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SECURITY IN THE SPHERE OF APPLICATION OF RENEWABLE ENERGY SOURCES IN UKRAINE: PECULIARITIES OF ORGANIZATION AND IMPLEMENTATION OF SYSTEMATICITY

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**БЕЗПЕКА У СФЕРІ ВИКОРИСТАННЯ ВІДНОВЛЮВАНИХ ДЖЕРЕЛ ЕНЕРГІЇ В УКРАЇНІ:
ОСОБЛИВОСТІ ОРГАНІЗАЦІЇ ТА РЕАЛІЗАЦІЇ СИСТЕМНОСТІ**

This article is devoted to the study of the content of nature, as well as the social and economic significance of the practical application of energy produced with the use of renewable energy sources. A relatively significant volume of applied and fundamental research by a wide range of leading scientists has been developed. A parallel was drawn between the content of practical knowledge regarding the production and subsequent use of renewable energy in Ukraine concerning European countries (under the conditions of a rather significant limitation of the amount of fossil fuel resources, the limitation of the possibility of realizing greenhouse emissions). Unique characteristics stratify types of possible renewable energy sources in Ukraine and European countries. The level of the energy potential of Ukraine in comparison with European countries regarding the practical implementation of modern approaches and means of implementation of renewable energy sources is determined.

Dissatisfaction with the state of the environment, as well as the level of energy deficit in Europe and domestic energy systems, suggest the need for theoretical and practical implementation of overcoming the difficulties of energy supply for industry and the population in the direction of the use in the life of various types of renewable energy sources. Rationality and limitations in the process of using organic resources in today's conditions create conditions for humanity to carry out its economic activities in such ways for about 50 years. Which, as an investigation, will necessarily cause at the global level the problem of the lack of energy to ensure any economic activity. Therefore, under today's conditions, the promising directions of the development of world energy generation in terms of the search for new approaches to the generation of renewable energy acquire a rather particular substantive importance.

In general, the natural factors of our country fully allow the use of several different renewable energy sources, such as wind energy, solar energy, water energy, and hydrogen energy. The peculiarities of practical management of the economy in industry and the everyday life of citizens make it possible to use and sell artificial products quite widely, among which it is worth noting: emissions of thermal energy, which have a place permanently in the activities of a wide range of industrial enterprises and organizations, combustible gas at enterprises in coal mining industry; waste from agricultural, household and industrial origin; products resulting from solid household waste processing; generation of alternative products-generators of alternative energy from agricultural waste. We believe that the practical implementation of tasks related to the development of energy produced using alternative sources in Ukraine, first of all, requires: the formation of a national-personal model for the development of the so-called "separate" energy industry with practically effective regulatory and legal instruments specifically for each type renewable energy source; a clear outline of the state's incentive policy for preferential policies for both producers and energy consumers; a constant search for alternative ways to attract additional funding to the RES sector.

Дана стаття присвячена дослідженню змісту природи, а також соціальному та економічному значенню практичного застосування енергетики, продукуваної з ви використанням відновлювальних джерел енергії. Опрацьовано досить вагомий обсяг прикладних та фундаментальних досліджень широкого кола провідних вчених. Проведено паралель змісту практичних знань щодо продукування та наступного використання відновлювальної енергетики в Україні відносно країн Європи (за умов досить значної обмеженості обсягів викопних паливних ресурсів, обмеженістю можливості реалізації парникових викидів). Стратифіковано за особливим характеристиками види можливих відновлювальних джерел енергії в Україні та країнах Європи. Визначено рівень енергетичного потенціалу України в порівнянні з європейськими країнами відносно практичного впровадження в дію сучасних підходів та засобів реалізації відновлювальних джерел енергії.

Невдоволеність щодо стану навколишнього середовища, а також рівень енергодефіцитності в Європі та у вітчизняних енергетичних системах наводять на думку потребу у теоретичному та практичному впровадженні здолаття складностей енергетичного забезпечення промисловості та населення в напрямі застосування в житті різного характеру відновлювальних джерел енергії. Рациональність, а також обмеженість в процесі використання в умовах сьогодення органічних ресурсів створюють умови для людства здійснювати свою господарюючу діяльність в такий спосіб близько 50 років. Що, як слідство обов'язково спричинить на глобальному рівні проблему відсутності енергетики з метою забезпечення будь-якої господарської дії. Від так, за умов сьогодення, досить особливої змістовної важливості набувають саме перспективні напрями розвитку світової енергогенерації в частині пошуку нових підходів о генерування відновлювальної енергетики.

