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Influence of Physical Economy on Energy Security

Abstract
The article examines the main scientific-theoretical and methodological approaches to solving the problem of complex analysis of the state of energy security at the national level. It is found that the situation is influenced by three main aspects: critical dependence on energy imports, the existence of excessive transit capacities, and the energy intensity of the gross domestic product. One of the most serious threats to Ukraine's energy security is its significant dependence on energy imports, which brings with it the risks of economic and political influence from other countries and dependence on global market conditions. Russia's full-scale invasion of Ukraine has caused "the first truly global energy crisis," according to a report by the International Energy Agency, which operates within the framework of the Organisation for Economic Co-operation and Development. There is a tendency to gradually neutralise threats to energy security by reducing natural gas imports and diversifying supplies. The opinion that constant monitoring of energy security threats is necessary to protect Ukraine's national interests is well-founded and is the basis for ensuring energy security. *Practical implications*. It was noted that in recent years, scientists have focused more attention and efforts on overcoming the energy crisis through the use of alternative energy sources, and that real energy security can only be achieved by increasing investment in domestic renewable energy sources. *The purpose* of the article is to determine the nature and content of energy security as a functional component of economic security, to identify the main challenges and threats to Ukraine's energy supply. *Results*. According to the author, the use of the ideas of the Ukrainian school of physical economy is of great importance in addressing the above issues. Thus, the author's vision of energy security, as well as a social model of Ukrainian society that will not only save it from economic and environmental disasters, but also lead to sustainable development and prosperity. *Methodology*. The research used comparative and structural-functional research methods. The comparative method was used to compare similar problems and ways of solving them, which made it possible to see the specifics of the researchers' searches. The use of the structural-functional method helps to outline the structural components in the search system of a particular model and their functional interpretation. A comprehensive approach to the study of energy security was also applied, an economic and statistical analysis of Ukraine's ability to meet energy needs, a comparative analysis of the main conceptual scientific views of S. Podolinskyi, V. Vernadskyi and M. Rudenko were carried out.

Keywords
energy security, economic security, state, threats, physical economy

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1 Introduction

Global problems of humanity, reflecting significant difficulties in the economic, energy, demographic, social, environmental and other spheres of human existence. The reason for their emergence is human activity, which is inseparable from social consciousness. According to many scientists, an important reason for the growth of global problems is the intensive development of scientific and technological progress, the consequences of which are manifested in all spheres of life. Mankind continues to search for ways to overcome the problems of modern civilisation. One of their variants was proposed by representatives of the Ukrainian school of physical economy, whose ideas appeared in the XIX and XX centuries.

Energy is one of the most important global issues. This is why it is the subject of constant attention not only by the leaders of developed countries, but also by those in transition and developing countries. Energy security is an important element of the economic security of any country, and the ability to ensure it determines the extent

to which a country can be an independent player on the world stage. In the modern world, energy underpins almost all aspects of life and plays a crucial role not only in a country's economic progress, but also in ensuring the sustainable development of society as a whole. At the same time, it is impossible to consider the level of energy supply of the state (society) as completely reliable under any socio-political conditions. In the conditions of globalisation influences, the positions of states that are energy suppliers are characterised by increased instability, unpredictability, political egoism and aggressiveness. As a result, countries that have been and continue to be energy consumers are faced with the need to create their own systems for ensuring energy security, the effectiveness of which must compensate for the dysfunctional influences (challenges, threats, dangers) created by the international environment. The scientists' forecast that the demand for energy resources will double by 2050 makes it appropriate to study energy security as a functional component of the economic and national security of the state.

2 Threats to Global Energy Security

The exponential growth in the volume of international energy trade and its share in securing energy consumption has increased the interdependence of energy market participants and moved the issue of energy security from the level of a single country to the global level. Thus, the problem of global energy security has emerged today as an urgent need to reliably supply the world economy with all types of energy without excessive damage to the environment and at prices that reflect basic economic principles.

