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RENEWABLE ENERGY OF THE EU COUNTRIES IN THE CONTEXT OF RISKS OF IMPORT DEPENDENCE

Introduction. *The large-scale invasion of the Russian Federation into Ukraine hastened the decision of the civilized world, in particular the EU countries, regarding the need to minimize, and in the future, completely eliminate, energy dependence on the aggressor country.*

Problem. *The development of mechanisms for strengthening the energy security of the importing countries includes, among a number of prerequisites, the abandonment of fossil fuels of the aggressor country. Russia's dominance in global energy markets leads to dangerous manipulations on its part in the field of European energy security.*

The aim *of the article is to reveal the state of dependence of the economies of the EU countries on the import of energy resources from the Russian Federation and to identify variable scenarios of refusal to finance an important strategic sector of the aggressor country due to the development of renewable energy.*

ВІДНОВЛЮВАЛЬНА ЕНЕРГЕТИКА КРАЇН ЄС У КОНТЕКСТІ РИЗИКІВ ІМПОРТОЗАЛЕЖНОСТІ

Вступ. *Широкомасштабне вторгнення рф в Україну прискорило рішення цивілізованого світу, зокрема й країн ЄС, щодо необхідності мінімізації, а надалі й повного позбавлення енергетичної залежності від країни-агресора.*

Проблема. *Розробка механізмів посилення енергетичної безпеки держав-імпортерів передбачає відмову від викопних видів палива країни-агресора. Домінування рф на глобальних ринках енергоресурсів призводить до небезпечних маніпуляцій з її боку на полі енергетичної безпеки Європи.*

Метою *статті є встановлення рівня залежності економік країн ЄС від імпорту енергоресурсів з рф та ідентифікація варіативних сценаріїв відмови від фінансування важливого стратегічного сектору країни-агресора через розвиток відновлювальної енергетики.*

The authors contribute equally.

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Methods. *Methods of analysis and synthesis, comparison, grouping and systematization, elements of institutional analysis and process approach were used.*

Results. *A high level of dependence of the economies of the EU countries on the import of energy carriers was identified against the background of the dominance of the Russian Federation as a priority supplier of the main types of fossil fuels. The decarbonization of the world economy and the transition to renewable energy sources is a long-term trend and a priority of the national energy strategies of the EU countries. The war of the Russian Federation against Ukraine acted as a powerful catalyst for the decarbonization of European economies. Trade relations between European states and the Russian Federation in the field of energy supply is directly related to the problem of their national security and sovereignty. The priority areas of development of the renewable energy sector of the EU are characterized.*

Conclusions. *The EU's efforts to reduce the level of energy dependence on Russian fossil fuels are reflected in a set of strategic measures in the field of foreign policy and coordination of efforts at the level of global partnership. They are compatible with the medium-term objectives of achieving climate neutrality of the EU by 2050.*

Prospects for further research can be seen in the assessment of the consequences of reducing the level of dependence of the economies of the EU countries on the import of energy carriers from the Russian Federation.

Keywords: energy security, energy strategy, renewable energy sources (RES), war in Ukraine, decarbonization of the world economy.

Методи. *Використано методи аналізу та синтезу, порівняння, групування та систематизації, елементи інституціонального аналізу та процесного підходу.*

Результати. *Ідентифіковано високий рівень залежності економік держав ЄС від імпорту енергоносіїв на тлі домінування рф як пріоритетного постачальника основних видів викопного палива. Декарбонізація світової економіки та перехід на відновлювані джерела енергії є довгостроковим трендом і пріоритетом національних енергетичних стратегій країн ЄС. Війна рф проти України стала каталізатором процесів декарбонізації європейських економік. Торговельні взаємини європейських держав із рф з постачання енергоресурсів загрожують їх національній безпеці й суверенітету. Охарактеризовано пріоритетні напрями розвитку сектору відновлювальної енергетики ЄС.*

Висновки. *Зусилля ЄС щодо зниження рівня енергозалежності від російських викопних видів палива знаходять відображення у комплексі стратегічних заходів у сфері зовнішньої політики та координації зусиль на рівні глобального партнерства. Вони є сумісними з середньостроковими завданнями щодо досягнення кліматичної нейтральності ЄС до 2050 р.*

Перспективи подальших досліджень вбачаються в оцінці наслідків зниження рівня залежності економік країн ЄС від імпорту енергоносіїв із рф.