Загалом, природні чинники нашої держави в повній мірі дозволяють застосовувати цілий ряд різноманітних відновлювальних джерел енергії, як енергію вітру, енергію сонця, енергію води, так і водневу енергію. Особливості практичного ведення господарства в промисловості та в побуті громадян дозволяють досить широко використовувати та реалізовувати продукцію техногенного характеру, серед яких варто відзначити: викиди теплової енергетики, що має на постійній основі місце в діяльності широкого кола промислових підприємств та організацій, горючого газу на підприємствах у вугледобувній промисловості; відходи від сільськогосподарського, побутового та промислового походження; продукти, що виникають в результаті переробки твердих побутових відходів; генерація з відходів функціонування сільського господар-

ства альтернативних продуктів-генераторів альтернативної енергетики. Вважаємо, що саме практична реалізація задач щодо освоєння енергетики продукуюваної з використанням альтернативних джерел в Україні, в першу чергу потребує: формування вітчизняної-особистої моделі щодо розвитку так званої "окремої" енергетичної галузі з практично дієвими нормативними та правовими інструментами спеціально для кожного окремо взятого виду відновлювального енергетичного джерела; чітке окреслення політики з стимулювання з боку держави пільгових засад як для виробників, так і самих споживачів енергії; постійний пошук альтернативних шляхів з залучення додаткового фінансування у галузь ВДЕ.

Key words: renewable energy sources, energy, alternative energy, safety in the energy field, systematic safety, use of RES.

Ключові слова: відновлювальні джерела енергії, енергетика, альтернативна енергетика, безпека в сфері енергетики, системність безпеки, застосування ВДЕ.

FORMULATION OF THE PROBLEM

In the first half of the XX century. Coal and firewood prevailed in the world energy sector later, and oil and gas played a more critical role in the economic flow of energy raw materials; today, the trend shows the consolidation of already established forms of renewable energy sources. This, in turn, is evidence of significant changes in the structure of the global energy system in the world.

Today, the issue of the application of various forms of green energy plays a critical role for Ukraine. In addition, the need for developing renewable energy sources is highlighted in the national energy Strategy and is consistent with European and global trends in energy security. The maximum volume of increasing the share of carbon-free energy in our "energy mix" is one of the critical priorities of the Ministry of Energy and Coal Industry of Ukraine," Farid Safarov noted at the time [7].

"The war forces us Ukrainians and the whole world to rethink the way of energy production and use of energy resources. We need more reliable sources for further energy generation and much more progressive approaches to its consumption — emphasized Herman Galushchenko [7].

In the words of the Minister of Energy and Coal Industry of Ukraine, the interpretation of reliability is clear and understandable given not only the dependence on Russian energy supply but also the formation of one's own sustainable, renewable, ecologically clean sources of supply of energy resources.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

This research has been the result of active scientific polemics of practitioners and professional theoreticians for a long time on renewable and various "non-traditional" sources of energy generation, as well as approaches to the implementation of traditional approaches to the method of energy supply. The in-depth research presented in this publication shows that the strategicness and depth of the outlined direction are significant.

The substantive relevance of this study is also strengthened to a large extent with the insufficiently significant specification of the essence, variety, source of origin, and

methods of practical use of renewable energy within the boundaries of management at all levels.

The theoretical basis of relatively relevant today's approaches, methods, tools, and technological solutions regarding the use of current forms of renewable energy sources: solar energy, wind energy, biomass, etc. — was studied by scientists [5, 6, 10, 12, 13, 20].

Delineation of the economic content and potential and ways of realization of renewable energy sources were dealt with [3, 4, 14, 16, 17, 21, 22].

FORMULATION OF THE GOALS OF THE ARTICLE

The purpose of this article is a multifaceted study, as well as to outline aspects of the features that take place in organizing and implementing security in the renewable energy sources in Ukraine for energy generation.

