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ANALYSIS OF THE PROCESS OF GENERATING ELECTRICITY USING SOLAR PANELS.

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Abstract. *This article reviews the latest advancements in solar panel technology, focusing on improvements in efficiency and cost-effectiveness. It covers new materials, such as perovskites, and innovative applications, including integration into buildings and large-scale solar farms. The article also addresses environmental impacts and the challenges of production scaling and geographic limitations. The goal is to highlight key progress and future directions in the field of solar energy.*

Key words: *solar panels, renewable energy, photovoltaic cells, sustainability, clean energy, electricity generation, solar power, environmental impact, energy efficiency, cost savings.*

АНАЛИЗ ПРОЦЕССА ПОЛУЧЕНИЯ ЭЛЕКТРОЭНЕРГИИ С ПОМОЩЬЮ СОЛНЕЧНЫХ БАТАРЕЙ.

Аннотация. *В этой статье рассматриваются последние достижения в области технологий солнечных панелей с упором на повышение эффективности и рентабельности. Он охватывает новые материалы, такие как перовскиты, и инновационные применения, включая интеграцию в здания и крупномасштабные солнечные фермы. В статье также рассматриваются воздействие на окружающую среду, проблемы масштабирования производства и географические ограничения. Цель – осветить ключевые достижения и будущие направления в области солнечной энергетики.*

Ключевые слова: *солнечные панели, возобновляемые источники энергии, фотоэлектрические элементы, устойчивость, чистая энергия, производство электроэнергии, солнечная энергия, воздействие на окружающую среду, энергоэффективность, экономия затрат.*

I. INTRODUCTION

Solar power generation is becoming an increasingly important component of the energy strategy of many countries. This is due to increasing pressure on environmental sustainability and the desire to diversify energy sources. This article examines various aspects of solar energy use in Uzbekistan, including the current situation, potential for development, and the main types of solar energy systems. We will also discuss various approaches to organizing solar energy systems, such as grid-tie, off-grid and hybrid systems.

We conclude with recommendations for using IoT-based monitoring technology to improve power generation efficiency. The use of such technologies will allow for constant monitoring and optimization of the operation of solar panels, which will significantly increase their performance and reliability. These measures not only help increase the efficiency of solar energy use, but also create a more sustainable and manageable energy system.

II. RELEVANCE OF THE WORK

Uzbekistan has seen significant growth in installed solar panel capacity in recent years, driven by active efforts to stimulate the development of renewable energy sources and diversify

the energy sector. Uzbekistan is committed to accelerating the development of solar energy by investing in solar energy projects and taking strategic measures to develop the sector. This strategy is a key energy priority and aims to achieve long-term sustainability and reduce dependence on traditional energy sources. Germany, China, the USA and India are important geographical areas showing high interest in solar energy. These countries play a key role in the global development of solar energy, which is reflected in both the production of solar panels and the overall consumption of solar energy.

Uzbekistan also has ambitious plans for the introduction of solar energy. The country aims to have up to 30% of its electricity generation come from renewable energy sources by 2030. Given the favorable climatic conditions for solar energy, Uzbekistan has significant potential in this area.

It is important to note that the gross and technical potential of solar energy in Uzbekistan represents significant figures, which indicates the possibility of using solar energy as an important source of energy in the country. This means that using existing technologies and infrastructure it is possible to significantly increase the share of solar energy in Uzbekistan's energy mix.

The absolute value of the annual energy of solar radiation falling on the territory of Uzbekistan exceeds the energy potential of the known reserves of carbon raw materials in the country. However, at the moment only a small part of this potential, just 0.6 million tons of oil equivalent, is used for electricity generation using solar energy, representing only 0.3% of the total technical potential.

Among the territories of Uzbekistan, the most promising for the implementation of projects for the construction of solar power plants are the Bukhara, Kashkadarya, Surkhandarya and southern parts of the Navoi regions, where the average global temperature radiation is 2028 kW/hour per year per square meter.

In 2022, electricity production in Uzbekistan increased by 15.3 billion kilowatt-hours compared to 2016, which is 25.9 percent.

III. MODELS OF ORGANIZATION OF SOLAR ENERGY SYSTEMS

1. **Grid-tie inverter:** An on-grid system is connected directly to the electrical grid. Solar panels generate energy, and this energy can be used at home or sent back to the grid if there is excess. This system does not have a battery for backup power, which means that if there is a power outage, the system will not be able to operate as it depends on the connection to the grid.