Ключові слова: енергетична безпека, енергетична стратегія, відновлювані джерела енергії (ВДЕ), війна в Україні, декарбонізація світової економіки.

JEL Classification: L52; L59; L94; L95; Q42.

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Introduction. In recent decades the problem of finding effective strategies for the modernization of national energy systems in the conditions of unprecedented volatility of prices on international energy markets, global environmental threats, and intensifying competition for access and distribution of exhaustive energy resources is permanently in the epicenter of attention of scientists – economists and ecologists, politicians and statesmen. At the same time, the demand for rapid and effective transformations in energy balances is more acutely articulated than ever in the agenda of the EU countries today, as it has not only an economic dimension but also directly relates to issues of energy and national security as a whole, both of the EU itself and its partners, in particular Ukraine.

The decades-old model of providing EU countries with imported energy sources, in particular from the Russian Federation, shows its vulnerability and hopelessness in the modern age because it creates the conditions for pressure from the Russian Federation on the European community and serves as a basis for financing the Putin's regime.

The large-scale invasion of the Russian Federation into Ukraine hastened the decision of the civilized world, in particular the EU countries, regarding the need to minimize, and in the future, completely eliminate energy dependence on the aggressor country. This will have far-reaching consequences not only for the European region, but also for the entire global economy and geopolitics. In view of the aforementioned, the topic of reducing the level of import dependence due to the structural transformation of the energy sector of the EU states thanks to the development of renewable energy is relevant and has not only theoretical, but also practical significance.

Problem. While countries around the world are developing mechanisms to strengthen their own energy security by renouncing the fossil fuels of the aggressor country and making appropriate decisions, Ukraine is fighting every day on all fronts for freedom, democracy, and a free world without bloody energy resources. The dominance of the Russian Federation on world energy markets leads to manipulation of the civilized world, as a result of which the energy security of the whole of Europe remains in question. According to the estimates of the International Energy Agency (IEA), the EU imports 90 % of the natural gas consumed, of which 45% comes from the Russian Federation. In addition, the aggressor country also supplies the EU with 25 % of oil, 45 % of coal and 20 % of uranium from total imports [1]. In 2021, the European Union's expenditure on energy carriers from the Russian Federation amounted to EUR 99 billion. And this number continues to grow every day, even since the beginning of the full-scale invasion of Ukraine. Nevertheless, there is a way out of this situation, and EU leaders see it precisely in the development of the sector of renewable energy sources (RES) and the strengthening of energy efficiency.

Analysis of recent research and publications. The request to reduce energy dependence on fossil fuels, in particular the energy resources of Russia, has been on the agenda of the governments of countries, international organizations, funds and financial and credit institutions for a long time. And all of them predict the emergence of new promising ways to solve this problem. A significant contribution to the study of problems and ways of ensuring energy security in terms of problems of import dependence on fossil fuels, identification of threats to the national interests of states was made by domestic scientists, including: A. Mazaraki, T. Melnyk, S. Maistro, M. Bilovskyi, O. Sukhodolia, U. Andrusiv, I. Mazur, O. Pavlova, K. Pavlov, O. Novosad, L. Matiichuk, Y. Kharazishvili, D. Bobro, G. Riabtsev, S. Zavhorodnia [2–7]. Foreign scholars have also studied this issue, including: B. Ang, W. Choong, T. Ng, F. Gökgöz, M. Güvercin, P. Gasser,

Y. Kharazishvili, A. Kwilinski, O. Sukhodolia, H. Dzwigol, D. Bobro, J. Kotowicz, J. Sachs, W. Woo, N. Yoshino, F. Taghizadeh-Hesary, S. Huang, Y. Chung, T.Wu [8–13] et al. Taking into account the significant amount of work in this area of research, we believe that the issue of the possibility of giving up the energy resources of the aggressor country to ensure the safety of the civilized world in the new realities of an open military conflict on the territory of Europe, as well as the prospects for the accelerated development of the sector of renewable energy sources, requires in-depth attention one of the ways to overcome energy dependence on the import of fossil fuels and approach the general trends of decarbonization of the world economy.

