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WIND ENERGY AS A RENEWABLE SOURCE OF ENERGY IN THE KHERSON REGION

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Today there is a transformation of approaches to the use of fossil energy sources and the transition to renewable energy sources.

Trends in the development of wind energy in the world make us re-evaluate the importance of wind energy resources in Ukraine and their strategic importance. The key factors in the development of renewable energy in Ukraine are the need to improve the environmental situation; exhaustibility of traditional fuel and energy resources; the urgent need to overcome dependence on energy imports; international obligations; the need for urgent renovation of fixed assets of energy equipment in the country.

The article presents a general description of the wind energy potential in the waters of the Sivash Bay of the Kherson region.

Although the wind energy has great potential to reduce greenhouse gas emissions from fossil fuels, it must also be completely safe for all components of the environment, and the potential impacts of which are investigated through the Environmental Impact Assessment (EIA). The scheme of the principle of construction of a wind power plant (WPP) is provided.

It is emphasized that the use of opportunities to involve certain categories of land and landscapes in the location of the wind energy facilities should be carried out not only on the basis of technical energy potential, but also taking into account environmental and landscape value (including existing norms and restrictions, wildlife, forests, soils, landscapes, water resources, protected species), as well as issues of environmental safety.

Based on the study of environmental impact assessment of the construction of Sivashska and Novotroitskaya wind farms, the main recommendations for planning the construction of wind farms have been formulated.

Key words: wind power plants (WPPs), renewable energy sources, wind energy potential, "green" energy.

Стратічук Н.В. Вітроенергетика як відновлювальне джерело енергії в Херсонській області

Нині відбуваються трансформація підходів до використання викопних джерел енергії та перехід на відновлювальні джерела енергії.

Тенденції в розвитку вітроенергетики у світі змушують по-новому оцінити важливість вітроенергетичних ресурсів України та їх стратегічне значення. Ключовими факторами розвитку відновлювальної енергетики в Україні є необхідність поліпшення екологічної ситуації, вичерпність традиційних паливно-енергетичних ресурсів; нагальна потреба в подоланні залежності від імпорту енергоносіїв, міжнародні зобов'язання, необхідність термінової реновації основних фондів енергетичного обладнання в країні.

У статті наведено загальну характеристику вітроенергетичного потенціалу в акваторії Сиваської затоки Херсонської області.

Незважаючи на те, що вітрова енергетика має великий потенціал зі зменшення викидів парникових газів в атмосферу, на відміну від викопного палива, вона має бути також цілком безпечною для всіх компонентів довкілля, можливі впливи на які досліджуються за допомогою проведення Оцінки впливу на довкілля (ОВД). Подано схему принципу будівництва вітроелектроустановки (ВЕУ).

Наголошується, що використання можливостей залучення певних категорій земель і ландшафтів до розміщення на них об'єктів вітроенергетики має здійснюватися не тільки на основі технічного потенціалу енергії, а й з урахуванням екологічної та ландшафтної цінності (зокрема, наявних норм і обмежень законодавства щодо окремих складників довкілля – рослинного, тваринного світу, лісів, ґрунтів, ландшафтів водних ресурсів, ландшафтів, видів, що охороняються), а також питань екологічної безпеки населення.

За результатом вивчення оцінки впливу на довкілля від спорудження Сиваської та Новотроїцької ВЕС сформульовано основні рекомендації у плануванні будівництва ВЕС.

Ключові слова: вітрові електростанції (ВЕС), відновлювальні джерела енергії, вітроенергетичний потенціал, «зелена» енергетика, вітроелектроустановки (ВЕУ).

Problem statement. As the world's population grows, so does the demand for energy. The use of traditional energy sources, due to their limitations, is impossible for a long time. The world economy, based on fossil fuels, as well as increasing greenhouse gas emissions, is causing radical changes in the climate system.

Efforts to stimulate the development of clean energy have contributed to the fact that as of 2018, more than 20% of the world's energy production came from renewable sources. However, one in five people still does not have access to electricity, and as demand grows, renewable energy production will need to increase significantly worldwide.

It is known that the main goal of the long-term development strategy of the state is to ensure sustainable economic growth. An important factor in Ukraine's economic growth is to reduce the dependence of production on unreasonable costs, which will allow the rational use of financial, material and labor resources.

