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ENERGY SECTOR OF UKRAINE AND ITS ROLE IN THE DEVELOPMENT OF A NEW GLOBAL ENERGY SECURITY PARADIGM

The state, dynamics and development trends of the energy market of Ukraine in recent years are taken into consideration in the paper. The key problems of the global energy market are identified, in particular, persistent dependence on fossil fuels, lack of diversification of energy supply sources in most European countries, which endangers national and energy security. The structure of the energy sector of Ukraine is analyzed, its main formation elements, the prospects for development and involvement in the use of the country's energy resources on the European market are determined. The main components of energy security, approaches to their assessment and research are defined. It is noted that the main way to overcome existing threats in the energy market is to reduce dependence on external factors and identify internal reserves. The potential of the Ukrainian energy system is analyzed from the point of view of identifying the potential and integration into the world and European systems, providing the economy with energy resources. The current state of affairs regarding the formation of stocks for the winter period in Ukraine and the ability to supply the domestic market have been studied. The structure of the energy sector of the world's largest countries, including European ones, is defined. The main steps taken by the government to reform the Ukrainian energy market, including increasing the share of renewable energy sources, infrastructure development through integration and digital transformation (political, infrastructural and technological solutions) are indicated. The basic provisions of the European Green Course have been analyzed. The first results of the implementation of the latest energy security strategy, which envisages an increase in energy saving and energy efficiency, diversification of imports and integration into the EU energy space, are evaluated.

Keywords: *energy balance, energy security, energy efficiency, energy saving.*

Introduction. Despite high level of social and economic development, most of the world's economies in the 21st century turned out to be imperfect and inefficient, showed persistent dependence on fossil fuels in the development of the energy security system. Under the

circumstances of war conflicts on the European continent, downsides have become more obvious and require immediate solutions and the development of new strategies, different from all known patterns and traditional approaches. Ukraine is not an exception and currently it experiences new challenges, such as: protection from external threats, overcoming the consequences of the pandemic, economic growth to ensure the stabilization of the country, etc. One of the most important places in the system of the complex, multiple and multifaceted concept of national security is taken by the country's energy security subsystem, since the country's independence from external energy resources is one of the factors of its stable functionality. In addition, Ukraine can become a reliable system-forming element of European energy security, as it has a powerful scientific potential, a significant stock of natural resources and raw materials, opportunities for finding and implementing innovative developments in the field of extraction, processing of fossil fuels, production, transformation, supply and consumption of energy, as well as convenient geographical location.

In previous decades, attention was focused on the development of renewable energy sources, increasing the share of 'green' energy, which reduce the burden on the environment, are ecologically safe and inexhaustible. This strategy has significant prospects for development, however, the development of the newest European energy security system in the current situation requires a certain transition period, the search for cost optimization solutions to maintain the energy balance and support industrial production.That will allow the most effective use of existing energy resources, taking into account security aspects. This determines the relevance of the statistical study of trends and regularities in the development of the Ukrainian energy sector, the disclosure of prospects for increasing its use to achieve energy saving not only in our country, but also in European allies.

Literature review. The researches of a great number ofnational and foreign scientists are devoted to the study of the essence of energy security, in particular the factors of its provision, the conditions for its achievement and implementation, the study of the state and dynamics of the development of energy sources. The most promising researches are by Leshchenko I., Ryabtsev G., Sukhodolya O,Tymchenko M., Fialko N., Khalatov A., Kharazishvili Y. and others.

The works by Leshchenko I. [Leshchenko I., 2019] highlight the issue of indicators of energy security of the country, provide the results of calculations of the values of indicators of energy security of the oil and gas industry of Ukraine, directions for improving state regulation of the electricity market, analyze various models of regulation of activities in the electric power industry, consider prospects for the development of the gas transportation system of Ukraine. In general, the author claims that there is a need to expand the list of indicators that would assess the protection of critical energy infrastructure, ensuring the stability of energy supply, diversification of sources and routes of supply and transit of natural gas, oil and oil products, reserves of oil and oil products, the level of integration of the energy markets of Ukraine and the EU, emissions of greenhouse gases and pollutants from the energy complex.