The aim of this article is to reveal the state and level of dependence of the economies of the EU countries on the import of energy resources of the Russian Federation and to identify variable scenarios of refusal to finance an important strategic sector of the aggressor country, in particular due to the development of renewable energy.

Methods. The information base of this article is statistical and analytical materials of international organizations (International Energy Agency, European Union), analytical and expert centers, and own research. Methods of analysis and synthesis, comparison, grouping and systematization, elements of institutional analysis and process approach are used.

Results. In 2014, when Russia treacherously invaded the territory of Ukraine, annexed Crimea and occupied parts of the Donetsk and Luhansk regions, the leading countries of the civilized world failed to recognize all the threats posed by Russia and the dependence of the economies of these states on Russian fossil fuels. And only since February 2022, after a full-scale invasion of the territory of Ukraine, after a hundred deaths of civilians and the destruction of peaceful cities, the entire civilized world began to notice that the price of dependence on Russian fossil fuels in all its senses is unacceptably high.

Today, it is obvious how tightly Russia tightened the energy blockade, primarily for the countries of the European Union, and what the profits from the sale of oil and natural gas are spent on, which according to the Bloomberg agency estimate for 2021 will account for half of Russian export revenues and form 40 % of the Kremlin's budget revenues [14].

According to another information resource, Europe Beyond Coal, every day EU countries pay hundreds of millions of euros to the Kremlin's criminal regime for oil, coal and gas. The amount of revenues from February 2022 already exceeds EUR 64 billion and continues to increase. In particular, the EU paid EUR 31.777 billion for oil imports from February 24 to July 1, gas – EUR 30.880 billion, coal – EUR 1.792 billion [15].

Payment for the import of energy carriers from the Russian Federation is significantly differentiated (*Table*), which reflects the different scales of the economies of the importing states and the differences in the levels of energy dependence on the Russian Federation.

Table

Expenditures of the EU countries on the import of energy resources from the Russian Federation by individual types of fossil fuels

EU country	Expenditures on the import of energy resources from RF, EU millions			
	Total	on coal	on oil	on gas
Austria	2093*	118	219	1757
Belgium	2417**	158	1460	799
Bulgaria	2784*	73	2136	575
Croatia	581**	61	119	401
Cyprus	13**	7	5	1
Czech Republic	4779**	30	1571	3179
Denmark	796**	6	790	no data available
Estonia	680**	no data available	510	170
Finland	3735**	135	3479	122
France	8173*	347	5685	2140
Germany	24116*	1562	14641	7913
Greece	3636 *	22	2924	690
Hungary	3446**	36	1566	2045
Ireland	252 *	4	247	no data available
Italy	14304**	738	3771	9795
Latvia	520**	1	101	418
Lithuania	3173 *	21	2827	324
Luxembourg	3**	1	no data available	2
Malta	280 *	no data available	280	no data available
Netherlands	13489**	441	11683	1365
Poland	9238**	681	8070	487
Portugal	629**	no data available	374	255
Romania	2502 *	122	2119	261
Slovakia	5140**	96	2270	2774
Slovenia	271**	2	102	167
Spain	5085**	228	3867	991
Sweden	1125**	93	938	94

Source: created by the authors on the basis of [15].

Note: * statistical data for 2019; **statistical data for 2021.

At the beginning of March 2022, the USA announced an immediate ban on the import of Russian oil, the same decision was adopted by the United Kingdom, although the share of Russian imports of oil, natural gas and coal in the energy consumption structure of both countries is quite insignificant, only 1 % and 7 %, respectively [14].

