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RENEWABLE ENERGY: SOURCES AND TECHNOLOGIES

У статті подана інформація про відновлювальні джерела енергії та їхня перспектива використання в Україні. Можливості прогресу енергетичного сектору та застосування синтезу нових підходів та технологій для досягнення бажаного результату.

Ключові слова: *відновлювальна енергія, оптимізація, основні постулати.*

The article provides information about renewable energy sources and their perspectives of use in Ukraine. Possibilities for progress in the energy sector and the application of the synthesis of new approaches and technologies to achieve the desired result.

Keywords: *renewable energy, optimization, basic postulates.*

The current stage of development of the world and national energy sector is characterized by a global transition to low-carbon technologies. For Ukraine, the issue of developing renewable energy (RE) is a strategic priority, which is due to the need to ensure energy security, decentralize generating capacities under martial law and fulfill international climate commitments. According to the National Action Plan until 2030, Ukraine seeks to achieve a share of renewable energy sources (RES) in gross final consumption of at least 27%.

Energy potential and technologies of solar and wind energy.

Solar energy remains one of the most dynamic sectors. Ukraine has formed a powerful research and development base for the production of silicon-based photovoltaic converters. The main technological trends are:

* Introduction of highly efficient monocrystalline panels, which allows to significantly reduce the levelized cost of electricity (LCOE).

* Development of decentralized systems: use of solar power plants (SPP) for the needs of private farms and the agricultural sector (lighting, irrigation systems, drying of products).

* Integration of SPP into autonomous power supply systems of critical infrastructure facilities.

Wind power in Ukraine has significant industrial potential. Strategic plans provide not only for the development of onshore wind farms, but also for the construction of up to 100 MW of offshore wind capacity by 2030. An important aspect is the introduction of small-scale wind power for local energy supply of communities, which requires specific approaches to the design of small-scale wind turbines.

Bioenergy and small hydropower as tools for decentralization.

The use of biomass energy has a high potential to replace natural gas in district heating systems. The main areas include:

Solid biofuels: Technologies for direct combustion of baled straw, pellets and firewood in specialized boilers with high efficiency.

Biogas technologies: Energy generation from agro-industrial waste and wastewater, which simultaneously solves environmental issues of waste disposal.

Thermochemical conversion: Pyrolysis and gasification of biomass to produce combustible gas and biochar.

Small hydropower (SHP) plays a key role in the energy supply of mountainous and remote regions. The development of this sector requires a balanced approach that takes into account environmental aspects and the interests of local communities, as well as the introduction of stimulating economic mechanisms, such as preferential lending.

Innovative areas: Geothermal and Hydrogen Energy.

Geothermal energy in Ukraine is based on the use of hydrothermal resources (hot water) and petrothermal energy (heat of dry rocks). Heat pump technologies allow for the effective use of low-potential heat from the surface layers of the earth for heating buildings.

Hydrogen energy is considered a universal tool for accumulating energy from renewable sources that operate periodically. The hydrogen strategy of Ukraine provides for three stages:

2022–2025: Creating a foundation and launching the export of "green" hydrogen.

2026–2030: Diversification of energy sources through the growth of domestic hydrogen production.

2031–2050: Large-scale expansion of the market and modernization of the gas transportation system for transporting hydrogen mixtures.

The role of local governments in the implementation of renewable energy.

The implementation of national energy transition strategies directly depends on the activity of territorial communities. Local governments (LGs) are key actors with the following tools:

Planning and coordination: Development of municipal energy efficiency programs and sustainable energy development strategies.

Stimulation: Implementation of local support mechanisms (for example, co-financing of green energy projects).

Guarantees of origin: Participation in the system of circulation of guarantees of origin of electricity from renewable sources, which confirms the environmental friendliness of the produced resource.

Energy cooperatives: Creation of conditions for the association of community residents for the purpose of joint production and consumption of energy.

Integration and balancing issues.

Increasing the share of RES in the power system requires solving technical challenges:

Forecasting: Using modern meteorological models and artificial intelligence systems to accurately predict the generation of solar and wind power plants.