Today, renewable energy is not just a modern trend, it is a necessity dictated by the challenges facing humanity, the most important of which are climate change and the COVID-19 pandemic. The European Green Deal and the COVID-19 Strategy for Recovery and Exit of the EU Economy clearly recognize the “green transition” as the main driver of economic recovery and future growth and prosperity in Europe. It should be emphasized that the EU's Recovery Strategy has identified wind energy as one of the “political foundations for recovery”. In particular, the share of wind energy in the EU electricity supply is expected to increase to 50% by 2050. This means huge investments, jobs, economic growth and the health of present and future generations, and today wind energy is one of the cheapest [1].

Today, Ukraine's economy is experiencing significant financial losses due to the purchase of oil and gas in foreign markets. It is possible to reduce dependence on energy imports, as well as to improve the environmental situation by introducing alternative types of energy, through the use of raw materials available in our country.

Ukraine has been trying to keep up with developed European countries, which dynamically developed “green” energy, making the most of its own natural potential. In 2015 alone, UAH 500 million was allocated from the state budget for the development of alternative energy in Ukraine for the facilities of the Ministry of Housing Policy and UAH 1.5 billion for the Ministry of the Regional Development and Construction.

The development of renewable energy has been important for the Ukrainian energy sector, both in terms of energy security and environmental friendliness. Renewable energy was an instrument of the country's technological leadership.

Analysis of recent research. The information is based on the study of analytical materials and works of native and foreign authors [2]. The National Academy of Sciences of Ukraine has paid considerable attention to research on renewable energy. In December 2003, the Institute of Renewable Energy of the National Academy of Sciences of Ukraine was established within the Department of Physical and Technical Problems of Energy of the National Academy of Sciences of Ukraine to further development and coordinate research in the field of renewable energy. The real wind potential of Ukraine was established thanks to the research of the institutes of NASU. There has been even a forecast of increasing this potential in the country, which fully confirmed the feasibility of the ongoing program to build wind farms.

Such scientists as A. Solovyov, K. Degtyarev, L. Khmelnytsky, and A. Idrisova were dealing with the issue of wind energy efficiency. D. Dixon and J. Corbett, they expressed confidence in the need to develop wind energy in Europe and the world. The above-mentioned researchers have seen one of the main problems in the development of the wind energy as inconsistent actions by politicians, so the solution would be

to create well-thought-out energy strategies that clearly define the priority role of alternative sources at the present stage. As for native scientists, most of them focused on the advantages and disadvantages of wind turbines, not considering economic changes in the power supply system due to the active use of electricity has produced by alternative energy sources such as wind energy.

Scientists have been dealing with wind energy in Ukraine: S.O.Kudrya, A.O. Rozhko, O.M. Adamenko, V.G. Vysochansky, V.A. Letko, M.O. Mikhailov and others. A number of scientists [3; 4] believed that the usage of small wind energy with energy storage system could be quite effective in solving certain socio-environmental problems.

Task setting. The aim of the article is to study the role of wind energy and assess the potential of wind farms in the Kherson region in the context of sustainable development.

Presentation of the main material of research. According to research by the Institute of Electrodynamics of the National Academy of Sciences of Ukraine, the water area of Sivash Bay in the Kherson region has had a fairly high wind potential. The wind speed here was 5.8–6.3 m/s at a height of 10 meters and 7.3–7.6 m/s at a height of 25 m, which has been quite high for the construction of wind farms. Given the dense development of this area, it was possible to generate electricity in the amount of 43.2 to 75.6 billion kWh per year. That is why the Ministry of Industrial Policy, back in 2005, after conducting research, decided to build a complex of windmills on the shores of Sivash Bay and lease facilities.

Environmental Impact Assessment (EIA) has had a component of design and permitting procedures under Ukrainian law. In general, environmental impact assessment was a clear procedure for carrying out an appropriate assessment of planned activities in line with European principles of better regulation. Normative provisions on the implementation of ATS and public consultations and disclosure of information are established by the Law of Ukraine “On Environmental Impact Assessment”, which came into force in December 2017. Preparation of the ATS report and planning of environmental protection measures is carried out on the basis of norms and standards within the framework of Ukrainian legislation [5].

December 10, 2018 (18 months from the date of publication) – the provisions of the Law on the Electricity Market regarding the unbundling and independence of the distribution system operator came into force.

On September 29, 2017, the grand opening of the first stage of the Novotroitsk wind farm in the Kherson region with a total capacity of 69 MW took place. The first stage of the Novotroitsk wind farm with a total capacity of 43.8 MW has consisted of 12 Vestas V-126 wind turbines with a unit capacity of 3.65 MW.