However, the EU countries that pay for imported energy resources are of great importance for the Russian budget. EU countries depend to varying degrees on the supply of natural gas from Russia, but collectively their share is about 45 % of gas imports to the EU for industry, residential buildings and electricity generation.

Moreover, Russia began to put pressure on the EU countries for their support for Ukraine, interrupting the supply of electricity and gas to Bulgaria, Poland [16] and Finland [17]. That is why the European Commission, concerned about energy dependence and its consequences, presented in early May 2022 a modernized energy strategy through the

RERowerEU program [18] in order to get rid of dependence on Russian fossil fuels and accelerate the «green» transformation.

REPowerEU program defines the possibility for the EU to reduce its dependence on Russian gas by 2/3 by the end of 2022 and to completely abandon the import of fossil fuels from the Russian Federation by 2030. Such a goal will require the implementation of a number of short-term measures (mitigation of the price shock, fiscal incentives, obligations to fill storage facilities, the initiative of joint gas purchases and the operation of the corresponding platform) and measures to ensure long-term security of supply and compliance with the goals of the European Green Deal (increasing imports of liquefied gas, production of renewable gases, development of RES, decarbonization, etc.).

As part of REPowerEU, the European Commission will also provide technical expertise to EU member states on the abandonment of fossil fuels of Russian origin and advice in case of price shocks. As of April 6, 17 EU countries wanted to receive such expertise.

It is worth noting that the importance of this plan is aimed specifically at the sector of renewable energy sources, where, in particular, it is proposed [19]:

- increase the share of capacities of rooftop solar installations, household wind installations, heat pumps and implementation of energy saving to improve the energy efficiency of buildings;
- to simplify the procedure for issuing permits in order to speed up the implementation of renewable energy projects and improve the network infrastructure in the electric power industry;
- accelerate the decarbonization of industry by transitioning to electrification and renewable hydrogen, expanding low-carbon production capabilities;
- by 2030, double the EU goals for biomethane production to 35 billion m^3 per year, especially from agricultural waste;
- speed up the development of a regulatory framework for the European hydrogen market and the development of integrated gas and hydrogen infrastructure, hydrogen storage and port infrastructure, as well as pilot projects for the production and transportation of renewable hydrogen produced in EU neighboring countries.

Thus, according to the European Commission, the annual production of an additional 15 million tons of renewable hydrogen in addition to the 5.6 million tons provided for in the Fit for 55 packages can replace 25–50 billion m^3 of Russian gas imports by 2030 [20].

Thus, the outlined strategy of the European Union is aimed not only at getting rid of dependence on coal and oil, but also at solving other problems that make the European economy vulnerable, in particular at accelerating the «green» transition, which is integral to achieving global climate ambitions.

According to the IEA, the development of the energy market in the last months of the current year 2022 – especially in Europe – once again proves the important role of renewable energy sources in increasing energy security, in addition to the well-established efficiency in reducing emissions [21].

Russia's invasion of Ukraine also prompted the IEA to develop a quick action plan to reduce natural gas imports from the Russian Federation. The IEA's plan, released in March 2022, consists of 10 points and provides practical steps to reduce Europe's dependence on Russian gas imports by more than a third within a year, while supporting a safe and affordable transition to clean energy.

The main points on reducing the EU's dependence on the consumption of natural gas from the Russian Federation are as follows [22]:

