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INNOVATIVE SOLUTIONS FOR ENSURING ENERGY SECURITY OF UKRAINE AND THE WORLD

The article examines the preconditions for the aggravation of the energy danger for Ukraine and the world as a whole, in particular in the context of the strengthening of the economic crisis and war in Ukraine. The issue of compliance by energy organizations with the International Climate Paris Agreement and the achievement of the Global Sustainable Development Goals by 2030 were studied. The component indicators of the global index of energy innovations were analyzed. The main global energy indicators and their results in 2021 compared to 2020 were monitored. The paper also estimates domestic electricity consumption in the world by country in 2021, as well as trends in the growth of global energy consumption in general and by continent in 2021 compared to 2020. The result of such trends was that the consequences of sanitary measures and the economic crisis of 2020 was felt mainly in the sphere of services, transport and carbon-intensive electricity production.

The authors considered the key changes in the field of energy in the world in 2021 compared to 2020 and the dynamics of CO2 emissions related to energy in the G20 countries in recent years and based on this justified the forecast of European gas prices and the price of Brent oil to 2026 year. The main characteristics of countries with a high index of global energy innovation were considered. It was found that, for example, the Norwegian government had developed a strategy for carbon capture and storage (CCS), which aimed to identify measures to promote technology development and reduce the costs of CCS. It was found that the main goal of the EU regarding the share of renewable energy sources is 32% of the final energy consumption by 2030. This target was not distributed among the Member States, but the share of renewable energy sources in the Member States should be at least the same as in 2020.

In the article, the authors examined the stages of state regulation of the innovation policy of the energy sector of Ukraine and substantiated the place of the energy sector in the national innovation policy of Ukraine. Formation of innovation policy in the energy sector of Ukraine requires definition of the concept and strategic plans of its innovative development. In particular, it was found that one of these priority areas should be renewable energy (wind, solar, etc.).

The result of the authors' scientific research is that the innovative system of the energy sector is a fairly developed network intellectual structure that connects research and design organizations belonging to different sectors of the economy. Using the potential of the positive influence of a number of important global factors should be the basis of the transformation of innovative management of energy industry organizations in Ukraine.

Key words: innovation, management, energy security, renewable energy sources
JEL classification: ***F29, O32, Q42***

У статті досліджено передумови загострення енергетичної небезпеки для України та світу в цілому, зокрема в контексті посилення економічної кризи та війни в Україні. Вивчено питання дотримання енергетичними організаціями Міжнародної кліматичної Паризької угоди та досягнення Глобальних цілей сталого розвитку до 2030 р. Проаналізовано складові індикатори глобального індексу енергетичних інновацій.

Здійснено моніторинг основних глобальних енергетичних показників та їх результати у 2021 р. в порівнянні з 2020 р. Оцінено внутрішнє споживання електроенергії у світі за країнами у 2021 р., а також тенденції зростання світового енергоспоживання загалом та в розрізі континентів у 2021 р. у порівнянні з 2020 р. Результатом таких тенденцій стало те, що наслідки санітарних заходів і економічної кризи 2020 р. стали відчутними головним чином у сфері послуг, транспорту та вуглецево місткому виробництві електроенергії.

Автори статті розглянули ключові зміни в сфері енергетики у світі у 2021 р. у порівнянні з 2020 р. та динаміку викидів CO^2, пов'язаних з енергетикою в країнах G20 за останні роки й на основі цього обґрунтував прогноз європейських цін на газ і вартість нафти марки Brent до 2026 р. Розглянуто основні характеристики країн з високим показником глобального індексу енергетичних інновацій.

Виявлено, що, наприклад, уряд Норвегії розробив стратегію для уловлювання та зберігання вуглецю (CCS), яка спрямована на визначення заходів для сприяння розвитку технологій та зменшення витрат на CCS. З'ясовано, що основна мета ЄС щодо частки відновлюваних джерел енергії складає 32% кінцевого споживання енергії до 2030 р. Ця ціль не була розподілена між державами-членами, але частка відновлюваних джерел енергії в державах-членах повинна бути як мінімум такою ж, як у 2020 р.

Автори у статті розглядають етапи державного регулювання інноваційної політики енергетичного сектору України та обґрунтовують місце енергетичного сектору в загальнонаціональній інноваційній політиці України. Формування інноваційної політики в енергетичному секторі Українипотребує визначення концепції та стратегічних планів її інноваційного розвитку. Зокрема, виявлено, що одним із таких пріоритетних напрямів має бути відновлювана енергетика (вітрова, сонячна тощо).

Результатом наукового дослідження авторів стало те, що інноваційна система енергетичного сектору – це досить розвинена мережева інтелектуальна структура, яка пов'язує між собою дослідницькі та конструкторські організації, що належать до різних секторів економіки. Використання ж потенціалу позитивного впливу низки важливих глобальних факторів має бути закладено в основі перетворення інноваційного управління організаціями енергетичної галузі в Україні.

Ключові слова: інновації, управління, енергетична безпека, відновлювані джерела енергії
JEL classification: ***F29, O32, Q42***

Problem Statement. The recovery of Ukraine's economy in the conditions of martial law, imposed as a consequence of the military aggression of the Russian Federation against Ukraine, largely depends on the level of energy security. Since ensuring its proper level today is a guarantee of the social and economic strength and stability of the country, especially in the context of European integration, the need for development and implementation of various innovative energy technologies is becoming more and more in demand.