Storage: Implementing battery energy storage systems (BESS) to smooth out consumption peaks and maintain frequency stability in the network.

Hybrid systems: Creating combined energy nodes (e.g. Wind + Solar + Biogas) that provide a more even power output schedule.

The development of renewable energy in Ukraine in 2025 is moving from the stage of quantitative accumulation to qualitative integration and technological diversification. The key factors for success are decentralization through active participation of communities, the introduction of hydrogen technologies as a means of balancing, and the creation of a transparent regulatory framework (including guarantees of origin of electricity). Further scientific research should focus on increasing the efficiency of converters and optimizing distributed generation control systems.

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ECONOMIC FEASIBILITY OF GROWING MISCANTHUS IN UKRAINE

У статті подана інформація про сільськогосподарську культуру міскантус, витрати та окупність його вирощування, а також значення міскантусу як сировина та енергетична культура.

***Ключові слова**: рентабельність вирощування, біомаса, виробничі витрати, промислова плантація.*

The article provides information about the miscanthus crop, the costs and payback of its cultivation, as well as the importance of miscanthus as a raw material and energy crop.

***Keywords**: profitability of cultivation, biomass, production costs, industrial plantation.*

Miscanthus is a perennial herbaceous plant from the family of cereals. Miscanthus is a highly efficient, environmentally friendly crop: after four years of cultivation, it accumulates 15-20 tons of underground biomass, which is equivalent to 7,2-9,2 tons/ha of carbon. The duration of plantation use is about 20 years, and commercial cultivation is 15 years. Low operating costs for cultivation open up wide possibilities for using this crop for the production of solid fuels [1].

Miscanthus is an agricultural crop that can be grown on both large and small areas of soil. There are many examples of growing miscanthus on homestead plots. For several years, Cherkasy resident Valentyn Lugovsky has been growing giant grass for heating one of the city's microdistricts. The yield reaches 65-70 t/ha at a humidity of 8-15%. 1 ton of fuel pellets from miscanthus is equivalent to 440 kg of crude oil, 820 kg of coal, 515 m^3 of natural gas, 1,2 tons of wood or 420 kg of diesel fuel. The biomass yield is about 30 t – equivalent to about 15 thousand m^3 of gas. According to the Cherkasy resident, about 5 thousand hectares of land are needed to heat the regional center with miscanthus [2].

According to the Bioenergy Association of Ukraine, the profitability of growing miscanthus is about 17%, while the same indicator for energy willow and poplar fluctuates within 11-12%. Profitability can be increased if a state investment program to support the cultivation of bioenergy crops is launched in Ukraine. Such support can be implemented by providing subsidies or reducing taxes on their cultivation. The practice implemented in the EU is also interesting. According to the requirements of the EU's common agricultural policy, all farmers who own more than 15 hectares of arable land must allocate at least 5% of the area - such as buffer strips, landscape elements, land for forest plantations and others – for growing perennial energy crops, without using pesticides and chemical fertilizers, or reduce their use to a minimum [3].

Despite the energy performance of the crop, the main factor in making a decision about its cultivation is the cost of production and the payback of industrial miscanthus plantations. Ukrainian miscanthus producers can be counted on the fingers and there are reasons for this. The first reason is the rather large amount of investment that needs to be made at the start. The average price of 1 hectare of industrial plantation (17,000 plants per hectare) is somewhere around 130,000 UAH, about 80% for planting material, the rest for mechanization, technology, labor and diesel fuel. Miscanthus is propagated vegetatively – by rhizomes. For example in 2020-2026 miscanthus planting material costs about 9-11 UAH per rhizome, 16-17 thousand rhizomes are required per hectare, plus it is worth considering logistics and customs clearance. Also, if you plan an area under the crop of more than 5 hectares, it is worth purchasing a specific planter. Its estimated price is €50 thousand. In addition, the payback of a miscanthus plantation will be only in the third year after its establishment, and only in the fifth year can a net profit be obtained [4].