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МОДЕЛЬ ОЦЕНКИ ЭНЕРГИИ СОЛНЕЧНОГО ИЗЛУЧЕНИЯ

Выходная мощность фотоэлектрических (ФЭ) систем во многом зависит от угла наклона солнечного модуля. Максимальную мощность ФЭ станции можно получить, если модули установлены под оптимальным углом. Описывается математическая модель для оценки энергии солнечного излучения на наклонной поверхности.

Ключевые слова: угол наклона, мощность солнечного излучения, наклонное излучение.

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A MODEL FOR ESTIMATING THE ENERGY OF SOLAR RADIATION

The output power of solar photovoltaic (PV) systems strongly depends on the tilt angle of the solar PV module. The maximum output power of a PV plant can be obtained if the PV modules are placed under the optimal tilt angle. A mathematical model for estimating the solar radiation on the tilted surface is presented.

Keywords: tilt angle, solar radiation power, tilted radiation.

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THE ANALYSIS OF SOLAR ENERGY DEVICES' MONITORING SYSTEMS

To investigate the characteristics and control the operating modes of solar power equipment, it is necessary to develop automated remote monitoring systems. This is a very important question and deserves the special attention of specialists in solar energy systems. In this paper, for some monitoring systems, a comparative analysis is implemented and the advantages and disadvantages of each system is discussed.

Keywords: solar energy, monitoring system, solar devices, comparative analysis.

Introduction. There are many companies presenting monitoring systems for solar energy devices. The main type of solar energy device which directly generates electricity is the photovoltaic cell, sometimes called a solar cell. They can be fixed-position PV panels, one or two axes of sun tracking panels, concentrator PV devices, concentrator thermo-electric transducer systems, etc.

Experimental setup and procedure. The following monitoring systems of solar energy devices are investigated:

- Chorus PV
- RMS-200
- Pure Energies
- Siemens PV Monitoring
- SolarEdge PV

The CERNUNNOS Company presents The Chorus PV system which helps people use their generated electricity as efficiently as possible. It is connected to the generation meter using an LED reader, and to the electricity supply using an LED reader and CT clip. These meter imported and exported electricity between the house and the grid. All data is then sent to the display, which shows – clearly and simply – all generation and consumption. The Chorus PV is a premium in-home display for tracking microgeneration and consumption. It provides a flexible platform with a color touchscreen and an intuitive graphical user-interface. The Chorus PV encourages ultimate efficiency through the display and a unique online web service, energynote that draws in consumers by inspiring and educating. The Chorus PV is easy to install it freely. It works with most generation meters and pulse output electricity meters (excluding where the electricity meter's LED pulse output flashes both on import and export) and the wireless sensors supplied mean that no additional wiring is required [1].

The EtherTek Circuits' RMS-200 remote monitoring system has been specifically designed for solar sites. The RMS-200 remote site monitoring board has a five-zone burglar alarm that can be used to alert you about solar panel tampering and removal. Knowing the time when your solar panels were removed, the police will have valuable information for apprehending the criminals. In fact, it is often the first question the police ask. Being alerted about the solar panel removal, one can have valuable time to visit the location and perhaps stop or scare away the criminals himself [2].

The presented by the Pure Energies monitoring system is concentrated on the system maintenance. One of the great things about the grid-tied solar system is that it is less maintained. There are no moving parts, so if designed correctly, there are only a few things you need to do to keep churning out free solar energy: Dusty solar panels will decrease solar output. Depending on Customer's roof and solar configuration, Customer might even be able to do this with an extended mop, extended squeegee, and a garden hose without getting on to the roof [3].

For highest profitability from photovoltaic plants, reliable operation and dependable forecasting are key requirements and the only way to ensure that the energy generated be marketed as effectively as possible. Siemens PV Monitoring Solutions fulfill these requirements and make plant performance fully transparent for operators – regardless of location, and in real time. This transparency allows operators to take immediate measures in the event of an outage in order to minimize yield losses [4].