Innovations have long gone beyond the purely technical scope of their application. Innovations can be environmental, economic, managerial, social, cultural, etc. The value of such innovations for modern Ukrainian society is much higher than the value of material and technical innovations, since they require a new level of knowledge, creative thinking, ingenuity and purposefulness. Along with scientific and technological development, whose achievements penetrate into all spheres of our life, the energy crisis is sharpening considerably.

One of the main tasks of the functioning of the Ukraine's energy system and the main direction of its further development is the creation of prerequisites for meeting the needs of the country and partner countries in fuel and energy resources, provided that the

requirements of rational use of natural resources and minimizing the negative impact on the environment are met. Besides, Ukraine is bound to implement its international obligations in the environmental protection and follow its socio-economic priorities and limitations. That is why the study of the innovative component of energy development in Ukraine is extremely relevant.

Literature Review. Scientists pay considerable attention to the study of the problems of innovative management and development of organizations in the energy sector of Ukraine. This issue is considered separately and in the system of researching strategies for the growth of the state's economy in the context of the development of the economic complex as a whole. Seminal contributions to the problems of the functioning and development of the state's energy industry have been made by O. Onipko, O. Polishchuk, and V. Mykytenko.

The prospects for the use of renewable energy sources in Ukraine have been explored in prior studies by specialists and scientists such as M. McGrath [11], G. Kopnin [6], Tulupova E. and T. Demydova [20] etc. But, at the same time, a number of issues, such as directions for the development of renewable energy, the state of energy security in the world and the use of innovative solutions in management are gaining considerable importance today. Therefore, we consider it expedient to make an attempt to address these issues in this scientific article.

Task Statement. The purpose of the article is to study the role and trends of the introduction of energy innovations in Ukraine and the world, to find out the reasons and factors for the growth of energy consumption in different countries of the world, as well as to study the issue of state regulation of the innovation policy of the energy sector of Ukraine.

Results. Addressing issues of security and innovative development is of great importance today for organizations in the energy sector. This is connected, in particular, with Russia's full-scale invasion of Ukraine and the desire of the aggressor country to destroy the Ukrainian energy supply system. In 2022, Ukraine joined the synchronous network of continental Europe (ENTSO-E), which provided for the export of electricity to European countries. However, Russia's desire to deepen the energy crisis on European continent and ruin millions of people destroyed the hopes of Europeans and Ukrainians for cooperation in the energy sector. However, willpower and the struggle for freedom allowed the Ukrainians to continue work on restoring their energy system and the rapid introduction of innovative developments into the energy system of Ukraine.

The development of market relations in the electric power industry of Ukraine today is connected with the implementation of a full-scale competitive model of the functioning of the electric energy market. The purchase and sale of electricity in Ukraine is carried out under conditions of constant and continuous maintenance of the balance of production and consumption of electricity. The rapid rise in fuel prices and the physical wear and tear of the majority of power units against the background of a lack of funds for the reconstruction of existing and the construction of new maneuverable generating capacities of the energy system of Ukraine determines the urgency of finding new effective solutions aimed at keeping the balance. World practice proves that one of the ways to solve this problem is the introduction of innovative developments and the adoption of balanced but innovative management decisions. The International Paris Climate Agreement, adopted on December 12, 2015, sets out the obligation of 175 participating countries to reduce harmful emissions into the atmosphere, regardless of the degree of their economic development. It is known that the burning of fossil fuels is one of the main sources of emissions that cause climate warming, and so far, it satisfies about 80% of the world's energy needs.

Therefore, one of the twelve global goals of sustainable development until 2030, approved at the UN summit on sustainable development, is Goal 7 "Affordable and clean energy". Achieving this goal by 2030 involves solving a number of tasks, in particular, increasing the share of energy from renewable sources in the global energy mix,

intensifying international cooperation with the aim of facilitating access to research and technologies in the field of environmentally clean energy, increasing energy efficiency, innovative and environmental technologies for using fossil fuels fuel, encouraging investments in energy infrastructure and clean energy technologies, etc.

All of the above actualizes the issue of researching trends in the development of innovations in the energy sector – technological and organizational, makes increasingly pressing the analysis of world experience in their implementation and use in order to determine modern trends in the development of innovations and energy-efficient measures, which will allow for increasing the country's energy efficiency and gradual achieving other environmental and economic goals [19].

Considering the speed of development of innovative technologies and approaches to innovative activities, as well as constant changes in the external environment, it is important to additionally analyze new opportunities and innovations, to determine which countries are the most effective in terms of energy efficiency and innovations in the energy sector. And taking this into account, to identify the main tasks and measures implemented by various countries in the world, which in the future will allow to determine a set of effective measures for Ukraine, obscurely defined at this point.

In order to determine the leading countries in the implementation of innovative technologies in the field of energy, we analyzed the rating of countries according to the Global Innovation Energy Index from the ITIF organization [3].

The Global Energy Innovation Index consists of three indices, each of which measures one of the functions of the innovation system, namely: option generation, innovation scaling and widespread use, and social legitimation. These three indices, in turn, are made up of 14 components with different weights. Indicator components (Fig.1) in terms of functional components, in general, determine the main modern general trends in the development of innovations in energy, because they include, in particular, specific directions for making investments [19].

