Study on main characteristics of HANWHA solar panels

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Abstract. In this article a Korean-made HANWHA solar panel is considered. Scientific research has been carried out in the first photovoltaic plant since this type of solar panels was installed at this plant. The scientific research based on the measurement, observation and monitoring methods were carried out in October 2022. It turned out that the characteristics of this solar panels are acceptable and can be used in the natural climate conditions of our country. But, in recent years the parameters of the characteristics of this panel have decreased. The average short circuit current value of this panel during the study was 3.5 Amps, which is about 60.18 % less than the nameplate value and the average power on the first and sixth day of the study was 99.60 and 91 Watt respectively, which differ by 8.63 %. After that the authors suggest that is necessary to increase the parameters of characteristics of this panels by applying new cleaning system.

1. Introduction

Today in this world there is a rapid development of energy sources due to the fact that they are becoming relevant and in the near future they will become important for supplying the population with consumers. Unlike hydropower and wind power which are also resource-saving and environmentally friendly, solar energy may be the key to the supply of electricity [1].

It is known that every second approximately 6 10^{11} kg of hydrogen is converted into helium and 4 10^{20} Joules of energy are released. The main part of this energy is scattered in the form of electromagnetic radiation from ultraviolet rays to infrared rays in the wavelength range of 0.2-0.3 microns. Therefore, sun can be considered as a huge source of energy [2]. The main source of solar energy is solar radiation flux density, which is commonly referred to as E (W/m^2). Solar radiation, to which the short circuit current and maximum ordinate power point of the solar panel is directly proportional, is observed almost every day, every hour, every minute, which once again confirms its huge potential [3].

It is known that more than 35% of households are located far from the centralized electrical network and supplying them with thermal and electrical energy is a complex technological process and the use of solar energy here very acceptable and convenient, since the main components of solar energy are solar panels and solar collectors, which are very convenient for operation [4]. They are different types of solar panels whose solar cells are made from different types of semiconductors. Due to problems with maintaining the stability of individual functional layers of perovskite solar cells about 85 % of solar panel are made from semiconductors silicon [5].

In modern conditions finding ways to increase their efficiency even by 1-2 % is an urgent task, especially when there is a disadvantage such as high cost [6-8]. Since all modules without exception are subject to degradation mono or polycrystalline resulting in reduced energy efficiency [9]. But above technological problems will find their optimal solutions in the future, for this, measures and decisions must be taken. So that in our country a number of resolutions are adopted for example, the Decree of the President of the Republic of Uzbekistan of 21.09.2018. No. UP-5544 “On approval of the Strategy of innovative development of the Republic of Uzbekistan for 2019-2021 years” became a significant impetus for the widespread introduction renewable energy sources according to which the share of electricity generation from renewable energy sources will be increased by at least 20 % by 2025, according to Decree of the President of the Republic of Uzbekistan of 22.08.2019. No. PP-4422 “On accelerated measures to improve energy efficiency of economic sectors and the social sphere, the introduction of energy-saving

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technologies and the development of renewable energy sources" the share of electricity generation from renewable energy sources will be increased by at least 25 % by 2030. To achieve these goals solar power plants with a capacity of 5 GW will be built [10-13].
But it should be not taken into account that during the operation of the joint solar panels and solar station various inconveniencies and technological problems arise which is most cases lead to an energy efficiency indicator although the solar power plant is acceptable this does not mean that is ideal. So that, it is required to periodically inspect, test and also study their characteristics [14-17].

2. Materials and methods

The authors of the study were carried out in October 2022 at the first photovoltaic station that was built Namangan region (40^0 $51^{|}$ $28^{||}$ N, 70^0 $57^{|}$ $39^{||}$ E) in 2015 under the name "KOREA-UZBEKISTAN PV TEST BED" which is shown in Figure 1 and scientific studies were based on monitoring, measurement and observation methods. At this station 4 types of Korean made solar panels were installed, we only consider HANWHA solar panel.
Panels of this type are manufactured by HANWHA SOLAR, so their name comes from the manufacturer, which is vertically integrated manufacturer of photovoltaic modules designed to meet the needs of the world's energy consumer. Table 1 presents the mechanical characteristics, Table 2 presents temperature characteristics, and Figure 1 shows the general view of the HANWHA solar panel. It is clear from the below tables and above figures that solar module is equipped with solar cable 4 mm^2, serving a temperature range from -40 to 90^0 C.
The connectors have specified polarities, they are marked with + and – signs. Cable and plugs are must be in good electrical and mechanical condition and the connection is safe and tight. Connectors must not be exposed to direct rain or laid in water drains.
Accordingly, the values of short circuit current I and open circuit voltage U marked on the module should be multiplied by a factor of 1.25 when selecting electrical components voltage ratings, conductor capacities, fuse type and type of control components connected to the PV output. The maximum series fuse rating is 15 A for modules this type of modules 156 x 156 mm cells.