G. Ryabtsev and O.Sukhodoli'sresearch [Ryabtsev G., Sukhodoli O., 2019] is devoted mostly to monitoring the implementation of the National Security Strategy of Ukraine in matters of the fuel and energy complex, manifestations of existing ones and detection of new threats to the state's energy security. Considerable attention is paid to mechanisms and tools

of state energy policy, reforming energy markets and ensuring transparency and development of competition in these markets, their demonopolization; diversification of energy supply sources and routes. The authors outline ways to overcome dependence in the supply of energy resources and technologies, to increase the resistance of the energy industry to negative external influences, to create conditions for reliable energy supply and to enlarge the energy efficiency of the national economy.

Tymchenko M. and Fialko N. [Tymchenko M., Fialko N., 2019] and Khalatov A. [Khalatov A., 2016] in their papers pay attention to the analysis of methodological approaches for determining quantitative indicators of energy security, statistical data on the current state of energy security of Ukraine by rating of countries with a large amount of energy consumption. The authors take into consideration the current state of the energy industry in Ukraine and the prospects for its development in the near future, the problems of a political and economic nature that have slowed down the development of the energy industry and led to a decrease in electricity production. Among the prospects outlined in the scientific works, the modernization and reconstruction of thermal plants, the extension of the operational life of nuclear power plants, the reduction of harmful emissions into the atmosphere, the introduction of innovative technologies, the reduction of energy losses, and the development of small energy are pointed out.

The modern concept of sustainable development from the standpoint of security, prospects, threats and ways of transition from the current state of the object of management to the desired one is considered in the thesis of Yu. Kharazishvili [Kharazishvili Yu., 2019]. The scientific paper also substantiates the conditions for the safe functioning of dynamic economic systems, outlines the concept of the methodology of identification of sustainable development, the development of a strategy for achieving goals from the standpoint of security, and considers adaptive methods of regulation in relation to management theory for the scientific justification of medium and long-term strategic planning. The author researched shadow indicators in the components of sustainable development to reveal the adequacy of the real state of the economy using the developed method of its evaluation and deshadowing, studied also the reserves of modernization and growth of the economy of Ukraine.

Thus, most scientists emphasize the need to intensify innovative activities, expand the range of indicators that assess the state of energy security in the national security system, and change methodological approaches to analysis. Despite the presence of a large number of scientific developments with the stated problems, a large volume of issues related to the development of climate-neutral energy sources in the context of achieving the main principles of sustainable development, reformatting of the entire system of European energy security, and the integration of the Ukrainian energy market into the global one requires further research and development.

Issues to be considered. The study of the mentioned issues is complicated by a number of circumstances, in particular, the military actions taking place on the territory of Ukraine, changes in the international legal order, the specifics of the construction of separate economic, energy and security systems of European countries, etc. However, even in such difficult circumstances, Ukraine needs to find reserves for recovery, reconstruction, economic growth, integration into the European energy system and reduction of dependence on external factors and threats, which is the object of this analysis.

The article is aimed at studying the prerequisites of the reform and perspective development of the energy market of Ukraine in the context of restructuring the economic system in the aggregate in the post-war period and promoting the strengthening of the competitiveness of the country's economy as a whole and its integration into the European energy sector.

Methods. General scientific and special methods are applied in the paper. They were used to analyze processes and phenomena in their relationship. The theoretical basis of the study was made up of fundamental provisions of economic theory, statistics, scientific works of national and foreign scientists in the field of energy security, theories of management of complex socio-economic systems.

The methods of logical, economic analysis, comparison, system analysis, synthesis, induction, deduction, and analogies were used in the research of the mentioned issues. The paper introduces statistical data from available information sources.