ITIF's Global Energy Innovation Index is calculated for 23 countries that make various significant contributions to clean energy innovation. The TOP-5 positions according to the overall rating and the greatest indicators of innovation include such countries as Norway, Finland, Japan, the USA and France.

One of the main indicators of the efficiency of the national economy is GDP growth rate. At the same time, the reduction in the energy intensity of GDP is one of the indicators of the energy efficiency of the national economy, and to ensure it, it is necessary to introduce innovative technologies in the field of energy.

Norway is the leading country in implementing energy innovations with an overall index score of 15.5 and a GDP per capita of $75,419.63. Finland is in second place with a total index score of 14.8 and a GDP per capita of $48,782.8. Further, respectively, in third place in terms of the total score of the index is Japan with a score of 13.7 and a lower GDP of $40,246.9 [19].

Based on the provisions of the countries, it can be said that there is no direct proportional relationship between GDP and the Global Energy Innovation Index. It is observed only in some countries from the list, in particular, Norway, the USA, Denmark, the Netherlands, Austria, China.

However, the conclusion that technologically highly developed countries, in particular, Finland, France, Japan, Germany, Canada, and the United Kingdom, have a high energy innovation index, i.e., invest in the development and spread of energy-efficient technologies, is obvious, with ranging from 40,000 to 50,000. For example, Finland's GDP per capita is 33% lower than that of the US, but Finland is 10% ahead of the US in energy innovation. This suggests that these technologically developed countries, regardless of their GDP, invest in energy efficiency and "clean" energy projects, which will reduce energy costs and polluting emissions [19].

At the same time, countries at the lower left in Fig. 2 such as Saudi Arabia, Chile, Mexico, Indonesia, India, Brazil, have rela-

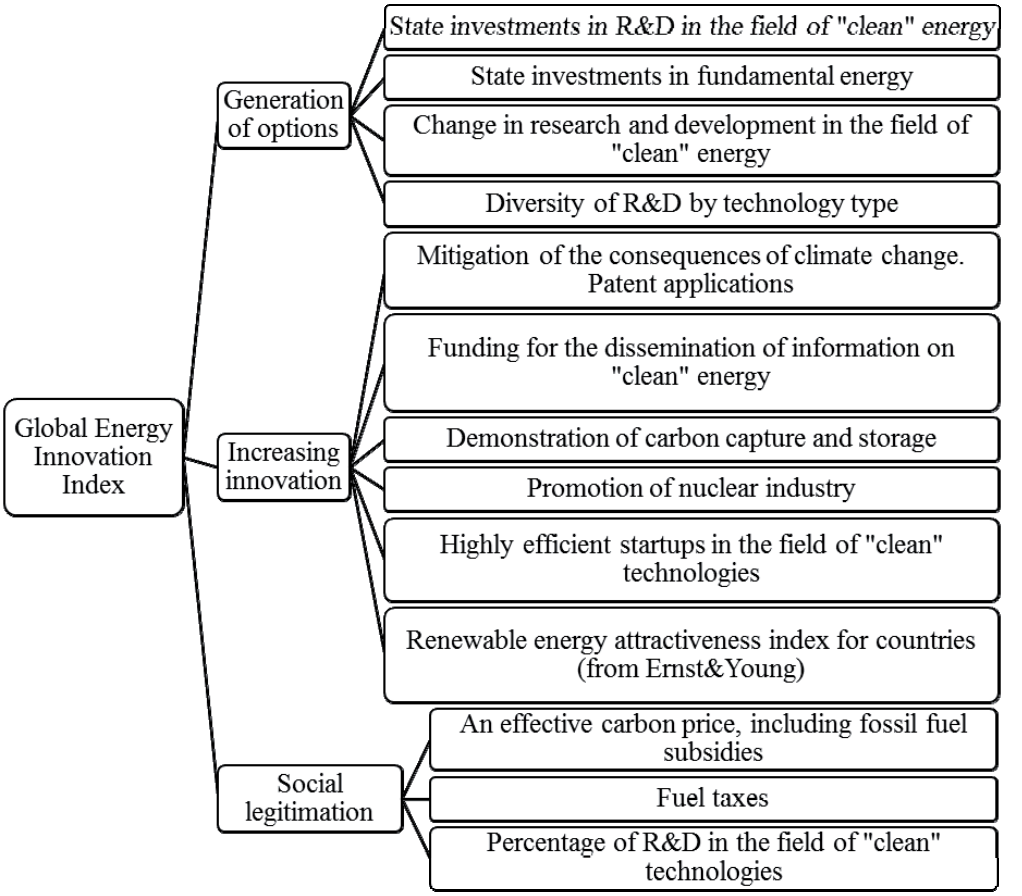

Fig.1. Component indicators of the global energy innovation index
(compiled by the authors based on [3])

tively low levels of GDP and commodity economies, and yet they are implementing much less energy innovation. For example, seven countries – China, Saudi Arabia, the United Arab Emirates, Indonesia, India, Mexico and South Korea – subsidized fossil fuel consumption by $171 billion in 2018, and spent much more than the 23 selected countries and the EU together on investments in R&D in the field of "clean" energy ($22.7 billion in 2018), which, of course, is a negative factor for the development of ecology and the provision of innovative energy development.