Planned activities for construction and operation of Sivashska WPP have belonged to the second category of planned activities and facilities that might have an impact on the environment and were subject to environmental impact assessment in accordance with Article 3, subparagraph 4 of the Law of Ukraine “On Environmental Impact Assessment” № 2059-VIII of May 23, 2017.

Initially, the construction of the Sivashska wind farm began as part of the state program for the development of renewable energy sources, after which in 2006 the facility remained unfinished. In 2009, a tender was announced for the completion of the wind farm – the winner was Sivashenergoprom, which has found investors to complete the construction, and was the management company of the facility today. Sivashska WPP has been generating electricity and receiving green tariff payments since September 2012.

The old wind farm has consisted of inefficient low-power turbines – 16 units per 100 kW and two – at 600 kW. The power utilization rate of “hundreds”, which were developed in the 1980s, is 10–12%, and more modern T600 – 26–28%, but they continued to work.

In 2006, the Kherson Regional State Administration transferred the unfinished Sivashska WPP to the concession of Sivashenergoprom LLC until 2055. In 2011, Sivashenergoprom has signed a lease agreement for 12 hectares of land under a concession wind farm and 1,300 hectares for the construction of new wind and solar generating facilities.

As of the end of 2015, 16 wind turbines (wind turbines) with a capacity of 107.5 kW each (manufactured by Pivdenmash under license from the American company Kenetec Windpower) were installed, connected and put into operation at the Sivashska WPP site. Also, two T600-48 wind turbines with a capacity of 600 kW each (manufactured by Pivdenmash under license from the Belgian company TurboWinds) were installed and put into operation. Nordex nacelles are under construction against the background of existing turbines USW56-100 [6].

In April 2018, NBT AS (Norway) acquired Sivashenergoprom LLC with plans to complete the wind farm. In early September 2018, an agreement has been signed on the implementation of an international investment project for the construction of wind farms in the Kherson region with the leading role of the Norwegian company NBT. According to it, 64 wind power plants would be built along the northern shore of Lake Sivash.

Thus, the total capacity of the Sivashska wind farm has had currently 2.92 MW. At the construction site of the Sivashska WPP, it was possible to supply up to 600 MW of power to the integrated power system of Ukraine, because 220 kV and 330 kV power transmission lines passed directly along the land allotment strip. Near the substation of the Crimean Titan plant is also located.

The proposed site has had an area of approximately 1307.99 hectares and is located in Chaplynskyi district of the Kherson region in the South of Ukraine. The construction site is located along the northern shores of Sivash Bay and consisted of land leased by Pershokostyantynivska, Hryhorivska, Pavlivska and Stroganivska village councils from nature reserves. The southern border of the south-western corner of the territory of the object has lied to the north of the border with Crimea.

The territory of the object has had mostly flat relief and consisted of agricultural lands and locally located wetlands, where the dominant plant is reed. Areas of the project area are used by local farmers to graze cattle and sheep. Currently, the infrastructure at this construction site included large irrigation canals in addition to the existing wind farms (WPPs), which indicated the availability of renewable energy sources in this area [7].

The project has included the construction and operation of a wind farm, which consists of the following parts: access roads to the project sites from paved roads; substations and their connection to the grid; on-site access roads from the control room to the wind farm and underground cable lines for collecting power from the wind farm at the substation; construction complex; control room and 64 wind turbines.

Wind turbines have had a tubular steel structure and are painted light gray at the bottom.

The upper third of the tower, gondola and shovels are painted white to ensure aviation safety. The blades are made of polyester, reinforced with fiberglass, or polymer resins. To reduce light reflection, the blades are covered with a matte finish. It is expected that wind turbines would have a service life of 20-25 years, the same would be the service life of the project.

