

The Impact of Utilization The Solar-Panels With a Cooling-Water System as a Source of Micro-Power Generation

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Abstrak

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Cara yang optimal untuk meningkatkan efisiensi serta menurunkan laju degradasi panel surya adalah dengan menekan suhu operasional area permukaan. Hal ini dapat dilakukan dengan mendinginkan panel/modul dan menurunkan panas yang tersimpan di dalam solar sel selama operasi berlangsung. Pada penelitian ini menggunakan metode eksperimental. Panel surya berkapasitas 100 WP sebagai sumber pembangkit listrik tenaga mikro, sudut kemiringan panel diatur dengan variasi 15^o, 20^o dan 25^o. Sistem pendinginan menggunakan air, proses pengaliran air menggunakan pompa submersible yang dipasang pada reservoir Air mengalir ke semua permukaan panel surya dan bersirkulasi secara terus menerus pada saat beroperasi. Hasil eksperimen menunjukkan bahwa proses pendinginan menggunakan air telah menurunkan tingkat temperature operasional panel surya. Penurunan temperatur rata-rata terjadi pada semua variasi sebesar 23%. Proses pendinginan sangat berdampak terhadap daya keluaran dan efisiensi operasional, sirkulasi pendinginan dapat meningkatkan skala insiden radiasi matahari pada panel surya karena efek pembiasan dari lapisan air, serta menjaga permukaan panel surya tetap bersih dari kotoran dan debu. Daya keluaran dan efisiensi operasional mengalami peningkatan hampir di semua variasi sudut kemiringan panel surya (15^o, 20^o dan 25^o), daya keluaran mengalami peningkatan rata rata 22% dan efisiensi mengalami peningkatan rata rata sebesar 2%.

Abstract

Keywords:

solar panels;
cooling systems;
power;
efficiency,

The optimal approach to enhance solar panel efficiency and decrease the degradation rate is to lower the temperature range of the surface area. It will be applied by allowing the panels/modules to be cooled and lessening the heat stored in the solar cells through an operation. In the research using experimental methods, the solar panels used have a capacity of 100 WP as a source of micro-power generation, the angle of inclination of the panels is adjusted with variations of 15^o, 20^o, and 25^o. The cooling system uses water, the process of draining water using a submersible pump mounted on a reservoir Water flows to all surfaces of the solar panel and circulates continuously when operating. The experimental outcomes show that the cooling process utilizing water has reduced the temperature operating of the solar panels. The decrease in average temperature occurred in all variations of 23%. The cooling process significantly affects the output power and operational efficiency; circulating cooling can increase the scale of incidents solar radiation on the solar panel due to the refractive effect of the water layer and keep the surface of the solar panel clean from dirt and dust. Output power and operational efficiency have increased in almost all variations in the angle of the solar panel tilt (15^o, 20^o, and 25^o), output power has increased by an average of 22%, and efficiency has increased by on average of 2%

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1. Introduction

Renewable energies are gaining popularity worldwide due to the adverse environmental effects of fossil fuels [1]. Because of its global availability, solar radiation is an ideal source of power. Sunlight can produce both thermal and electrical energies. A wide range of technologies has been used to create various applications. The use of solar cells power and heat systems has increased significantly over the years worldwide [2]. Numerous studies have been conducted to identify the impact of solar cells alignment and tilt on performance. Illustrated that the effective incidence angle is a perfect match for the latitude. Daily solar energy obtained by a solar photovoltaic module with a single wick east-west monitoring method was revealed to be 19–24% greater than by a fixed standard [3]. Another form of energy from the sun is intended to permanently adjust the collector's photovoltaic tilt angle and angle of rotation in a particular direction. These perspectives could be chosen to maximize solar irradiance each year or daily global solar insolation year-round. The fixed-collector method is frequently considered in terms of the more expensive solar module. Numerous researches have been operated to determine the ideal stable support for solar modules in various locations worldwide [4].

Tilt and azimuth angulation have an impact on the yearly solar irradiance of a fixed collector. A shape plot of the outer edge direction factor can visualize the relationship between tilt and azimuth angulation. It is calculated as the proportion of yearly solar irradiance received by a fixed surface that has been oriented explicitly compared to the daily average solar irradiance received by an ideally oriented fixed surface [5]. The issue of energy and the environment has sparked widespread interest all over the world. Researchers may use the multi-energy coupled system to generate new ideas for reducing fossil-based energy usage and emission levels Gas-based blended heating, power, and cooling systems can generate electricity while also producing heat, resulting in cascade energy resource utilization [6]. This technology has played an essential role in generating electricity and heat while emitting no greenhouse emissions. Thermal solar power systems have gotten a lot of attention in the last few decades. Many researchers have developed power sources, such as specific residences water and region heating [7][8].

The photovoltaic system involves converting radiant energy into electricity. A portion of the luminous power is transformed to heat can also be used for solar thermal applications. While high temperatures were indeed permissible in a thermal implementation, contents could be used. Furthermore, using extractors can help to reduce the immediate surface of PVT modules. Numerous studies on various aspects of the CPVT and CCHP frameworks have been published in the literature. As a result, the literature is organized into four major sections [9]. Solar energy is converted into other forms of energy for users via solar thermal concentrators and photovoltaic (PV) boards. Non-concentrating (stationary) and focusing tracking solar heat collectors are used to heating the liquid to various temperatures by permeating irradiance of the solar, whereas the Pv panel has to organizations quickly transform solar

radiation to electricity. DESs of solar support is equipped with a system of solar cooling [10].