It is also worth considering the fact that in 2021, the 20 largest countries accounted for 80% of global energy consumption. The reason for this was, first of all, economic growth in many of these countries by a total of 5.9% in 2021 compared to 2020. However, we must also be aware of the result of global trends, in particular, an increase in the global level of energy consumption by 5% in 2020-2021 (in 2009-2019 by 1.7% and in 2019-2021 by another 0.4%) and an increase in CO2 emissions in 2021 by 5.9% compared to 2019.

Global electricity consumption, which decreased by 0.7% in 2020 due to the Covid-19 pandemic, increased by 5.5% in 2021, which is 4.8% higher than in 2019 [20]. In China, the world's largest consumer of electricity, that accounts for 31% of global energy consumption, energy costs will rise by almost 10% in 2021 thanks to the economic recovery. This exceeds the trend of 2010-2019 (+7.3% / hour) and a similar indicator in 2019 [4].

The revival of the economy contributed to the recovery of demand for energy resources in other countries as well. This is especially noticeable in Europe (+4% – growth to the level of 2019, a noticeable increase in Turkey, France, Germany, Italy and Poland), in the USA (+1.7% – slightly below the level of 2019) and in Russia (+ 6%) [16].

Electricity consumption increased in most of the Asia-Pacific region (+5% in India, Indonesia and South Korea), but remained flat in Australia and decreased in Japan due to strict measures to combat Covid-19. In Canada, energy consumption remained at the same level in 2021 compared to 2020.

Electricity consumption increased in Latin America (+6.1%, growth of 8.6% in Brazil and dynamic trends in Mexico, Argentina, Chile and Colombia), in Africa (by almost 5%, including +2.3% in South Africa) and the Middle East (by almost 5.5%, including +4% in Saudi Arabia). In Ukraine, the level of energy consumption for the period 2000-2021 also shows an upward trend.

As a result of these trends, the effects of the 2020 sanitary measures and the economic crisis were felt mainly in services, transport and carbon-intensive power generation. New capacities of alternative energy sources (wind, solar, etc.) are growing in 2021-2022, despite the crisis [16].

However, by the end of 2021, the indicators of energy efficiency and decarbonization returned to previous trends, which is not enough to achieve the goals of the Paris Agreement (Figure 2).

The level of CO2 emissions in 2021 was 1% below 2019 levels, but is still far from reaching the goals of the Paris Agreement (a temperature increases of 20C). Post-Covid-19 economic growth has led to high demand for raw materials and energy (Fig.3). In 2022 the Russian Federation's war against Ukraine increased the pressure on the energy markets even more. The European Union has fallen into the trap of dependence on natural gas imports, especially from Russia. Tackling the problem of energy consumption through increasing energy efficiency and energy sufficiency appears to be a major solution for the EU, yet having been insufficiently addressed so far.

Let's consider the main measures of countries with a high index of global energy innovation. The Norwegian government has developed a strategy for carbon capture and storage (CCS), which aims to identify measures to promote technology development and reduce CCS costs [12]. A feasibility re-

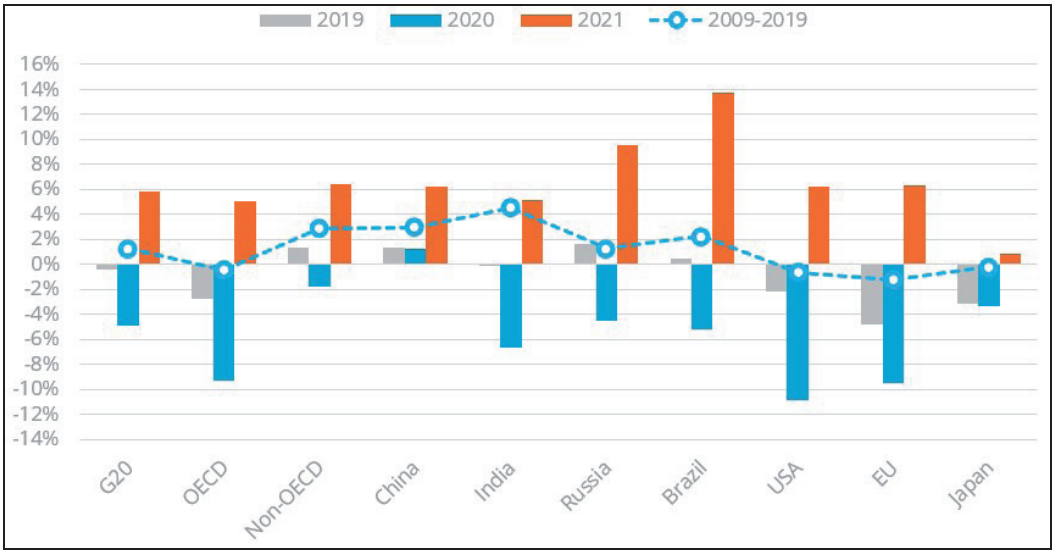

Fig.2. Dynamics of energy-related CO2 emissions (% / hour) in G20 countries in 2009-2021 [4]