Research results. The concept of energy security is multifaceted as it is differently interpreted. In particular, the International Energy Agency defines energy security as the constant availability of energy sources at an acceptable price [13]. In the UN, this concept is interpreted as uninterrupted availability of energy at affordable prices. Asia Pacific Energy Research Center (APERC) uses the "4 A's" model - availability, accessibility, affordability, acceptability [12] when studying energy security, which takes into account four components: resource sufficiency, technical reliability, economic profitability, and environmental acceptability. This model was later supplemented with additional parameters, in particular, greenhouse gas emissions and the use of renewable sources began to be taken into account. Nowadays, there is no unified methodological approach to the description and understanding of energy security, but the transformation of definitions is observed. In this paper we consider ***energy security*** as a complex concept that implies the availability of reliable and uninterrupted, optimally formed and balanced sources of energy, which allow maintaining the balance of the economic system and production as a whole as well as providing the household sector with the necessary energy, while the force majeure suspension of any link or component does not lead to critical consequences for the economy in the aggregate. Therefore, this concept is closely related to the national security of the country. For a better understanding of the situation, it is necessary to analyze the energy balance of the country (see Table 1).

Table 1

Energy balance of Ukraine for 2016-2020, thousand tons of oil equivalent

Supply and Consumption / Years	2016	2017	2018	2019	2020
Production	66323	58863	60083	60095	57017
Import	29152	35145	33847	34768	30726
Export	-1427	-1944	-1464	-1830	-1246
International bunkering	-157	-251	-300	-121	-32
Stock change	492	-2351	526	-3840	-63

Source: compiled by the authors based on the data of the State Statistics Service of Ukraine [5].

The energy balance is a system of indicators for the production and use of all types of fuel and energy. According to the given data, there is a slight drop in production by 2.5% over the past five years. The peak of imports occurs in 2017, but after that these processes slow down, which indicates a decrease in dependence on external factors. A trend towards an increase in exports is followed, which requires a detailed analysis in order to determine the potential for the future. Net import (difference between import and export) of primary energy in 2020 amounted to 29.5 million tons of oil equivalent and decreased by 10.3% compared to 2019 due to the decrease in coal and natural gas imports. In the structure of energy imports, the specific weight of crude oil and oil products was the largest and reached 39.1%, coal - 35.9%, natural gas - 24.0%. In the structure of energy exports, 35.5% of the volume belonged to electricity, 34.0% – to biofuel, and 27.4% – to crude oil and oil products.

According to the data of the State Statistics Committee, the largest share in energy production is obtained from the use of gas (27.5%) and coal (26.4%).Nuclear power produces 23.1% of energy, followed by energy from the use of oil (16.4%) and renewable energy sources (6.6%) (see Fig. 1). This situation is caused by the fact that Ukraine has excessive transit capacity and an energy-intensive gross domestic product.

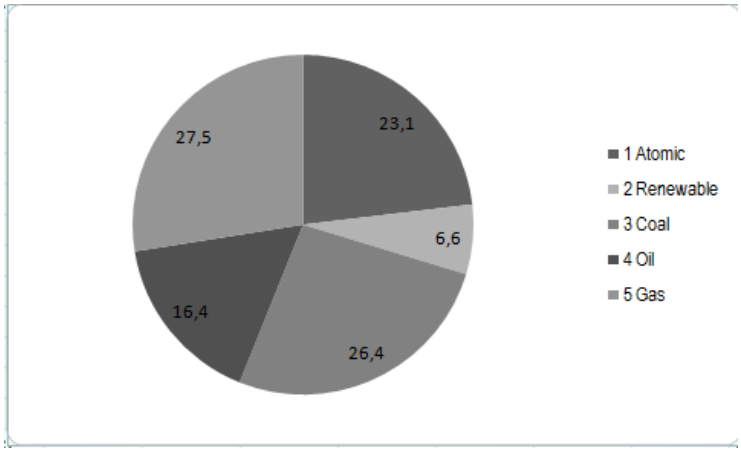


Fig. 1. Distribution of energy sources in the total supply of primary energy for 2020
Source: compiled by the authors based on the data of the State Statistics Service of Ukraine [5].

