

UDC 620.91

***Zakharchenko Ruslan***

Candidate of technical sciences, associate professor

***Kryvorot Anatolii***

Candidate of technical sciences, associate professor

National University «Yuri Kondratyuk Poltava Polytechnic»

### ***THE EFFICIENCY OF USING BIFACIAL SOLAR PANELS***

Solar energy is an important source of renewable energy that helps reduce dependence on fossil fuels and decrease greenhouse gas emissions. Due to its inexhaustible potential and environmental benefits, solar energy is becoming a key component of energy transformation in many countries around the world. Since fossil fuels are limited and cause significant environmental pollution, the use of solar energy not only reduces negative impacts on nature but also ensures long-term energy independence. Innovative solutions in solar energy, such as bifacial solar panels, represent a significant step forward in improving electricity generation efficiency. These panels can generate electricity from both sides, greatly enhancing their productivity compared to traditional monofacial panels. The use of bifacial panels allows for maximum utilization of solar radiation, including reflected light, which is often ignored by traditional systems. This makes them highly attractive for projects focused on optimizing energy resources under various conditions.

Bifacial solar panels differ in that they absorb solar energy from both the front and rear surfaces. This allows for a significant increase in panel efficiency, especially in situations where sunlight is reflected from the ground or other objects. Installed on reflective surfaces, such as snow, gravel, or concrete, these panels can generate 10-30% more energy than monofacial panels. The use of such panels in northern regions, where snow coverage dominates in winter, provides additional energy, which is especially important in short daylight conditions. This makes bifacial panels effective not only in warm climates but also in regions with moderate and cold climates. Due to innovative materials and designs, these panels are more reliable, efficient, and durable. For instance, monocrystalline bifacial panels can achieve efficiencies in the range of 20-22%. This level of performance makes them one of the most promising solutions for large-scale industrial and commercial applications. Moreover, they are less prone to overheating, which allows them to be used in warmer climates without significant efficiency loss, a common issue with some traditional panel types [1].

The high efficiency of bifacial panels is ensured by their ability to use both direct and reflected sunlight. This technology is especially useful in conditions of low insolation or variable weather. Panels that can produce energy from both sides even on cloudy days or in diffused light conditions are a reliable solution

for regions with frequent climate changes. Due to reflective surfaces, the installation of such panels is an effective solution for northern regions or areas with significant snow coverage [2]. Another advantage is the efficient use of space. Bifacial panels can generate more energy from the same area as monofacial ones, which is a strong argument in favor of their installation in space-limited conditions.

In addition to increased productivity, bifacial panels are economically advantageous. Their ability to generate more electricity per unit area reduces the need for additional panel installations, thereby lowering installation and maintenance costs. The return on investment in such panels accelerates, particularly in commercial and industrial projects where the use of large areas for solar farms is key. Furthermore, their durability and reliability contribute to lower maintenance costs over the entire system lifecycle [3].

Bifacial panels are becoming increasingly popular in both industrial and private projects. They can be installed on rooftops of houses, carports, or other architectural structures. This allows for efficient use of limited space and ensures energy independence for households. Additionally, combining such panels with modern energy storage systems allows for the accumulation of excess electricity for use in the evening or at night when energy production decreases. This is important for stable energy supply, especially in conditions of uneven solar energy distribution throughout the day [4].

Bifacial solar panels are an innovative and efficient solution for improving the productivity of solar power plants. Their ability to absorb light from both sides and generate more energy per unit area makes them a profitable investment choice for both large industrial facilities and residential buildings. In the context of the global shift to renewable energy sources, bifacial panels have significant potential for further development and widespread adoption. They contribute to sustainable development and serve as an effective tool for addressing modern environmental and economic challenges.

#### *References*

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