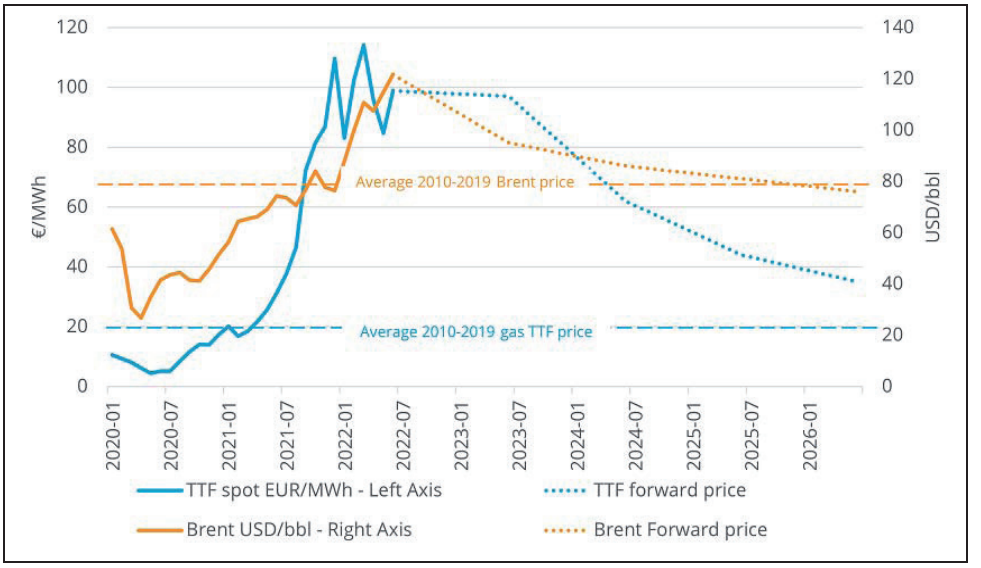

Fig.3. Forecast for European gas prices and the price of Brent oil up to 2026 [4]

port presented in 2016 showed that the implementation of a full-scale CCS network in Norway by 2022 was possible and with relatively low costs. Part of the CCS strategy is to support CLIMIT, the Norwegian Research Centers for Climate Energy (FME) and international research activities. The Norwegian government's investment in energy research and development is a priority.

In Finland, renewable energy sources meet about 40% of final energy consumption. The goal set by the National Energy and Climate Strategy until 2030 is to increase the use of renewable energy so that during the 2020s its share in final energy consumption could increase by more than 50% [13].

As for Japan, since its dependence on fossil fuels remains high, the country's energy policy takes into account future changes to provide resources in line with the increasingly volatile energy supply and demand patterns in the world [2]. The Japanese government is developing an action plan to implement an optimal resource portfolio and ensure stability and resource savings by diversifying core resources and reducing the risk of acquiring each resource by diversifying sources of supply, securing interests in joint projects, and improving relations with supplier countries [18].

The new EU Renewable Energy Directive (REDII) was approved on December 3, 2018. The main EU target for the share of renewable energy sources is 32% of final energy consumption by 2030. This target was not distributed among the Member States, however, the share of renewable energy sources in the Member States should be at least the same as in 2020. That is why today it is important to analyze the successful experience of other countries regarding the application of innovations in the energy sector and introduce innovations in the energy sector of Ukraine, based on the effective use of the existing potential of alternative energy sources and external opportunities [9].

The implementation of innovation policy in the energy sector of Ukraine is based on the general principles of its state regulation. Therefore, it is important to display it according to the main stages (Fig. 4).

As for the first stage, it can be recognized that the importance of the energy sector for the innovative development of Ukraine is determined both by the priorities of the development of science and technology, and by the priorities of innovative activity (Table 1).

Innovative technological restructuring of the energy sector of Ukraine is a response to today's external challenges. At the same time, in recent years there has been a significant decrease in the number of innovatively active enterprises in the energy sector - by 105 units over 5 years (by 8.50%).

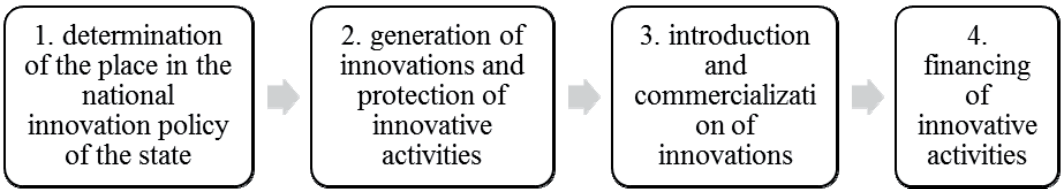

Fig.4. Stages of state regulation of innovation policy of the energy sector of Ukraine [15]

Table 1

The place of the energy sector in the national innovation policy of Ukraine [15]

State agency	Regulatory legal acts	Referred to the energy sector
Verkhovna Rada of Ukraine	Law of Ukraine "On Priority Areas of Development of Science and Technology" dated July 11, 2001 No 2623-III (Article 1)	Among the areas of development of science and technology until 2020, energy and energy efficiency (priority 3) and rational use of nature (priority 4) have been separately identified
	Law of Ukraine "On Priority Areas of Innovative Activity in Ukraine" dated September 8, 2011 No 3715-V (Article 2)	Among the strategic priority areas for 2011-2021 are (Article 4) the development of new energy transportation technologies, the introduction of energy-efficient, resource-saving technologies, the development of alternative energy sources (priority 1)
Cabinet of Ministers of Ukraine	Resolution of the CMU "Some issues of determining medium-term priority areas of innovative activity at the branch level for 2012-2016" dated May 17. 2012 No 397	Implementation of strategic priority 1 is divided into: 39 medium-term priorities, including 8 by part of the development of new technologies of energy transportation includes; 22 – implementation of energy-efficient, resource-saving technologies; 9 – development of alternative energy sources

In the absence of own funds for the implementation of innovation policy in the energy sector and deficit of the state budget, the search for foreign investors is promoted at the state level. In particular, the search for investors for the implementation of projects in the field of alternative electricity is conducted by the State Agency for Energy Efficiency and Energy Saving of Ukraine by presenting domestic projects to potential investors during relevant international events.