In 2020, primary energy production amounted to 57.0 million tons of oil equivalent, which is 5.7% less than in 2019. In the structure of own production, the largest specific weight was the following: atomic energy - 35.1%, natural gas - 27.8% and coal - 22.4%, renewable energy sources (RES) - 10.3%. Own production provided 66.0% of the total supply of primary energy. The structure of own production of primary energy is characterized by the following changes: the shares of coal and nuclear energy decreased by 1.5 and 0.9 percentage points. At the same time, the shares of renewable energy, natural gas, and oil increased by 2.4, 0.8, and 0.2 percentage points, respectively. Fossil energy resources accounted for 54.5% of total energy production.

In the structure of the total volumes of production of RES in 2020, the largest share was taken by biofuels and waste - 75.4%.

In the structure of electricity production, as it used to be before, hydropower stands out with the largest specific weight among RES. However, in 2020, the share of hydropower decreased by 16.3 percentage points, and for the first time it was less than half of the volume of electricity production from renewable energy sources, while the shares of solar energy increased by 11.8, wind energy by 3.3, and biofuels by 1.2 percentage points [State Statistics Service of Ukraine, year].

In 2021, the volume of electricity production by power plants of Ukraine as a whole amounted to 156,575.7 million kWh, which is 7,719.5 million kWh or 5.2% more than in 2020. The main share in the total output in 2021 is the output of nuclear power plants - 55.1%, thermal power plants and heating plants - 29.3%, and the output of hydroelectric power plants - 6.7%. In 2020, the share of production of nuclear power plants, thermal power plants and heating plants and hydroelectric power plants was 51.2%, 35.2% and 5.1%, respectively.

Despite the war in the country, a 30% reduction in its own production, the loss of control over two state mines and constant shelling of logistics hubs, Ukraine managed to double its coal reserves in warehouses to 1.35 million tons in the first quarter of 2022. At the end of May, 10.2 billion cubic meters of gas were stored in Ukraine's gas storage facilities. As a result of the act of aggression, the volume of gas consumption decreased by 32%, and the volume of production decreased by 12% and fell to the level of 48.8 million cubic meters per day. The accumulation of gas for the winter period will be due to imports, the largest volume of which was recorded in March and amounted to 8.9 million cubic meters per day. At the same time, 1/3 of this volume was imported via reverse, the rest of it - physically. Gas exports from Ukraine to the EU stopped at the beginning of March. In general, the need for natural gas for the winter period will be approximately 14 billion cubic meters, which will be covered by own production and imports, respectively 70% and 30%. Taking into account the current reserves and the need to cover consumer demand in the first quarter of 2023, our country needs to purchase 7.7 billion cubic meters of blue fuel on the European market. At the beginning of the heating season of 2022, 17.2 billion cubic meters will be stored in Ukraine's gas storages, which is 7% less than the previous year. Taking into account the current demand for natural gas, in April 2023, 9.3 billion cubic meters of blue fuel will remain in storage. Electricity consumption also decreased by a third. The daily demand of 10 GW is covered by 6 GW of nuclear power plants; 2.1 GW – by generation; 1.3 GW – by hydroelectric power stations; 0.6 GW -by renewable energy sources. More than 20% of oil storage bases

were destroyed due to hostilities, the work of the Kremenchug Refinery and the Shebelinsky Refinery was stopped [1].

Each country has its own structure of energy production and consumption. For example, gas, oil and coal are produced and consumed evenly in the USA. 20% of electricity is provided by 99reactors operating in 31 states. The International Renewable Energy Agency (IRENA) predicts that by 2030, the share of this type of production in the US energy balance could potentially reach 27%. The energy of Great Britain uses natural gas the most, while Canada builds its energy policy on the consumption of hydropower, but 15% of the required reserve is produced by nuclear plants. Poland uses coal to meet its energy needs, but plans to gradually abandon it and increase energy consumption from RES. Today, such consumption is 13%, and according to the approved strategy, renewable energy sources should account for at least 23% of total energy consumption by 2030. At the same time, the country is increasing its nuclear power capacity: by 2040, it is planned to build two nuclear power plants with six power units. The first reactor with a capacity of 1-1.6 gigawatts is expected to be commissioned in 2033, and the last one - another ten years later. The largest use of nuclear energy in the structure of fuel and energy resources, according to data, is observed France and Japan [13]. It is interesting to note that Japanese car corporations are investing heavily in research and development of future generation of hydrogen-powered cars.