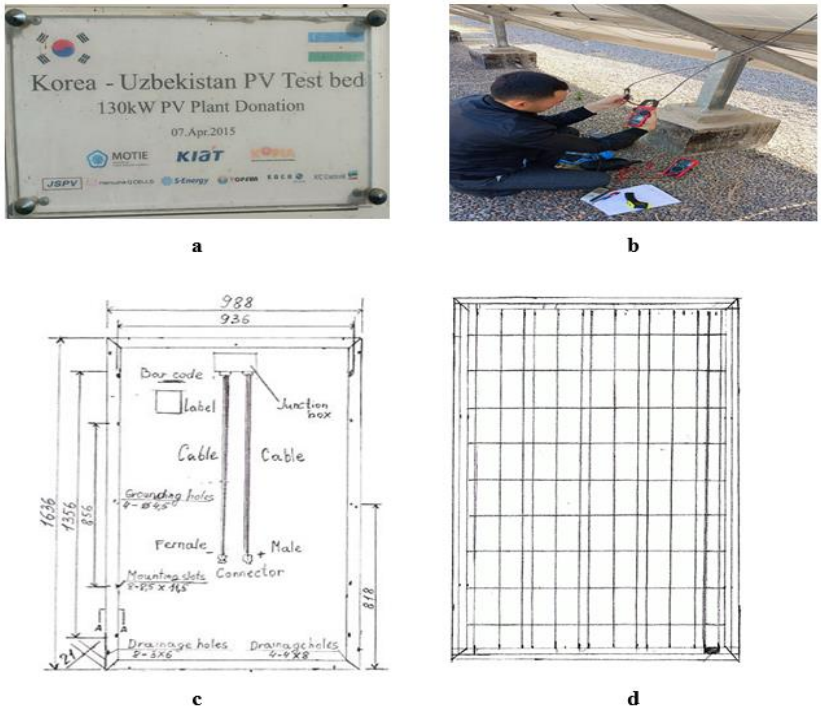

Figure 1. (a) Solar photovoltaic plant; (b) The process of measuring parameters during the study; (c) Panel rear view; and, (d) Panel front view

This type of panels equipped bypass diodes which provide proper circuit protection for system and the use of a diode to bypass the shaded area can minimize both heating and array current reduction. The cable from the junction box

made to the mounting substructure with nylon line, to avoid direct contact of the cable with the back surface of the module.

Table 1. Mechanical characteristics of Hanwha solar panel.

Name of parameters	Value
DIMENSIONS	1636*988*40 mm
WEIGHT	19±0.5 kg
FRAME	Aluminum alloy
FRONT	3.2 mm
ENCAPSULANT	EVA
BACK COVER	Composite sheet
CELL TECHNOLOGY	Polycrystaline
CELL SIZE	156mm x 156 mm (6 in x 6 in)
NUMBER OF CELLS	60 (6x10)
JUNCTION BOX	IP 67 with 3 bypass diodes
SOLAR OUTPUT CABLES	4 mm^2 1000 mm
CONNECTOR	Amphenol H4

Table 2. Temperature characteristics of Hanwha solar panel.

Name of parameters	Value
NORMAL OPERATING CELL TEMPERATURE (NOCT)	45^0C + / -3^0C
TEMPERATURE COEFFICIENTS OF P	- 0.43 % / ^{0}C
TEMPERATURE COEFFICIENTS OF V	- 0.31 % / ^{0}C
TEMPERATURE COEFFICIENTS OF V	+ 0.05 % / ^{0}C

Also, this solar panel is designed to full fill the criteria of Application Class A requirements. Rated electrical characteristics are within 10 % of measured values at standard test conditions of: 1000 W/m^2, 25^0 C cell temperature and irradiance of AM 1.5 spectrum.

3 Results and discussion

In order to find out the current state of the modules during the study some parameters of the HANWHA solar were obtained by measurement. Table 3 shows the obtained parameters during the scientific study.

Table 3. Current parameters of the Hanwha solar panel

Time t, hour	Solar radiation E, W/m^2	Open circuit voltage U_{oc}, V	Short circuit current I_{sc}, A
9:15	111.1	34.29	1.1
10:15	632	33.68	6.3
11:15	665	33.32	6.53
12:15	652	33.26	6.14
13:15	607	33.41	5.44
14:15	495	33.60	3.86
15:15	348	33.74	2.43
16:15	105	32.8	0.54
17:00	44	31.81	0.37

The tables shows that the parameters are much different from the catalog parameters, this is primarily due to the fact that the station does not have a solar panel cleaning system, because of this the surface the modules is heavily pollutted over time and on the territory where station is located the dust content often becomes higher than normal and this can be seen from Figure 2.