In order to attract financial resources, the institution cooperates with the following international financial institutions: the International Finance Corporation, the World Bank, the European Bank for Reconstruction and Development, the Development Bank of the Council of Europe, the European Investment Bank, the Nordic Environmental Finance Corporation, the Eastern European Partnership for Energy Efficiency and the Environment, the KfW Financial Group, the Ukrainian energy efficiency improvement program is a credit line developed by the EBRD [5].

Considering the above, it can be concluded that the state's innovation policy in the energy sector is inconsistent and unsystematized. In this case, in Ukraine, it is appropriate to use the so-called cluster approach, which is considered the key to the successful implementation of innovative policy in the energy sector. This approach allows to create special incentives, distribute power and resources, as well as increase the availability of information, and thereby ensure the effects and benefits that cannot be achieved by individual enterprises. The need for creation cluster models in Ukraine has been recognized by the Cabinet of Ministers of Ukraine, in the project "Concept of creating clusters in Ukraine".

The adaptation of cluster models in the energy sector of Ukraine will allow the implementation of innovative methods of industrial use of national/local energy resources to meet energy needs both within a separate territory and throughout the country. The formation of cluster models should be based on the principle of energy self-sufficiency, according to which cluster structures are formed depending on the energy potential of the area (both fossil fuels and renewable energy sources), which allows for the development of the energy sector based on the structural rationality of its use [14].

Considering the above, it should be noted that the formation of innovation policy in the energy sector of Ukraine requires the definition of the concept and strategic plans of its innovative development. It is possible to increase the innovative activity of energy sector enterprises in the "business-science-state" plane.

The formation of future innovation policy should be based on a cluster approach that will provide a synergistic effect of the interaction of the three subjects of its formation and ensure the structural rationality of using the existing energy potential of the state. The energy sector is quite promising in Ukraine. The number of energy organizations is growing every year. However, issues related to increasing the effectiveness of strategic innovation management, in particular, innovation processes of energy organizations, are still relevant in Ukraine.

Energy innovation is a set of processes that lead to the emergence of new or improved existing technologies that further reduce the diversity of energy resources used, increase the reliability of energy systems, and reduce the economic, environmental, and political costs associated with the production and distribution of electricity.

Among the currently important achievements of innovative developments in the field of energy, innovative solutions in renewable energy occupy a prominent place [7]. Thus, by the end of 2021, 3,064 gigawatts (GW) of renewable generation capacities were operational worldwide, including 40% of hydroelectric power plants (1,230 GW), 28% of solar power plants, and 27% of wind power plants. Statistically, solar power and wind have grown many times faster than hydropower.

Solar and wind power have almost equal market shares with 849 GW of capacity (843 GW of PV and just over 6 GW of solar thermal generation) and 825 GW respectively. Other renewable energy sources with a combined share of about 5% include 143 GW of bioenergy, 16 GW of geothermal and 524 MW of marine energy [17]. Renewable generation capacity increased by 257 GW (+9.1%) in 2021. Solar energy continued to lead capacity expansion with an increase of 133 GW (+19%), followed by wind energy with 93 GW (+13%). Hydropower capacity increased by 19 GW (+2%), bioenergy – by 10 GW (+8%). Geothermal energy increased by 1.6 GW.

Solar and wind power continued to dominate renewable capacity expansion, together accounting for 88% of all net renewable additions in 2021. Along with higher growth in geothermal energy, this growth in wind and solar power has led to high annual increases in renewable generation capacity (Fig.5).

In 2021, Asia accounted for 60% of new capacity, increasing its renewable capacity by 154.7 GW to 1.46 TW (48% of the world total). A huge part of this increase came from China (+121 GW). Capacity in Europe and North America increased by 39 GW (+6.4%) and 38 GW (+9.0%) respectively, with a large expansion seen in the US (+32 GW).

Thanks to the addition of new capacity in all major regions of the world in previous years, total global solar capacity has now surpassed that of wind power. In 2021, the increase in renewable energy capacity slowed slightly compared to 2020, while remaining well above the long-term trend. Most of this expansion has occurred in China and, to a lesser extent, in the United States. Most other countries continued to add renewable capacity at similar rates to previous years.

The share of renewable sources in total capacity expansion reached 81% in 2021, compared to 79% in 2020. The share of renewable sources in total generating capacity increased by almost two percentage points from 36.6% in 2020 to 38.3% in 2021 (Fig.6).