In recent years, scientists have focused more attention and effort on overcoming the energy crisis through the use of alternative energy sources. A significant proportion of agricultural produce is used to produce biofuel, which makes food more expensive. Experts identified the following composition of threats to global energy security:

– energy supply is lagging behind the growth in energy consumption;
– growing tensions in meeting the energy needs of transport;
– increasing regional energy disparities;
– more severe energy disruptions due to man-made disasters and system accidents;
– irreversible changes in regional and global climate.

The risk of energy supply lagging behind the growth in energy consumption is primarily due to the risk of another (third) wave of growth in global energy consumption. The previous long wave began in the late 1940s and ended in the mid-1990s, when global energy consumption increased almost fivefold, and the consumption of showers almost doubled (Podolynskyi, 1880). Its end was connected with the stabilisation of the average per capita energy consumption in the world from the beginning of the 80s of the XX century.

This is explained by a reduction in total and shower energy consumption in former planned economies and a reduction in shower energy consumption in the Organisation for Economic Co-operation and Development countries, with a relatively moderate increase in shower energy consumption in developing countries.

Ensuring the necessary energy supply will require huge investments in the energy sector, which the International Energy Agency estimates will amount to 17 trillion USD by 2030. Of this, two-thirds will be used to replace existing capacity and one-third to create new capacity (Fortov, Makarov, Mitrova, 2007).

Russia's full-scale invasion of Ukraine has created "the first truly global energy crisis", according to a report by the International Energy Agency, part of the Organisation for Economic Co-operation and Development. A study presented at this year's UN International Conference on Climate Change found that Russia's military actions in Ukraine had already resulted in the emission of 49 million tonnes of CO_2 in the year of the full-scale invasion.

3 Physiocrats' Contribution to Solving the Energy Problem

The Ukrainian school of physical economy made an original contribution to solving the energy problem of mankind thanks to the work of the scientist and public figure S. Podolynskyi (1850–1891) "Human Labour and its Relationship to Energy Distribution" (1880). In it, the scientist identified energy as the key object of his system. He noted that universal energy is an unchanging quantity, but its peculiarity is that it is unevenly distributed in different parts of the universe, which causes its tendency to balance and dissipate.

Based on the facts, the Ukrainian scientist concluded that plants have been and continue to be successful in energy conversion. They mainly store solar energy, but do not convert it into mechanical work. As a result of the activity of plants, there is an accumulation of energy, not in the form of heat, electricity or even light, but in a higher form, preserved for ages and capable of all possible transformations. He established a close connection between the relationship between plants and animals on the one hand and the dispersion and accumulation of solar energy on the other. The essence of this relationship is as follows: "If the amount of energy accumulated by plants is greater than the amount dissipated by animals, then reserve energy is accumulated. On the contrary, if animal life began to prevail over plant life, then after the reserves were exhausted, animal life itself would be preserved in accordance with the amount

of energy stored by plants at any given time" (Podolinsky, 1880).

S. Podolinsky considered human work to be the main factor in the conservation and accumulation of solar energy, and therefore the origin of the ability to work in the human body was of great scientific interest to him. The scientist set himself the task of tracing where in the body the energy needed to perform the actions called work comes from, what devices are used to perform these actions, and what side effects are associated with them. "Human labor," wrote S.A. Podolynskyi, "returns to people in the form of food, clothing, housing, and satisfaction of life's needs, a large amount of energy that was consumed in production" (Podolynskyi, 1880). However, it should not be assumed that the stored energy will meet all the needs of all people. If this were the case, there would be no poverty or shortages on Earth. According to the scientist, the amount of organic life is directly dependent on the amount of solar energy currently stored by plants. Man has had more opportunities than animals to use the energy stored in plants (to build homes, clothing, make fire, etc.). Humans overcame the strongest animals because they were able to raise their energy balance to a higher level than the animals.

The Ukrainian scientist constantly emphasises the energetic properties of human work. In his opinion, work is such a manifestation of the energy of the human body, through which it obtains such amounts of energy, which, without its intervention, would be lacking in nature, without the exchange necessary for a person. All people who live on the products of agriculture and animal husbandry, wrote S. A. Podolynskyi, in the present conditions satisfy their need for food almost exclusively thanks to the energy of the sun, which is brought to the surface of the earth in exchange by human labour. And the higher the level of man's development, the more complicated his moral and spiritual life, the more work he is forced to do for his own satisfaction.