Fig. 2. Current state HANWHA solar panel.

Also, from the date obtained during the study the power generated by the HANWHA solar module during the on different days was calculated by the mathematical method and for comparison a graph of the power differences was built on program, which is shown below (Figure 3).

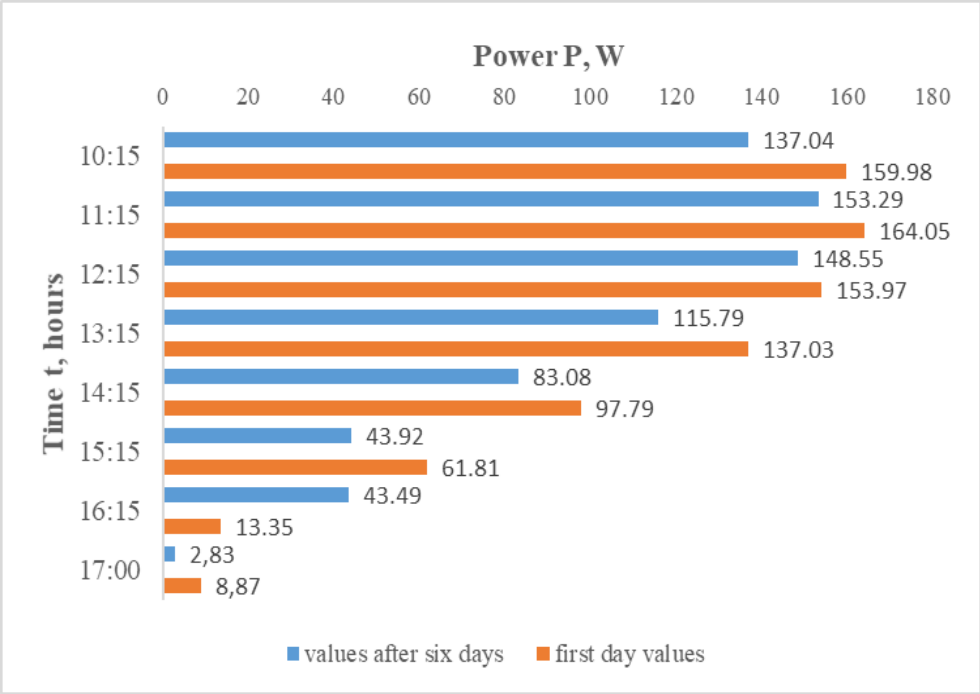

Fig. 3. Power difference graph.

It is not difficult to understand from the graph that the power generated by the module decreases over time, as a result of which the energy efficiency of the station itself also decreases. When the calculating the powers by the mathematical method the fill factor ξ was taken equal to 0.754 for all calculations and the density of the solar radiation flux E on the first and sixth day by the clock was conventionally assumed to be equal to each other. This is done to make comparison easier. For example, at 11:15 o'clock, when the solar radiation flux density E is of great importance the power on the first day was 164.05 W, on the sixth day 153.29 W. If we compare these values, the power on first day is 6.55 % less than the power on sixth day. At 17:00, the power measured on the first day is 8.87 W and on the sixth day it is 2.83 W, which is 68.09 % less. This value is very unacceptable, since if each solar panel produces less power by 68.09 %, then the energy efficiency of solar panel itself will decrease significantly, this is extremely unacceptable, especially when the trend in electricity demand every year is only growing. So that, it is required to periodically clean the surface of the panels, test and monitor to analyse their condition.

3. Conclusions

Thus, from the above we can conclude that renewable energy sources, namely solar energy, in the near future it is possible to cover the entire spectrum of the energy industry, since it has many advantages alon other inexhaustible

energy sources. Decree of the President of the Republic of Uzbekistan serve for the widespread introduction of alternative energy sources in the country in order to provide energy to all segments of the population without harming the environment and ecology, also improve the energy security of the country.

The HANWHA solar panel studied above is one of the modern modules and its mechanical and thermal characteristics are acceptable and applicable to the natural-climate conditions of our country. However, the authors, conducting scientific research found that the current state of these modules has deteriorated significantly, primarily due to the lack of a panel cleaning system, so its devise and application is essential for this photovoltaic power plant. The power generated by the module at 11:15 am on the six day of the study was 164.05 Watts and on the first day it was 153.29 Watts, which is 6.55 % less. This is due to the fact that additional dust and dirt accumulated on the surface of the panels within 6 days, which have a negative impact on characteristics parameters. The average short circuit current value of this panel on the sixth day of the study was 3.5 A, which is 60.18 % less than the rating value and the average power on the first and sixth day of the study was 99.60 and 91 Watt respectively, which differ by 8.63 %. If the surface of the modules is not cleaned, then this value can certainly increase, as a result of which the power of the station supplied to the network will decrease, which can lead to a lack of energy to some extent.

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