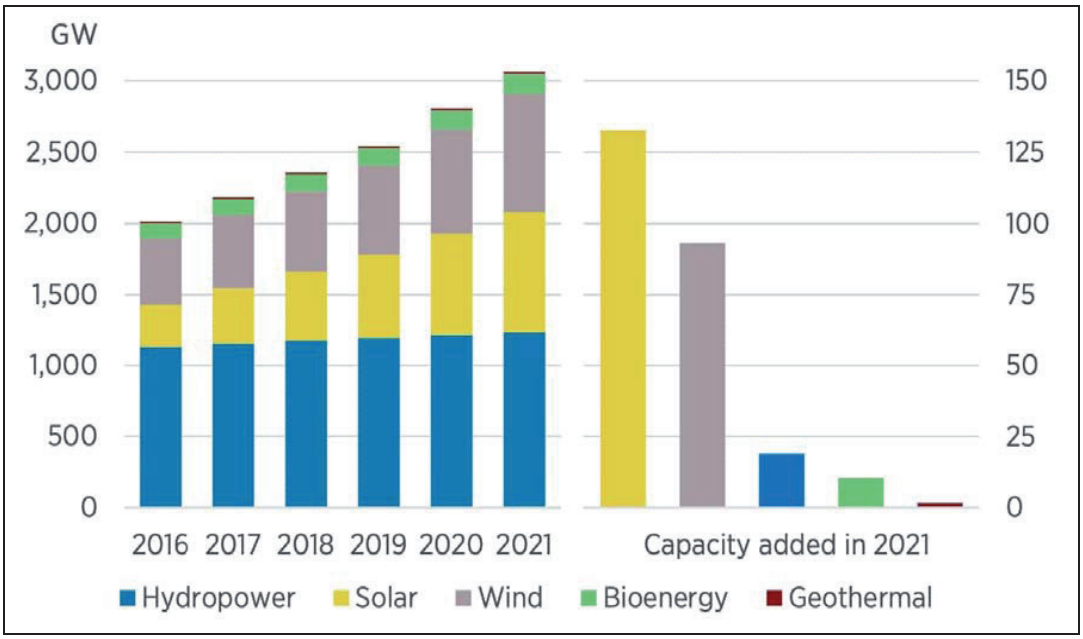

Fig.5. Renewable power capacity growth in the world in 2021 [17]

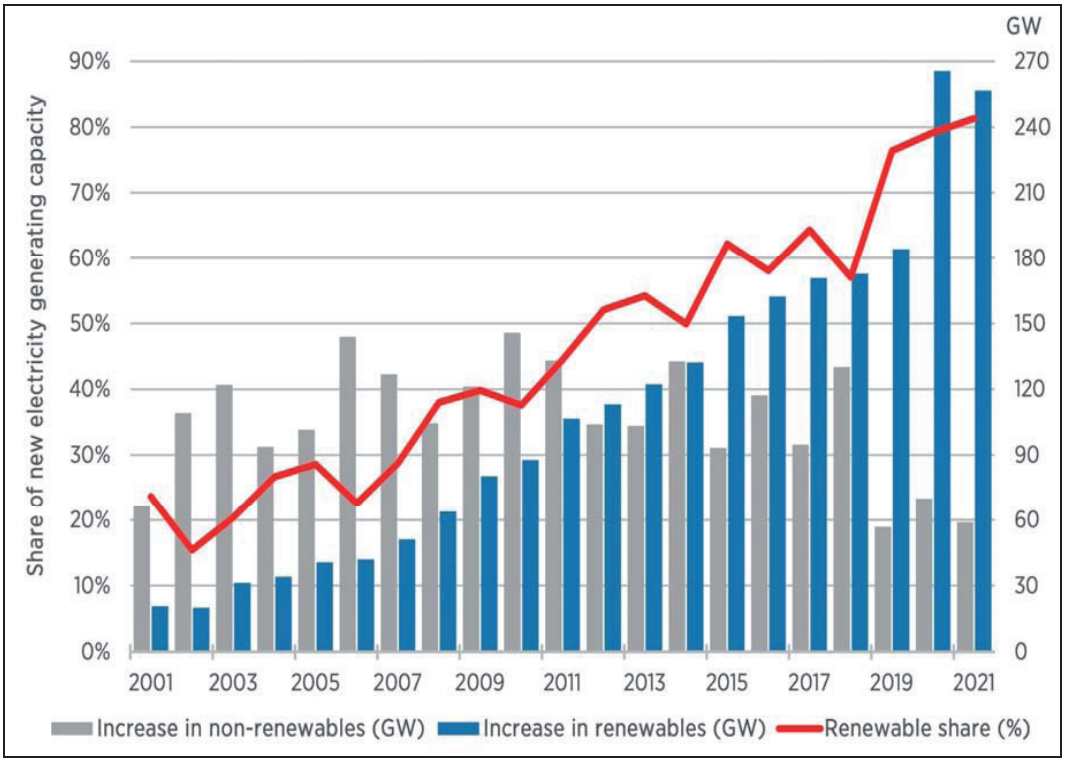

Fig.6. Renewable share of annual power capacity expansion in the world in 2021 [17]

The upward trend in these shares reflects not only the rapid and increasing growth in the use of renewable energy sources, but also the reduction in the expansion of non-renewable capacities. Globally, the latter is also affected by the large amount of net decommissioning that has occurred over the years in some regions.

In 2021, non-renewable capacity continued to expand in Asia, the Middle East and Africa (but with much smaller expansion in the Middle East and Africa), while net decommissioning continued in Europe and Eurasia.

The energy transition suggests that the use of renewable sources should expand more than the growth in energy demand, so that less non-renewable energy be needed. Many countries have not reached this point yet, despite the dramatic increase in the use of renewable energy sources for electricity generation.

Innovation in energy technologies is a process reflected in the energy market and other factors related to the growth of new energy technologies. The process begins with the invention of technology and ends with its expansion [2]. Scaling up energy innovation is one of the demonstration projects that play a vital role in the commercialization of energy innovation. The level of novelty of technologies in the energy sector changes the key role in their expansion.