It should be noted that at the beginning of the second quarter of 2022, European gas storage facilities are filled by an average of 50%, therefore, the forecast for the winter period is quite optimistic. Poland and Portugal were filling their reserves most actively [1].

According to experts, by 2030 the demand for energy in the world will increase by more than a third compared to the data of the beginning of 2000s. This opens wide prospects for countries that are able to provide it. Today, most of the world's economies are dependent on fossil energy sources and hydrocarbons. The world realized the perniciousness of such dependence after the start of hostilities in Ukraine and open blackmail with energy resources by Russia, and therefore the world energy market requires reforming.

The world's leading countries focus on the ecological component of energy security, reducing anthropogenic impact and switching to ‘green’ energy. The main provisions were laid down by the European Commission in December 2019 in the European Green Course (EGC). This document defines a set of measures for the coming years in such areas as climate, energy, industrial policy, etc., to implement a sustainable green transition of Europe to a climate-neutral continent by 2050. Ukraine has also joined the implementation of the EGC, and this is a particularly relevant issue, as it provides an opportunity to analyze the EGC from the point of view of opportunities and threats for the country in such areas as energy, industry, pollution, finance, trade, etc. The following benchmarks have been established for the energy industry:

1) RES as the basis of electric power generation (refusal of the use of coal, transition to decarbonized gas, disclosure of the potential of sea wind power)
2) energy efficiency, in particular in the building sector
3) fair energy transition
4) infrastructure development through integration and digital transformation (political, infrastructural and technological solutions enabling a fully integrated EU energy market) [3].

Ukraine has already taken a number of steps to implement the plan. Nowadays, a number of international obligations have been fulfilled in the energy sector, namely: the Law of Ukraine 'On the Electricity Market' was adopted, which came into effect in 2017 as the part of the fulfillment of obligations under the Treaty on the Establishment of the Energy Community and the Association Agreement between Ukraine and the European Union; regulatory restrictions on the import of electricity were abolished, the market became more transparent, and therefore more competitive; in December 2020, the construction of the first start-up complex of the Centralized Storage of Spent Nuclear Fuel of VVER-type reactors was completed; an independent gas transportation system was created, gas transportation and storage activities were separated; the country is integrated into the ENTSO-E networks (European energy system), which significantly increases its role in the European energy market and the opportunity to become an equal and competitive partner.

The new Energy Strategy of Ukraine until 2035, recently approved by the government with the aim at forming the foundations of energy security, energy efficiency and competitiveness, contains a number of promising forecasts for the development of the industry from the environmental and climate points of view. Among them there is an increase in the share of renewable energy sources - up to 25%, a significant reduction in thermal energy, a halving of the energy intensity of GDP. The Strategy's forecast regarding the share of RES in total energy consumption correlates with the forecast of the International Energy Agency IRENA, which estimated Ukraine's ability to achieve a share of RES in 2030 at the level of 22%.

Conclusions. Military actions, unjustified aggression and ill-considered policy of Russia raised a large layer of problems, showed the threatening dependence on fossil energy resources, ineffectiveness and perniciousness of the existing energy strategy of Europe. The transition period to a climate-neutral energy sector policy has accelerated in pace. Faced with a difficult choice, countries are forced to react reactively to existing challenges and make adjustments to their plans and strategies in order not to violate the national security system, including the energy one.