PRESENTATION OF THE MAIN MATERIAL OF THE STUDY

Taking into account the energy potential of our country, it is worth noting that its origin, under the conditions of the implementation of its military Strategy for exiting the energy crisis, consists to a greater extent of nuclear energy and renewable energy sources.

For reference, it is worth noting that from 2011 to 2021 inclusive, the share of renewable energy sources in Ukraine increased from 4% to almost 14%" [7].

According to forecasts based on the data of the international agency for renewable energy sources IRENA, unlike the countries of South-Eastern Europe, Ukraine has enormous potential for the use of renewable energy sources, namely 408.2 GW, and this is without taking into account quite significant losses from hydroelectric power stations, which usually have a place. Particular success should be expected from innovative technologies using wind and solar power plants: 321 GW and 71 GW, respectively [18].

According to pre-war forecasts, the economically justified feasibility of implementing RES in Ukraine as of 2030 is estimated at 16—22 GW [18].

We consider the possibilities of introducing renewable energy sources in the thermal power industry to be even

more thorough, which over time foresees a complete transformation of traditional energy sources by 2030. In this direction, there are convincing statements by the international agency for renewable energy sources IRENA, regarding the fact that in 2030, about 57 million Gcal of thermal energy can be produced from renewable energy sources, where the particular weight will fall on biomass (32.7 million Gcal).

The fulfillment of this forecast will save about 7 billion cubic meters of natural gas every year. Implementing the expected forecasts will reduce the cost of wind power plants (wind power plants) and SES (solar power plants) technologies to — 13% within the next ten years.

Let us talk about the possibility of modernization and increasing the energy independence of electricity and heat generation through renewable energy technologies. This is one of the critical directions for increasing the level of energy security, which can be present and possible only under the condition of the stability of the political and economic systems of Ukraine.

The pre-war period for Ukraine was critical in building a significant and tangible potential for generating hydrogen, biomethane, and other forms of renewable energy sources. The dynamics of the implementation of various energy-saving technologies were also positive, focusing primarily on modern European practices in an energy audit, energy management, eco-design, and the implementation of state programs, the content of which includes measures to reduce the level of energy consumption, etc.

It is no secret that the war in Ukraine caused not only an actual economic, social and humanitarian crisis but also called into question the continuation of any positive practices regarding improving the energy market.

Evidence of this aspect is the practice carried out an analysis of the electricity consumption levels in Ukraine during the pre-war and post-war periods. As a result, it can be stated that the country's GDP decreased by as much as 30%.

Coverage of the primary material. The process of restoring the post-war economy is challenging and requires a significant level of patience, financial and material resources, and an extended period. At the same time, we note that corruption, a relatively opaque judicial system, and weak awareness of special and social support services will be inhibiting factors in restoring the economic and, ultimately, the energy systems. However, each country had its own experience and tools for implementing the recovery plan, as well as the way to implement it.

The experience of success in the post-war recovery of European countries was based not only on financial aid and the expansion of market relations. An essential aspect of recovery has become the personal motivation of those recovering nations, manifested in zero tolerance for corrupt actions and the development of an independent system of democratic foundations [15].

For example, in Japan, at one time, more than 70% of all existing industrial assets were consolidated for re-equipment of production and supply technology for study, as well as the implementation of the best technologies. The content of the main document of the reconstruction of post-war Japan, entitled "The main problems of the

economic reconstruction of Japan," described the priority of the production policy, which was primarily focused on the accumulation of limited resources in several strategically necessary and "priority" industries, areas with the expectation of a multiplier effect on other areas of the national economy.

The first step in implementing this document was the increase of coal production to form a base for the renewal and reconstruction of several industries, simultaneously with the projected increase in the volume of steel exports.

The main priority was the production policy, which provided for the concentration of scarce resources in several strategically important industries. It should multiply the effect on adjacent sectors of the economy [19].

In a few years, France, Germany, Italy, Belgium, the Netherlands, and Luxembourg took over the mentioned experience in its turn. Over time, the energy orientation of these countries led to the formation of the "European Union of Steel and Coal," which was immediately reformed into the modern economic model of the European Union.