2. **Off-grid:** An off-grid system is designed to operate without being connected to an electrical network. Typically such systems include batteries that store energy for use at any time, including during power outages. An inverter converts direct current (DC) into alternating current (AC), which is used to power household appliances. A standalone type system offers greater independence, but requires proper battery management and additional equipment.

3. **Hybrid:** Hybrid systems combine elements of grid and autonomous systems. They include a battery and can be plugged into the mains. In a hybrid system, the inverter can send energy to the grid when the battery is fully charged, or use energy from the battery when the grid is unavailable. Built-in MPPT (Maximum Power Point Tracking) optimizes battery charge. Hybrid systems provide greater flexibility, allowing you to take advantage of both types of systems.

IV. SOLAR ENERGY MONITORING SYSTEM USING IOT

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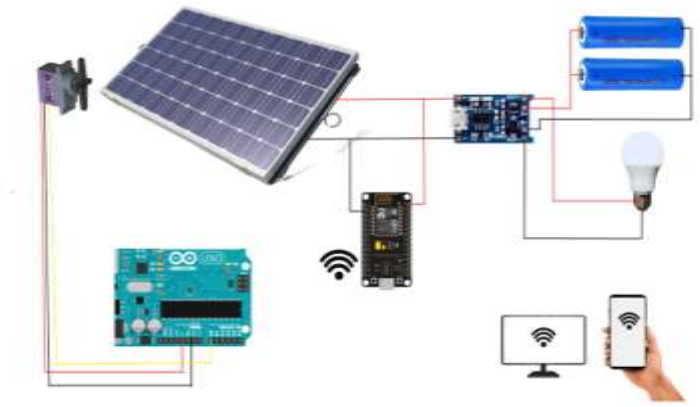
Applications of the Internet of Things concept include the implementation of various projects such as solar cities, smart villages, microgrids and solar street lights. In the context of the rapid development of renewable energy sources, a system for online monitoring of solar energy consumption is proposed as one of such sources. Intelligent analysis of data on the use of renewable energy sources allows users to effectively manage their energy consumption, which in turn influences the expansion of the use of renewable energy sources and solving problems associated with electricity supply.



Picture 3. "Solar panel control scheme using IoT technologies and a solar tracking system."

The implementation of this system includes several key components and processes which are shown in Figure 3.

Monitoring and Data Transfer: The ESP8266 module analyzes the current level of energy received from the solar panel and transmits this data via Wi-Fi to a central database. This database is available for analysis on smartphones or computers.

Charging and Power: The energy collected by the solar panel is sent to the TP4056 charging board, which is responsible for charging the lithium-ion battery. This charged battery in turn powers the LED bulb, providing constant illumination.

Optimized Efficiency: The MG90S servo motor, controlled by an Arduino Uno, actively controls the angle of the solar panel to ensure it is optimally positioned relative to the sun. This process improves the energy efficiency of the entire system, maximizing solar energy collection.

In this way, the system ensures continuous monitoring and optimization of solar energy use, making it efficient and environmentally sustainable.

Table 1. Description of solar panel control devices using IoT technologies

1 Solar panel main source of energy

2 The ESP8266 module analyzes the current energy received from the solar panel and transmits the data via Wi-Fi to a database for further analysis using a smartphone or computer.

3 The TP4056 charging board receives electricity from the solar panel and transfers it to the lithium-ion battery.

4 The lithium-ion battery stores energy for later use.

5 The LED lamp is powered by a lithium-ion battery.

6 MG90S servo motor rotates the solar panel at right angles to the sun to improve efficiency.

7 Arduino Uno Controls the direction of the servo motor to provide sun tracking.

It is important to note that the application of the Internet of Things concept to renewable energy sources such as solar energy plays a key role in improving the efficiency and sustainability of energy supply. The implementation of an online monitoring and optimization system for solar energy consumption through IoT technologies demonstrates the potential of this approach to improve energy resource management and promote environmental sustainability.

Conclusions

The introduction of solar panels with modern monitoring systems represents an effective and strategic approach to the production and management of electricity. These systems not only help reduce energy costs and reduce the load on the electrical grid, but also provide the ability to control and optimize your energy needs.

The operating principle of such a system is based on monitoring the current energy produced by the solar panel and transmitting the data to a database via Wi-Fi for further analysis. Electricity from the solar panel charges a lithium-ion battery, which powers consumers such as an LED lamp. At the same time, the servo motor rotates the solar panel at the optimal angle to the sun, increasing its energy efficiency.

Such systems ensure stable and reliable operation of solar installations and also promote awareness of energy conservation and energy efficiency. Overall, they represent a promising and environmentally sustainable solution to today's energy needs, helping to create a more sustainable and efficient energy system.

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