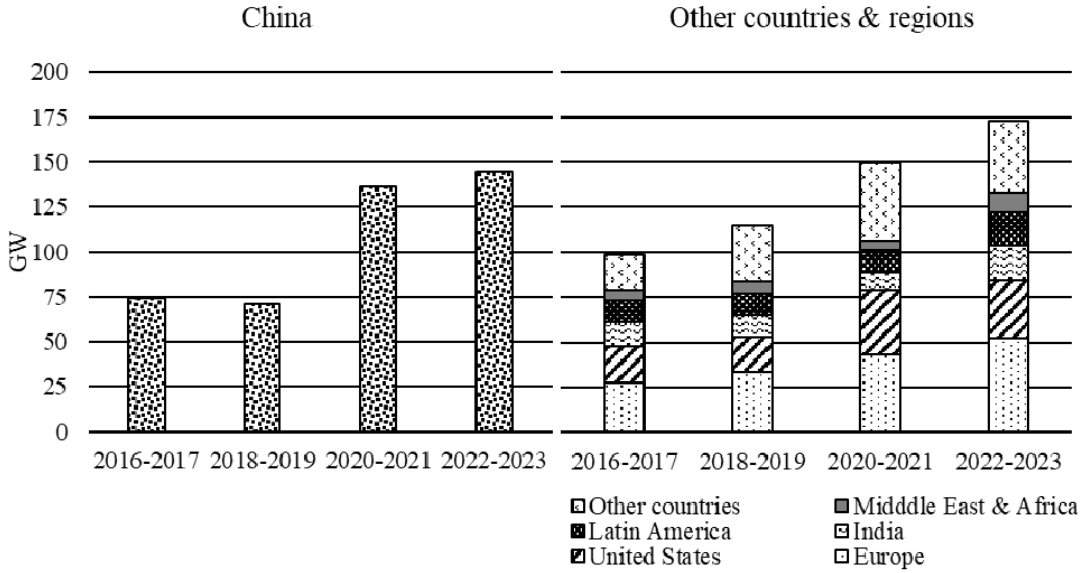
- Refusal to sign new gas contracts with Russia. This will provide significant supply diversification from this year onwards;
- Replacement of approximately 30 billion cubic meters of gas from the Russian Federation with other sources during the year;
- Introduction of minimum obligations regarding gas storage, which will increase the stability of the gas system next winter;
- Accelerating the deployment of new wind and solar projects, which will reduce gas consumption by 6 billion cubic meters during the year;
- Maximum increase in electricity generation due to bioenergy and atomic energy. According to experts, such projects will allow to reduce gas consumption by 13 billion cubic meters during the year;
- Introduction of short-term tax measures to protect vulnerable electricity consumers from high prices;
- Accelerating the replacement of gas boilers with heat pumps, which should reduce gas consumption by an additional 2 billion cubic meters during the year;
- Accelerating the improvement of energy efficiency in buildings and industry to reduce gas consumption by almost 2 billion cubic meters per year;
- Encouraging a temporary decrease in the temperature of the coolant for consumers by 1°C, which can reduce gas consumption by approximately 10 billion cubic meters during the year;
- Intensify diversification efforts and transition to sources that ensure the flexibility of the energy system. This will contribute to the weakening of the close ties between gas supplies and Europe's electricity security.

Representatives of the renewable energy sector of Ukraine support European plans to urgently reduce energy dependence on the aggressor country. The Ukrainian Wind Energy Association (UWEA) appealed to international partners to support a full embargo on Russian natural gas and oil. Also, Ukrainian experts analyzed the international experience of crisis situations and came to the conclusion that an oil and gas embargo is possible not only for the USA and Britain, but also for the EU [23].

Examining recent market and policy developments as of April 2022, the IEA forecasts new global renewable capacity additions and biofuel demand for 2022 and 2023.

In particular, the IEA's new Renewable Energy Market Development Report for May 2022 notes that while looming market uncertainty is exacerbating challenges, a new focus on energy security – particularly in the European Union – is also creating unprecedented political momentum to accelerate energy efficiency and development of renewable energy sources. According to the IEA, global renewable capacity is expected to grow by more than 8 % in 2022 compared to last year, surpassing the 300 GW mark for the first time [21].

Note that not only European countries have accelerated the development of RES. According to the IEA forecast, in 2022–2023, there will be a further increase in the installed capacity of RES around the world. China will lead in this process, however, the EU's share of growth will also be significant and, as predicted, will increase to 52.3 GW of capacity in 2023 (*Figure*).



Annual average RES capacity additions by country and region, 2016–2023, GW

Source: created by the authors on the basis of [21].