It is clear that Ukraine, under any circumstances, should take into account the positive features of the mentioned experience on the way to carbon neutrality in the energy sector, as well as the achievement of a 5% increase in the GDP level every year.

The first step in implementing this process is to end dependence on imports from other countries through advanced technologies, decarbonization, decentralization, digitalization, diversification, etc.

For the majority of countries that applied the policy of "decarbonization," the main five areas of energy recovery of the economy were, in this case, Ukraine is no exception:

- supply of primary energy;
- the infrastructure of modernization of energy markets;
- the restoration of the competitive market mechanism;
- increasing the qualitative and quantitative satisfaction of consumers;
- formation of new methods and practices of personnel rehabilitation in the energy sector [1].

Therefore, when considering the scope of renewable energy sources, the energy security system should be identified, taking into account the peculiarities of the sphere and the interdependence between other components of the energy sector. Enormous potential for using renewable energy sources, namely 408.2 GW, is without considering significant losses from hydroelectric power stations, which usually have a place. Particular success should be expected from innovative technologies using wind and solar power plants: 321 GW and 71 GW, respectively [18].

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regarding the fact that in 2030, about 57 million Gcal of thermal energy can be produced from renewable energy sources, where the particular weight will fall on biomass (32.7 million Gcal).

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Evidence of this aspect is the practice carried out an analysis of the electricity consumption levels in Ukraine during the pre-war and post-war periods. As a result, it can be stated that the country's GDP decreased by as much as 30%.

In our opinion, the first criterion for ensuring energy security in renewable energy sources is the decarbonization of energy resources.

Back in the day, the signing of the "Paris Agreement" by several countries on climate change in 2016 was essentially a forced and consequential step in the direction of global climate change, which in turn was a consequence of the use of coal and an increase in the concentration of CO₂ in the atmosphere. In turn, this affected the counting of decarbonization processes.

Note that the stages of energy development for society were different and consist of the following successive stages:

1. Long-term use of charcoal and transition to hard coal;
2. Formation of oil parity in energy;
3. Dominance in the economic development of gas resources.

It should also be noted that the world energy system is changing its established development guidelines from competitiveness and convenience to the issue of choosing ecological and renewable energy carriers.

Energy systems theorists and practitioners estimate that industrial heat accounts for two-thirds of total industrial energy demand and nearly one-fifth of global energy consumption. As a result, fossil heat produces the

most significant emissions of CO₂ because it is obtained from fossil fuels.

From this, we can conclude that decarbonization processes are primarily designed to form the basis of energy policy and sharply reduce the total volume of CO₂ emissions, which will significantly reduce the risk of impact on the human and natural environment.

However, decarbonization cannot be complete due to the lack of technological and resource support and does not allow abandoning the use of mined coal, oil, and natural gas. Therefore, we should talk about partial decarbonization rather than full decarbonization.

The second no less critical criterion of the security system is the need to develop a wholly new and objective Strategy for the energy sector of Ukraine under the conditions of post-war recovery.

It is known that the basis of the objective energy Strategy of Ukraine should be based on low-carbon development. Despite the need to systematically introduce the low-carbon energy generation model, its highly high investment component and prospects should be noted. This presupposes the intensification of actions in applying renewable energy sources to a greater degree of thermal generation at a sufficient level. Applying these types of energy resources can introduce new technologies for the adaptability and flexibility of energy security.

Summarizing and summarizing the facts noted above, we can conclude that such a Strategy for the recovery of the energy sector of Ukraine after the war will be relevant and essential. After all, it foresees reforms in the structures of the energy industry, and its goal is to provide the national economy and industry with fuel and energy resources (Table 1).

Today, Ukraine is characterized by a good potential in producing and generating renewable energy. According to statistical data, the number of foreign investments in renewable energy projects in Ukraine over the past two years (as of January 1, 2022) amounted to about 1.7 billion dollars. This indicates the country's great potential in this field of energy [2].

Therefore, taking into account the above, it should be understood that the process of development of the energy industry and energy security of our country involves:

- substantial capital investments in modern ecological innovation renovations;
- increasing the density of the energy commonwealth and the competitive environment with European countries.

In connection with the high level of energy intensity in Ukraine, using "alternative" energy is one of the most reliable and ecologically clean ways of reproducing energy security.