The energy budget of every human being is increasing. The working machine called mankind is becoming stronger and more perfect, and a smaller amount of the transformed energy of human labour is able to transform a larger amount of lower energy into its higher forms. And yet, the energy theory of the economy of the Ukrainian scientist in the 20th century attracted the attention of many researchers. It was especially fruitfully used by the eminent naturalist V. I. Vernadsky, who created the doctrine of the noosphere, which is completely based on the theoretical foundations of S. A. Podolinsky. Complementing and concretising the theoretical foundations of his predecessor, V. I. Vernadsky proved that man has become a planetary force. He can adapt to the environment, but he can also destroy it (Zlupko, 1999).

At a time when most countries in the world are using fossil fuels, the energy sector may have better prospects. Renewable energy sources such as wind and solar power provide a continuous supply, low prices and almost zero environmental impact.

4 Energy Support to Ukraine

The energy transition will continue to shift the geopolitical balance, shifting power from those who control fossil fuel resources to those who develop clean energy technologies. This will require countries currently heavily dependent on fossil fuel exports to diversify their economies. Achieving zero emissions is vital to saving the Earth, but it will also have foreign policy benefits: a world powered by clean energy will be more stable and a better world for all. At the same time, it will create new forms of dependency due to the resources needed to produce such energy. First, solidarity and support from partners in the European Union.

The first year of Russia's full-scale war against Ukraine has highlighted the consequences of dependence on Russian oil, gas and coal, as well as the benefits of energy efficiency and decentralisation. It has also shown the threat that dependence on Russian resources poses to the whole of Europe, and the casualties caused by the inability to wean ourselves off them immediately. Unfortunately, it will be difficult to completely switch to renewable energy sources independently. It is in these processes that the support of the European Union and foreign partners should be sought.

It is also important that the funds received for reconstruction are spent as intended. Through its decisions at the governmental level, through legislative processes, Ukraine must prove that it is interested in the energy transition, i.e., in ensuring a good investment climate for investors in the reconstruction process. Unfortunately, it is well known that it is almost impossible to raise funds from investors during a war.

As Ukraine will receive significant financial assistance from international partners, it is important to ensure that this money is spent effectively. In particular, through transparent mechanisms and public access to monitoring.

5 Conclusions

For Ukraine, the following areas of development of technologies for the use of solar energy are promising: solar collector heat supply; passive solar heating; active-passive combined heat supply systems using solar collectors, heat pumps, daily and seasonal heat accumulators; combined solar-fuel power plants of the thermodynamic cycle. The main source of geothermal energy is the heat contained in the earth's interior. Two main directions

are being developed: the first is related to the use of hot underground water, and the second is the use of dry underground heat. Given that Ukraine has about 30% of the world's black soil and favourable climatic conditions, it should not lose the opportunity to produce enough food to feed a population of at least 1 billion people. Such a goal will become a reality if agrarian reforms in Ukraine are implemented on the basis of the physical economy. Ukraine has all the known energy sources on the planet. It ranks seventh in the world in terms of mineral resources, and most of the explored energy resources need to be developed. A threat to Ukraine's energy security is its high dependence on oil and gas imports.

Energy security is a priority for Ukraine during and after the end of the war started by Russia. After all, this war includes massive attacks on energy infrastructure, nuclear terrorism and damage to more than half of the country's entire energy system. Despite the discovered modest gas reserves, Ukraine is able to supply itself with 30 or 40% of this fuel in the next decade if the budget includes more funds for geological exploration in the Poltava and Kharkiv oblasts and directs them to the development of hydrocarbon resources in the Ukrainian Black Sea and Azov Sea sectors (Nakonechnyi, Korchynskyi, 2015).

Therefore, the improvement of the methodology of formation and management of energy resources, first of all domestic ones, taking into account the peculiarities of the Ukrainian economy, is a primary task of the modern period. This is the vision of the principles of the social model of Ukrainian society, which will not only save it from economic and ecological disasters, but also lead to sustainable development and prosperity (Vorobjova, 2018).

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