Undoubtedly, the dependence of the EU energy sector on the Russian Federation is still high: from 100 to 200 TWh of EU electricity based on natural gas is provided by Russia. On the other hand, thanks to a series of institutional and political steps, we should expect a gradual increase in electricity production from renewable sources to 180 TWh in the period from 2021 to 2023. This means that, as a whole, Europe will be able to independently cover the need for energy that was previously covered by the Russian Federation.

One of the problems that is reflected in the synchronization of decisions of EU countries regarding the adoption of joint decisions on limiting the supply of energy resources is asymmetry in the levels of dependence of the economies of EU states on Russian supplies, and therefore the countries of the European Union depend to varying degrees on the supply of natural gas from Russia. Among the member states, Germany and Italy are most dependent on Russia in terms of absolute electricity production. However, the potential for the development of renewable energy sources to reduce dependence is much higher in Germany than in Italy.

The dependence of France and the Netherlands on Russian gas is relatively small, which allows to increase the potential of renewable energy sources to replace natural gas. Conversely, in Austria, Hungary and Greece, the expansion of the use of renewable energy sources remains limited in order to reduce the countries' dependence on Russia [24].

Although the contribution of RES to reducing energy dependence is significant, much will also depend on the policies for energy efficiency measures that shape the domestic demand for their implementation. It is also important that the trend towards the gradual withdrawal of coal and nuclear energy from regenerative processes in EU member states is irreversible.

It should also be noted that Ukraine takes a proactive position in the matter of reducing the EU's energy dependence on Russian supplies. In particular, the joining of Ukraine to the European Network of Transmission System Operators for Electricity (ENTSO-E) can play a certain positive role, which will allow the countries of the European Union to reduce their dependence on Russian energy carriers. After all, joining the integrated energy system of Ukraine to the energy system of continental Europe ENTSO-E ensured additional stability and security of the European energy system. Moreover, after the synchronization of the Ukrainian and European energy systems, even in wartime, Ukraine started exporting electricity to Poland. Currently, work is underway to start a larger-scale commercial exchange with EU countries. Thus, Ukraine has already started supplying its electricity to Europe, thereby partially compensating for the share of energy consumption that came with Russian gas or coal. Ukraine, in turn, will be able to attract additional funds for the Ukrainian economy and the restoration of the country from the export of electricity to the EU.

Conclusions. Decarbonization of the world economy and transition to renewable energy sources is a long-term trend and priority of the national energy strategies of the countries of the world vanguard, in particular the EU.

The attack of the Russian Federation on Ukraine acted as a powerful catalyst for decarbonization processes, forcing the countries of the world community to rethink their perception of the Russian Federation’s international trade in fossil fuels as a source of funding for its military

aggression. Currently, the issue of trade relations between European states and the Russian Federation regarding the supply of energy resources goes beyond the exclusively economic basis and directly affects threats to their national security.

The EU's efforts to reduce the level of energy dependence on Russian fossil fuels are reflected in a set of strategic measures in the field of EU foreign policy and global partnership. Moreover, the EU's goal of getting rid of the energy resources of the aggressor country is compatible with the medium-term objectives of achieving climate neutrality of the EU by 2050, which significantly enhances its value.

The issue of the EU's refusal to import Russian energy carriers and the systemic transformation of its energy sector in the direction of the development of renewable energy is directly related to the problems of modern Ukraine: the sooner the refusal of the supply of energy resources of the aggressor country to the countries of the civilized world will be, the closer Ukraine's victory in the war against the Russian Federation will be. In turn, accelerated integration of the Ukrainian energy system into the European ENTSO-E energy grid contributes to additional stability and security of the energy systems of Ukraine and EU countries. And additional revenues from the export of Ukrainian electricity will allow to direct financial funds to support the country's economy and its recovery after the victory.

Prospects for further research can be seen in the assessment of the consequences of reducing the level of dependence of the EU country's economies on the import of energy sources from the Russian Federation due to the systemic transformation of the energy sector, conducting a comparative analysis of the effectiveness of the national energy strategies of individual EU countries regarding the mechanisms of financial support for the modernization of the energy sector, directions of strategic cooperation between the EU and the USA and countries of the Middle East regarding the stabilization of energy resources global markets.

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