Innovation in the power industry is associated with technological change, but it cannot be argued that this is the only type of innovation possible in the industry. The electric power industry and electric power companies are changing with the introduction of organizational innovations caused by a change in the market environment [10]. On the one hand, energy is a factor of production that has a certain value as a factor of production, and on the other hand, energy transformation is part of innovation process.

The innovative system of the energy sector is a developed network intellectual structure that connects research and design organizations related to different sectors of the economy. They actively interact with large corporations, state and university laboratories, small scientific firms, and independent non-profit institutes. The characteristics of the network structure are the geographical, institutional and thematic distribution of its links, the variety of connections within the system and its ability to quickly and flexibly change the configuration of these connections.

The main factors in the formation of such a structure were the presence in the industry of powerful large global corporations competing with each other in the field of innovation, as well as the variety of organizational forms of financing R&D that have emerged in our time [1].

The global presence of energy industry players provides access to the world's best intellectual resources. The financial label allows corporations to actively use institutionally diverse forms of R&D (own research, academic sector, small scientific business, private scientific institutes, state laboratories) for the profit of innovative development, to support a wide thematic spectrum of R&D (from research in the field of alternative energy sources to computer tools computer) [8].

The lack of experience of venture investment, technological complexity, imperfection of legislation determines a low level of development of innovative outsourcing and transfer of innovative ideas in the energy sector. Conversely, a high level of involvement of innovative ideas creates conditions for the development and implementation of innovative technologies.

The use of the potential of the positive impact of these factors should be the basis for changes in the management of enterprises in the energy sector of Ukraine. The need for transformations is caused by the problems, whose elimination will provide the state and society with a stable basis for the development of industries of a new technological order.

Conclusion. The analysis of global trends in economic development and the factors that determine it convincingly proves that innovative processes have taken an important place and their role has been steadily growing. Commitment to an innovative type of development in modern business condi-

tions is becoming a key success factor, and strategic innovative management of the energy potential of organizations is one of the important tasks for ensuring competitiveness and sustainable development.

The study of trends in the development of innovative processes in Ukraine shows that Ukrainian energy companies underestimate the importance of innovative potential and its innovative management, which leads to a weakening of their positions on the market, losing consumers, reducing competitiveness, and cutting production volumes.

The results of innovative management of the activities of organizations in the energy sector have a great impact on all spheres of development of human society, change the environment of human life and the ways of its development. The modern economy is characterized by increased competition. In this regard, innovations in management become mandatory components of the economic activity of energy companies and are the main driving force and prerequisite for their development.

That is why innovative activity is one of the main areas of activity of any company that uses knowledge and interacts in the field of technology, economy and ecology, social psychology, fundamental and applied sciences, theory and practice of production and management, strategy and tactics.

Innovative management is gaining special importance today, because it is considered as a practical guide to managing innovative processes inherent in any modern organization. Competition is intensifying and consumer demands are increasing, thus constant innovations can become one of the factors of obtaining competitive advantages of organizations. Therefore, the study of the experience of energy companies in the field of innovative management and its implementation in Ukraine is relevant and timely.

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INNOVATIVE SOLUTIONS FOR ENSURING ENERGY SECURITY OF UKRAINE AND THE WORLD

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The article examines the preconditions for the aggravation of the energy danger for Ukraine and the world as a whole, in particular in the context of the strengthening of the economic crisis and war in Ukraine. The issue of compliance by energy organizations with the International Climate Paris Agreement and the achievement of the Global Sustainable Development Goals by 2030 were studied. The component indicators of the global index of energy innovations were analyzed. The main global energy indicators and their results in 2021 compared to 2020 were monitored. The paper also estimates domestic electricity consumption in the world by country in 2021, as well as trends in the growth of

global energy consumption in general and by continent in 2021 compared to 2020. The result of such trends was that the consequences of sanitary measures and the economic crisis of 2020 was felt mainly in the sphere of services, transport and carbon-intensive electricity production.

The authors considered the key changes in the field of energy in the world in 2021 compared to 2020 and the dynamics of CO2 emissions related to energy in the G20 countries in recent years and based on this justified the forecast of European gas prices and the price of Brent oil to 2026 year. The main characteristics of countries with a high index of global energy innovation were considered. It was found that, for example, the Norwegian government had developed a strategy for carbon capture and storage (CCS), which aimed to identify measures to promote technology development and reduce the costs of CCS. It was found that the main goal of the EU regarding the share of renewable energy sources is 32% of the final energy consumption by 2030. This target was not distributed among the Member States, but the share of renewable energy sources in the Member States should be at least the same as in 2020.

In the article, the authors examined the stages of state regulation of the innovation policy of the energy sector of Ukraine and substantiated the place of the energy sector in the national innovation policy of Ukraine. Formation of innovation policy in the energy sector of Ukraine requires definition of the concept and strategic plans of its innovative development. In particular, it was found that one of these priority areas should be renewable energy (wind, solar, etc.).

The result of the authors' scientific research is that the innovative system of the energy sector is a fairly developed network intellectual structure that connects research and design organizations belonging to different sectors of the economy. Using the potential of the positive influence of a number of important global factors should be the basis of the transformation of innovative management of energy industry organizations in Ukraine.

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