The third important criterion for the availability of energy security is the improvement of the energy efficiency of economic development.

The fourth criterion for the availability of energy security is the financing program for introducing renewable energy sources in Ukraine.

In this sense, the criterion coincides with the "national action plan" on energy efficiency, which was approved on December 29, 2021 [8].

The main directions of energy efficiency among renewable energy sources are the spread of highly efficient

Table 1. Measures to ensure the energy security of the regions due to alternative sources of energy sources

Directions	Tools	The results
An alternative from suppliers of energy carriers	1. Reverse deliveries of natural gas from Hungary, Poland, and the Slovak Republic; 2. Transportation using the main oil pipeline «Odesa-Brody-Gdansk»; 3. Import substitution of natural gas from Kazakhstan.	1. Lowering the level of prices for energy carriers due to balanced competition; 2. Practical provision of the appropriate level of reliability of the supply process; 3. Refusal to cooperate with monopolists-importers; 4. Compulsory insurance of possible risks; 5. Constant exchange of technological achievements and solutions between market counterparties.
Increasing the volumes of own production (energy resources) of hydrocarbons	Natural gas, oil, hydrogen energy resource	1. A decrease in the level of imports of energy carriers, as well as, as a consequence, a decrease in the level of a possible negative balance (balance) of trade; 2. Ensuring the most effective and efficient investment-friendly investment climate. 3. Provision of technological improvement and processes of production (extraction) of energy carriers.
Implementation of extraction of non-traditional sources (energy resources) of hydrocarbons	Natural gas, oil, bitumen	1. Increasing the volume of energy resources on the consumption market; 2. Environmental friendliness of energy use processes;
Search and further improvement of alternative converters of energy resources	Dnipro Hydroelectric Power Station Zaporizhzhia nuclear power plant	1. Reducing the level of natural gas consumption; 2. Ensuring the availability of jobs and investment inflow; 3. Application of ecological and clean technological solutions; 4. Regulation and control according to the schedule of energy load on energy systems in full accordance with the current standards of the world level; 5. Ensuring uninterrupted operation of energy networks and systems of Ukraine; 6. Increasing the level of volume and power generation of electric energy.

and combined production of thermal and electrical energy (cogeneration) with further use of waste energy potential following the principles and provisions of EU legislation.

However, this "task" is currently under the competence of the Ministry of Regional Development, the National Commission for State Regulation of Energy and Utilities (NKREKP), and local self-government bodies.

Also, for its implementation in practical and economic development, a legislative basis (base) should be formed for the further development of highly efficient cogeneration [8].

The fifth regulatory criteria, which confirms the hypothesis of the systematicity of criteria influencing energy security, are state-market instruments for regulating renewable energy in Ukraine. This is due primarily to the consolidation of Ukraine and Europe's efforts to stimulate joint projects in renewable energy. To begin with, joint efforts in this aspect should be noted in the euro denomination in "green" tariffs, which differ in type, forms, terms of implementation, and capacity of facilities. According to international agreements, these obligations stipulate the obligation to purchase electricity at the "green" tariff until 2030.

CONCLUSIONS

Summing up, we note that Ukraine is characterized by a reasonably significant potential (including among

European countries) for generating and further using renewable energy sources.

In general, the natural factors of our country fully allow the use of several different renewable energy sources, such as wind energy, solar energy, water energy, and hydrogen energy. Features of practical management of the economy in industry and the everyday life of citizens make it possible to widely use and sell manufactured products, among which it is worth noting:

- emissions of heat energy, which has a place permanently in the activities of a wide range of industrial enterprises and organizations, combustible gas at enterprises in the coal mining industry;

- waste from the agricultural, household, and industrial origin;

- products resulting from solid household waste processing;

- generation of alternative products-generators of alternative energy from agricultural waste.

We believe that the practical implementation of tasks related to the development of energy produced using alternative sources in Ukraine, first of all, requires:

- the formation of a national-personal model for the development of the so-called "separate" energy industry with practically effective regulatory and legal instruments specifically for each type of renewable energy source;

— a clear outline of the policy on the stimulation by the state of preferential bases for both producers and energy consumers themselves;

— the constant search for alternative ways to attract additional funding to the RES sector.

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