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TECHNICAL PARAMETERS AND ECONOMIC PERFORMANCE ANALYSIS OF A 510 KW SOLAR POWER PLANT AT KARSHI STATE UNIVERSITY

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Abstract

The rapid development of renewable energy sources has become one of the main priorities for sustainable economic growth and environmental protection. Solar photovoltaic (PV) power plants are widely used due to their environmental friendliness, low operating costs, and long service life. This study analyzes the technical parameters and economic indicators of a 510 kW solar photovoltaic power plant installed at Karshi State University in Uzbekistan. The analysis focuses on the performance of solar panels, electricity generation efficiency, and economic benefits obtained from renewable energy utilization. The research evaluates the installed capacity, energy output, system efficiency, and financial savings resulting from reduced electricity consumption from the grid. The findings indicate that the solar station significantly reduces operational energy costs and contributes to sustainable energy development. According to available data, the solar power system installed at Karshi State University produces approximately 152,880 kWh of electricity per month, saving about 153 million UZS in energy costs and generating an annual economic benefit of approximately 734 million UZS. The results demonstrate that solar power plants installed in educational institutions can serve not only as a sustainable energy source but also as a research and training platform for students and engineers. Furthermore, the economic analysis confirms that renewable energy investments are economically viable in regions with high solar radiation such as southern Uzbekistan.

Keywords

solar energy, photovoltaic system, renewable energy, solar power plant, energy efficiency, economic efficiency, Uzbekistan

Introduction

The increasing demand for electricity and environmental concerns have accelerated the global transition toward renewable energy sources. Solar energy is one of the most promising renewable resources due to its abundance, sustainability, and low environmental impact. Photovoltaic technology converts solar radiation directly into electricity using semiconductor materials such as silicon.

Uzbekistan possesses favorable climatic conditions for solar energy production, particularly in the southern regions such as Kashkadarya. The average annual solar radiation in the region ranges from 1500 to 1800 kWh/m², which makes solar power plants economically viable and technically efficient.

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In recent years, Uzbekistan has been actively implementing renewable energy projects in order to reduce dependence on fossil fuels and increase energy security. Large-scale solar power plants are being constructed across the country, including projects with capacities reaching hundreds of megawatts.

As part of this initiative, Karshi State University has installed a solar photovoltaic power plant with a capacity of **510 kW** on its territory. The solar power station supplies electricity to university buildings and reduces electricity costs by producing renewable energy locally.

The objective of this study is to analyze the **technical parameters and economic performance** of the 510 kW solar photovoltaic power plant installed at Karshi State University. The study focuses on evaluating energy production, system efficiency, and financial benefits of the solar installation.

Literature Review

Numerous studies have examined the effectiveness of photovoltaic systems in improving energy sustainability. Solar power plants convert solar radiation into electrical energy using photovoltaic modules, inverters, and electrical transmission systems.

Photovoltaic (PV) systems typically consist of the following main components:

-Solar panels (PV modules)

-Inverters

-Power transformers

-Monitoring and control systems

-Electrical transmission infrastructure

Solar panels generate **direct current (DC)** electricity which is converted into **alternating current (AC)** using inverters so that it can be used by electrical devices or transmitted to the grid.

Research has shown that solar power plants provide several advantages:

1. Reduction of greenhouse gas emissions
2. Decrease in electricity production costs
3. Energy independence
4. Sustainable power supply

According to recent studies, photovoltaic systems can achieve conversion efficiencies between **15% and 22%**, depending on the technology used. Monocrystalline silicon panels typically have higher efficiency compared to polycrystalline panels.

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Furthermore, solar power plants installed in educational institutions provide additional benefits such as practical research opportunities and energy awareness among students.

Technical Parameters of the Solar Power Plant

The main technical parameters of the solar power station installed at Karshi State University are summarized in Table 1.

Table 1

Technical characteristics of the 510 kW solar power plant

Parameter	**Value**
Installed capacity	510 kW
Type of technology	Photovoltaic
Average monthly generation	152,880 kWh
Annual generation	1,834,560 kWh
System type	Grid-connected
Inverter type	DC–AC inverter
Solar module type	Silicon PV modules

The photovoltaic system converts solar radiation into electrical energy according to the following relation:

$P=\eta \times A \times GP = \eta \times A \times G$

Where:

P – electrical power generated (W)
η – efficiency of solar panels
A – area of solar panels (m^2)
G – solar radiation intensity (W/m^2)

The total energy produced by the solar power station can be calculated as:

$E=P \times t$

Where:

E – electrical energy generated (kWh)

P – installed capacity (kW)

t – operating time (hours)

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These formulas are commonly used to estimate solar power plant performance and energy output.

Economic Analysis and Discussion

The economic benefits of solar power plants depend on factors such as:

-electricity tariffs

-system installation cost

-maintenance cost

-energy production

According to available data, the solar power plant at Karshi State University produces approximately **152,880 kWh of electricity per month**, which results in significant financial savings for the university.

Table 2

Economic performance of the solar station

Indicator	Value
Monthly electricity production	152,880 kWh
Monthly savings	153 million UZS
Annual electricity production	1.83 GWh
Annual economic benefit	734 million UZS
Indicator	Value

The annual economic benefit can be calculated using the following formula:

$S=E\times C$

Where:

S – financial savings
E – produced energy (kWh)
C – electricity tariff (UZS/kWh)

Additionally, excess electricity generated by the solar power plant can be sold to the local power grid, further increasing financial returns.

Solar power plants also reduce carbon dioxide emissions. Considering that 1 kWh of electricity generated from fossil fuels produces approximately **0.6 kg of CO_2**, the solar station helps reduce greenhouse gas emissions by several hundred tons annually.

Results

The analysis of the solar power plant installed at Karshi State University demonstrates several key results:

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1. The solar station generates more than **1.8 GWh of electricity annually**.
2. Monthly energy production reaches **over 150 thousand kWh**.
3. The university saves approximately **153 million UZS per month**.
4. The annual financial benefit reaches approximately **734 million UZS**.
5. Renewable energy significantly reduces carbon emissions and dependence on fossil fuels.

The results confirm that photovoltaic power plants are highly efficient in regions with high solar radiation such as southern Uzbekistan.

Conclusion

The study analyzed the technical parameters and economic indicators of the 510 kW solar photovoltaic power plant installed at Karshi State University. The research shows that solar energy systems provide significant economic and environmental benefits.

The results indicate that the solar power plant produces a substantial amount of electricity and significantly reduces the university's energy costs. The economic analysis demonstrates that investments in solar power technology can be recovered through electricity savings and potential energy sales.

Furthermore, the installation of solar power plants in educational institutions plays an important role in promoting renewable energy technologies and supporting scientific research.

In conclusion, the development of photovoltaic power systems in Uzbekistan is an effective strategy for ensuring energy security, reducing greenhouse gas emissions, and promoting sustainable development.

References:

1. International Renewable Energy Agency (IRENA). Renewable Energy Technologies.
2. Duffie J.A., Beckman W.A. Solar Engineering of Thermal Processes.
3. Messenger R., Ventre J. Photovoltaic Systems Engineering.
4. Uzbekistan Energy Development Strategy Reports.
5. Solar power plant operation principles and technologies.
6. Renewable energy development in Uzbekistan.
7. Solar panels installed at Karshi State University economic benefits.
8. Grid-connected photovoltaic systems operation principles