The web-based SolarEdge monitoring portal provides enhanced PV performance monitoring and yield assurance through immediate fault detection and alerts at module level, string level and system level. No hardware or wiring is required to transmit data from the power optimizers to the inverter: the monitoring sensors and transmitters are built into the SolarEdge power optimizer and solar inverter, and measurement data is transmitted over the regular power lines. [5]

Results and discussion. All systems mentioned above have some advantages and disadvantages. In the *Table 1* the main advantages and disadvantages of each product are demonstrated.

Table 1

	Advantages	Disadvantages
Chorus PV	• Web based remote monitoring • Wireless sensors – no need to run extra cabling	• There is no report generation
RMS-200	• Simple to use • Cost effective	• Can't be used in industrial environment
Pure Energies	• Can be used for education • Web based remote monitoring	• It is necessary to buy third party hardware
Siemens PV Monitoring	• Web based remote monitoring • Reliable forecast • System downtime monitoring	• Absent mobile application • It is expensive
SolarEdge PV	• A display of all installations on a map • Web based remote monitoring	• Designed specifically for home use

In *Table 2* all main features per product are demonstrated.

Table 2

	Chorus PV	RMS-200	Pure Energies	Siemens PV	SolarEdge PV
Real Time Monitoring	✓	✓	✓	✓	✓
Historical Trending and analyzing	✓	✗	✗	✓	✓
Reliable forecast of energy generation	✗	✗	✗	✓	✗
Alarm and Event monitoring and notification	✓	✓	✓	✓	✓
Report Generation	✗	✗	✗	✓	✓
Remote monitoring	✓	✓	✓	✓	✓
Mobile application	✓	✗	✓	✗	✗
Calculation of CO2/money saved ratio	✓	✗	✓	✗	✗
System downtime monitoring	✗	✗	✗	✓	✗

Conclusion. Thus, the Chorus PV, RMS-200, Pure Energies, Siemens PV Monitoring and SolarEdge PV monitoring systems of solar devices have the following disadvantages:

Chorus PV: There is no report generation,

RMS-200: It cannot be used in industrial environment

Pure Energies: It is necessary to buy third party hardware

Siemens PV Monitoring: The system is expensive

SolarEdge PV: It cannot be used in industrial environment

It is planned to solve these problems during future work.

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Տ.Ա. ՀԱՄԲԱՐՁՈՒՄՅԱՆ

ԱՐԵՎԱՅԻՆ ԷՆԵՐԳԵՏԻԿ ՍԱՐՔԱՎՈՐՈՒՄՆԵՐԻ ՄՈՆԻՏՈՐԻՆԳԱՅԻՆ ՀԱՄԱԿԱՐԳԵՐԻ ՎԵՐԼՈՒԾՈՒԹՅՈՒՆ

Արևային էներգետիկ սարքավորումների բնութագրերի ուսումնասիրության և աշխատանքային ռեժիմների կարգավորման համար անհրաժեշտ է մշակել ավտոմատացված մոնիթորինգային համակարգեր: Այս հարցը ունիկարևոր նշանակություն և արժանի է համապատասխան մասնագետների ուշադրությանը: Իրականացվել է որոշ մոնիթորինգային համակարգերի համեմատական վերլուծություն, քննարկվել են դրանց առավելություններն ու թերությունները:

Առանցքային բաներ. արևային էներգիա, մոնիթորինգային համակարգ, արևային սարքավորումներ, համեմատական վերլուծություն:

Т.А. АМБАРЦУМЯН

АНАЛИЗ СИСТЕМ МОНИТОРИНГА СОЛНЕЧНЫХ ЭНЕРГЕТИЧЕСКИХ УСТРОЙСТВ

Для исследования характеристик и регулирования режимов работы солнечных энергетических устройств необходимо разработать автоматизированные системы мониторинга. Этот вопрос имеет важное значение и заслуживает большого внимания специалистов солнечных энергетических систем. Проведен сравнительный анализ некоторых систем мониторинга, обсуждены преимущества и недостатки каждой системы.

Ключевые слова: солнечная энергия, система мониторинга, солнечные устройства, сравнительный анализ.