable energy technologies based on SWOT analysis. Priority of implementation of technologies using energy of renewable sources on leveling of threats to energy supply of the country is defined. The scientific and methodological approach to assessment of innovative development of Ukraine in the system of energy security using a modified model of SWOT analysis is substantiated. The advantage of the model is compactness of development due to the use of a single platform and efficiency of use due to the absence of the need to reload data into a specialized system. With the help of fractal analysis, a graphical interpretation of the comparison of SWOT analysis components in the innovative development of Ukraine in the system of energy security is built. The peculiarity of the proposed model lies in the fact that the data, having both qualitative and quantitative characteristics, are subject to analysis. As a conclusion, it is proposed to carry out an economic analysis of the factors influencing the prioritization of key technologies in the Ukrainian industry.

Key words: security, energy saving, SWOT analysis, innovation, development.

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У статті досліджено визначення показників ефективного оцінювання енергетичної безпеки України при впровадженні технологій відновлюваних джерел енергії на основі SWOT аналізу. Визначено пріоритетність впровадження технологій використання енергії відновлюваних джерел на нівелювання загроз енергозабезпеченню країни. Обґрунтовано науково-методичний підхід до оцінювання інноваційного розвитку України в системі енергетичної безпеки з використанням модифікованої моделі SWOT аналізу. Перевагою моделі є компактність розробки завдяки використанню однієї платформи й оперативність використання завдяки відсутності необхідності перезавантажувати дані в спеціалізовану систему. За допомогою фрактального аналізу

побудовано графічну інтерпретацію зіставлення компонентів SWOT аналізу при інноваційному розвитку України в системі енергетичної безпеки. Особливістю запропонованої моделі є те, що аналізу піддаються дані, що мають як якісні, так і кількісні характеристики. Виділено п'ять сильних характеристик із найбільшим значенням: великий запас природних ресурсів для різних галузей; вигідне торговельне географічне розташування; зміна виду енергії (альтернативні) та постачальника; сприяння внутрішнім реформам за умов інтеграції мереж із ЄС; зручне географічне розташування для розвитку електроенергетичної промисловості. Найслабші характеристики такі: політична та соціальна нестабільність; високий рівень корупції; міграція трудових ресурсів на постійне місце проживання за кордон; встановлення відповідних тарифів, коефіцієнтів для підприємств; збільшення вартості на енергоресурси. Отже, найімовірнішими можливостями є такі: інноваційне оновлення відповідно до світових стандартів; значний потенціал запасів нетрадиційного природного газу (метану вугільних родовищ, сланцевого, біогазу полігонів твердих побутових відходів тощо); упровадження стимулювальних податків; розвиток відновлюваних джерел енергії. Найнебезпечніші загрози такі: зовнішня агресія постачальника енергоресурсів; вплив інвестиційних капіталів з України; соціальна загроза (висока аварійність виробництва, страйки та інші можливі акції протесту тощо). Як висновок, запропоновано здійснювати економічний аналіз факторів, що впливають на визначення пріоритетів ключових технологій в українській промисловості.

Ключові слова: безпека, енергозбереження, SWOT аналіз, інновація, розвиток.