SUSTAINABLE DEVELOPMENT: MODERN THEORIES AND BEST PRACTICES

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SOLAR ENERGY TECHNOLOGIES IN A WATER SUPPLY COMPANY: ECONOMIC EFFICIENCY SUBSTANTIATION

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Renewable energy has already become a global trend: in recent years, investments in it have consistently surpassed investments in traditional energy technologies [1, 2]. Many countries, particularly developed ones, are refraining from investing in new energy projects that involve fossil fuels. Progressive societies have come to realize that sustainable development is key to the stable future of national economies, and a just energy transition is one of the pathways to achieve it [3].

Mechanisms for a green energy transition require the active participation of all stakeholders in processes aimed at rationalizing and greening energy systems, introducing cutting-edge renewable energy technologies, and improving energy efficiency in production and consumption. Implementing such initiatives at the enterprise level is crucial, especially in the residential and municipal sectors. The latter represents a significant consumer of energy resources, where savings can have powerful positive economic effects (in terms of reducing costs for sector enterprises), social benefits (potentially lowering utility tariffs for the population while maintaining or even enhancing utility quality), and environmental advantages (reducing the environmental footprint and decreasing environmental pollution).

Alongside municipal energy companies, a substantial portion of production costs for water supply enterprises is allocated to electricity for water extraction, purification, transportation, and other associated processes. Therefore, optimizing energy

consumption for water supply enterprises through the application of innovative renewable energy technologies is a significant contribution to their stable operation and the development of their production capacities. For Ukraine, whose municipal and energy infrastructure is affected by Russian shelling, the issue of stable energy supply, its decentralization, and the reduction of energy consumption by economic entities are of critical importance. This is especially pertinent to water supply enterprises, for which power outages mean a complete halt in their activities.

To decentralize energy supply and optimize electricity expenses, a pilot project has been developed to implement solar power plants at the municipal water supply enterprise "Miskvodokanal" in Sumy, Ukraine [4]. The project involves the use of solar photovoltaic panels to generate electricity for self-consumption and the storage of the generated green energy, alongside maintaining diesel generators for emergency backup in case of power outages [4]. The project's implementation is expected to be funded through donor contributions and municipal council funds, aimed at supporting uninterrupted water supply to critical infrastructure in the event of emergencies. Under normal operating conditions, green electricity production by the new energy installations will lead to cost savings for the enterprise through the reduction of the need to purchase electricity from the local electric company. Let us delve into the details and provide substantiation for the economic feasibility of implementing a solar power station at one of the city's water intakes.

The annual electricity consumption for the water pumping stations at the considered water intake facility amounted to 1122.36 MWh in the pre-war period, with monthly fluctuations ranging from 88 MWh (June) to 102 MWh (August). To partially cover the electricity needs of the water intake through its self-generation, it is proposed the installation of a solar power station with a capacity of 120 kW, capable of generating 174.8 MWh annually. This would enable the substitution of purchased electricity with self-generated power, covering from 1.4% to 19.1% of the existing needs, depending on the month [4]. The relatively low percentage of substitution is influenced, firstly, by investment constraints, secondly, by the enterprise's focus on using generated energy exclusively for its own needs, and thirdly, by the requirement to establish an emergency reserve of stored electricity.

The operational lifetime of solar panels is set at 25 years. Taking into account the degradation of solar equipment technical characteristics over time due to physical depreciation, the estimated total electricity production over the entire lifecycle amounts to 3023.4 MWh [4]. The average economic indicators for the project's construction of a solar power plant, considering a 17%-discount rate, investment and operational costs over the entire lifecycle amounting to 7573 thousand UAH, and the current electricity tariff of 2.05 UAH/kWh, are as follows (Table 1).

Table 1 - Average economic indicators for the solar power plant construction project (calculated based on [4])

Indicator of the project's economic efficiency	Unit of Measurement	Indicator's value
Net Present Value, NPV	thousand UAH	9206.8
Internal Rate of Return, IRR	%	35
Discounted Payback Period, DPP	years	4.65
Profitability Index, PI	fractional units	2.05
Levelized cost of electricity, LCOE	UAH/kWh	2.37

Based on the obtained project performance metrics, it can be noted that they are entirely acceptable in terms of investment, ensuring the profitability of the solar power plant, a relatively high internal rate of return for the project, and a short payback period. The levelized cost of electricity slightly exceeds the current electricity tariff, which is a common characteristic of renewable energy projects. However, in light of recent increases in electricity tariffs and their expected ongoing growth due to the reconstruction, repairs, and development of Ukraine's energy infrastructure, replacing a portion of purchased electricity with self-generated energy is unquestionably economically viable.

The primary economic risks that may arise during the implementation of the proposed project encompass the following:

- complicated logistics and increased logistical costs due to the war, resulting in delays in the supply of necessary equipment and higher equipment costs;
- increased investment costs for the construction of the solar power plant due to inflationary fluctuations of the hryvnia, as the main equipment for the power plant is purchased abroad.

However, there are factors that will strengthen the enterprise's interest in implementing the project, including the aforementioned consistent rise in electricity prices and corresponding gradual increases in energy expenses for water supply. Overall, the project's implementation will contribute to improving the quality and reliability of water supply to critical infrastructure in the city through energy decentralization and the rationalization of the enterprise's energy consumption.

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