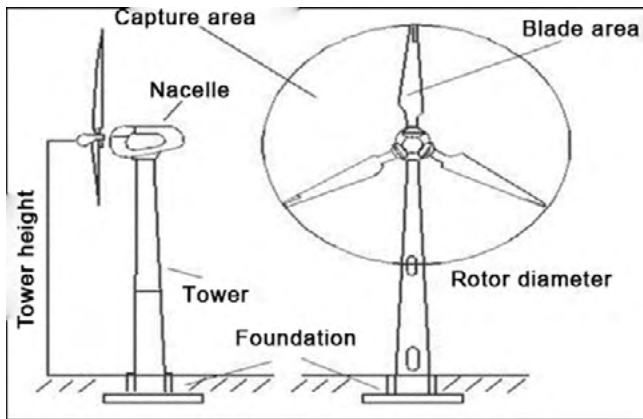


Figure 1. Scheme of the principle of construction of wind turbines

Electricity generation the project is estimated at approximately 913 million kWh/year, which would account for about a third of the Kherson region's consumption. The project would replace the amount of electricity produced in the United Energy System of Ukraine by burning about 480 thousand tons of coal, saving this amount of fossil fuels and preventing emissions of about 860 thousand tons of CO₂-eq. The company operating the Project is registered in the Chaplynskyi district of the Kherson region, which meant that part of the taxes from the Project would go to the local community budget – about 2.5 million hryvnias annually. In addition, the Project would continue to work with local communities to support them under the corporate social responsibility program.

Conclusions and suggestions. Construction and operation of wind farms have caused a number of impacts on environmental components, both at the stage of construction of wind farms and in the process of its further operation. Significant damage is caused to the natural environment in the steppe areas during the construction of wind farms.

Wind turbines have produced electricity almost without polluting the environment, but their negative impact is associated with the allocation of large areas for construction and landscape change, the threat of bird death, metal consumption of wind turbines, which caused pollution in metal production.

Speaking about the disadvantages of wind turbines usage, it should be noted that almost every one of them could be solved. The instability of generators is compensated by the presence of auxiliary “battery stations”, and the “acute issue” of the high cost of installation has recently receded into the background.

Reducing the impact on natural complexes has been possible with the location of wind farms within agricultural landscapes. In this case, when placing the wind farm within the agricultural landscape, the buildings and generating units themselves are located in the forest belts, and communications are laid under arable land. After the return of the fertile soil layer, the plots could be used for growing crops. With this location of wind farms, the impact on vegetation and soils and, as a consequence, on the climatic aspect is minimized.

During the construction of wind farms between agricultural lands and laying of communications under arable land, the total area of construction-damaged areas is significantly reduced, as arable land is easily restored after laying communications to its

original state. The location of wind farms on land that has lost its value and was previously used for growing crops (salt marshes and depleted lands) would also reduce the negative impact on natural steppe areas.

A special environmental problem has been the noise effects of wind turbines with a capacity of 250 kW and more. The problem of generating ultrasonic wind turbines was overcome by choosing the profile of the blade and the speed of rotation of the windmill, or rather the ends of the blades of the windmill.

The problem of noise reduction is solved by placing wind turbines at considerable distances (permissible noise level – 40–50 decibels) from the houses. Therefore, the distance from the wind turbine to the habitation should be 150 m, and wind farms – 250–300 m.

The results of the assessment of the impact of wind turbines on the death of birds have showed that the mortality of birds from wind farms with a capacity of 1000 MW was 300 times lower than from car traffic and 50 times lower than from power lines. This is also facilitated by the transition to more powerful wind turbines and reduce their speed.

Therefore, the main recommendations for planning the construction of wind farms were as follows:

1. Do not allow the allocation of land within the territories of the nature reserve fund and in areas where it is planned to create objects of the nature reserve fund.

2. Do not allow the allocation of steppe areas, which are a place of distribution of rare species of flora and fauna.

3. To prevent problems with environmental legislation, it is necessary at the stage of selection of land for allotment to identify rare and endangered species of plants, animals, fungi and lichens, as well as plant groups listed in the Green Book of Ukraine to prevent allotment there are these species and groups.

4. When choosing a site for construction, take into account the risk of erosion processes that can lead to short-term operation of the wind turbine and damage to the fields in the vicinity of the wind farm. It is necessary to avoid the proximity of slopes, beams, precipices and to abandon areas along the slopes.

5. If possible, carry out the location of wind farms within the agricultural landscape, and the buildings and generating plants in the forest belts. For example, to build wind farms in degraded forest strips between fields, on former livestock complexes or rice checks, saline soil, thus not damaging arable land and natural areas.

6. Follow the recommendations of the environmental impact assessment.

7. When designing the infrastructure of wind farms in the steppe zone, make the most of the existing road network, minimize the construction of new roads both within the wind farm site and outside it.

8. Lay communications under the arable land, which reduces the total area of construction-damaged areas, as the functions of the arable land are easily restored after completion.

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