In May this year, a number of measures were proposed by the European Commission as a response to changes in the energy market caused by military aggression. These proposals formed the basis of a plan called REPowerEU, which envisages three strategic directions for the EU's abandonment of Russian hydrocarbons: energy conservation (including the creation of tax incentives), diversification of the supply of energy carriers and acceleration of the transition to RES. Ukraine is able to strengthen the energy security of the European Union in the field of electricity supply, diversification of gas imports and the use of renewable energy sources.

In the national energy strategy of Ukraine, the goals are clearly stated: the formation of an energy-efficient society; laying a strong energy foundation to promote the development of a competitive economy; safety and reliability of supply and transportation of energy resources; integration into the EU energy space, strengthening of global ties. In order to implement the declared, Ukraine signed an additional Agreement with the EU on the financing of the event "Energy Efficiency Support Program of Ukraine - EE4U", aimed at increasing the financing of the Energy Efficiency Fund. The program has been extended for three years, until 2028, and the amount of co-financing from Germany has been increased by 10 million euros. This Agreement also aims to improve cooperation between donors, the Multi-Donor Trust Fund,

the International Finance Corporation and the Energy Efficiency Fund. In addition, the European Union guarantees support for the repair and reconstruction of the energy infrastructure in Ukraine and promotes the reverse flow of gas to Ukraine through Slovakia, Hungary, Poland and to Ukraine through Romania (the Trans-Balkan gas pipeline).

On March 16, 2022, the Ukrainian energy system became part of the united energy system of continental Europe ENTSO-E, which strengthened the energy security of Europe and the stability of the national energy system. It is important to note that 70% of the Ukrainian energy mix is produced by nuclear and RES generation capacities, and is carbon-neutral. And therefore, they meet the goals of the European Green Deal. Thus, the country is rapidly forming the newest energy market and is successfully integrated into the European and global ones, and the basic configuration of the energy security formula, which provides for an increase in energy saving and energy efficiency, the development of renewable energy sources, the diversification of imports and integration into the EU energy space (connected and synchronized energy network) is fully implemented.

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ЕНЕРГЕТИЧНИЙ СЕКТОР УКРАЇНИ ТА ЙОГО РОЛЬ У ФОРМУВАННІ НОВОЇ ПАРАДИГМИ СВІТОВОЇ ЕНЕРГЕТИЧНОЇ БЕЗПЕКИ

Розглянуто стан, динаміку та тенденції розвитку енергетичного ринку України за останні роки. Визначено ключові проблеми енергетичного світового ринку, зокрема стійку залежність від викопних видів палива, відсутність диверсифікації джерел енергопостачання у більшості європейських країн, що ставить під загрозу національну та енергетичну безпеку. Проаналізовано структуру енергетичного сектора України, визначено основні елементи, що його формують, перспективи розвитку та залучення до використання на європейському ринку енергетичних ресурсів країни. Визначено головні складові енергетичної безпеки, підходи до їх оцінки та дослідження. Зазначено, що основним шляхом подолання існуючих загроз на енергетичному ринку є зменшення залежності від зовнішніх факторів та виявлення внутрішніх резервів. Проаналізовано потенціал української енергетичної системи з точки зору виявлення потенціалу та інтеграції у світову та європейські системи, забезпечення економіки енергетичними ресурсами. Досліджено поточний стан справ щодо формування запасів на зимовий період в Україні та спроможність забезпечити внутрішній ринок. Визначено структуру енергетичного сектора найбільших країн світу, в тому числі й європейських. Зазначено основні кроки уряду щодо реформування українського енергетичного ринку, зокрема збільшення частки відновлювальних джерел енергії, розвиток інфраструктури через інтеграцію та цифрову трансформацію (політичні, інфраструктурні та технологічні рішення). Проаналізовано базові положення Європейського зеленого курсу. Оцінено перші результати реалізації новітньої стратегії енергетичної безпеки, що передбачає збільшення енергозаощадження та енергоефективності, диверсифікацію імпорту та інтеграцію в енергетичний простір ЄС.

Ключові слова: *енергетичний баланс, енергетична безпека, енергоефективність, енергозаощадження.*