The present paper aims to demonstrate solar-panel water cooling and irrigation purposes for residents of urban locations that require water pumping from wells. Cooling is required in solar panel implementations for several reasons: to improve the solar panel's lifetime and reduce the area of the solar module by increasing the module's output power. In the created cooling mechanism, water goes over the solar panel's upper surface. Circumvent water flow from either the water trap /irrigation pump-flows system straight down mainly on the top-side of the solar panel and is thus obtained through an outlet connected to the irrigation flow at the solar panel's lowest part. The gain of that kind of cooling mechanism has been that it excludes the need for a systemic circulation pump but instead expands radiant energy through water layer deflection.

2. Method

2.1. Solar-panel energy systems.

Renewable resources have a significant role in the future energy divestment case due to their environmental friendliness. Solar energy, for example, is easily obtainable alternative energy. A photovoltaic based on the solar system can be categorized according to its application as an on-grid or off-grid system. Solar radiation affects photovoltaic modules with varying slope angles (30^0 - 50^0) for comparison purposes. In the research, a 100 Wp solar module has been used. This study considers the slope angle of the module and the weather patterns, such as sunshine or cloudy situations. A significant analysis is conducted on the solar-cell performance at similar temperatures from 28 to 50 degrees Celsius [11].

Solar radiation is a term that refers to the electromagnetic energy that the sun emits and that the earth receives. Solar energy is made up of photons of solar energy particles that have been converted to electrical power. Solar showing up at the earth's surface is called global solar irradiance, quantified by the receiving area's surface energy output. As measured by a solar constant, the mean result of solar radiation striking the earth is 1.353 W/m^2 . The operating cycle of the rotation of the world has affected solar radiation. Cloud quantity and quality are considered to be weather conditions. In Indonesia, solar radiation intensity peaks between 4 and 5 hours [12]. Solar panels can convert solar radiation into electric power. Solar cells that are exposed to the sun will make photons that produce an electric current. In this study, we will analyze the efficiency level of using solar panels with a capacity of 100 Wp as a micro-power generation generator; the specifications for solar panels are shown in table 1.

Table 1. Specification of Solar Panel.

Indicator for Electrical Devices	Description
Power (P_{max})	100 W
Current (I_{mp})	5.49 A
Voltage (V_{mp})	18.2 V
Short CC (I_{sc})	6.00 A
Open CV (V_{oc})	22.1 V
Max. Voltage System	800 V _{dc}
Power Tolerance	±3%
Weight	8 Kg
Max. Series Fuse	10 A
Dimension (mm)	1005 x 665 x 30

2.2. The cooling system of solar-panel

Hybrid solar-cells/thermal (PV/T) solar systems were the most effective approaches to cooling solar cells. The mixed solution integrates photovoltaic solar panels with such a cooling system. The cooling analyst, which can be either water and otherwise air, was being distributed around the photovoltaic panels to cool the solar cells, allowing the hot water or air exiting the boards that could be used for residential uses such as heating and electricity. A hybrid photovoltaic/thermal solar method was discovered to refrigerate the solar-board by water to increase the solar panel's power output by nearly 50 percent. Additionally, They established what chilling the panel-solar discourages the increment temperature of the solar cells from exceeding 46°C upon four hours of absorption of solar radiation [13][14].

Solar module with a maximum power output of 100 W. The panel is connected to a variable resistance to determine the module's characteristic curve. Figure 1 shown. The solar charger detector controls the voltage and current flowing from the solar panel system to the battery's load. Water-powered submersible pump by a 24-volt direct current motor with approximately 80 liters per minute flow capacity and a hydrostatic head of 4 meters. The pump is placed inside a water tank in the shape of irrigation well. The packs of batteries (12-volt) will be set up to power the water pump while the indoor cooler is set up and the water flow rate is measured. A cooling water constantly coming arrangement is comprised of water slowly leaking tube (L=95 cm, D=2.54 cm) affixed to the solar panel's upper side, a water channel along on the bottom part of the panel (L=95 cm), and an ignore for cooling water supply via either a submersible pump or a circulating pump.

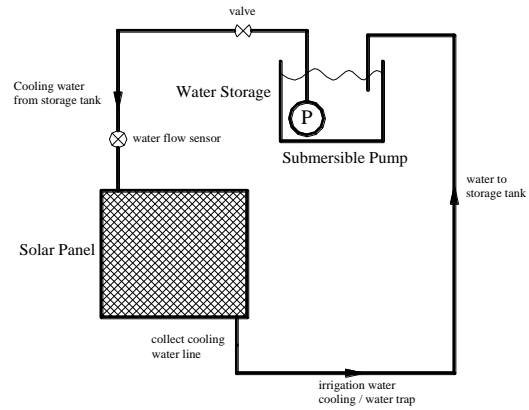


Figure 1. Configuration of a solar panel water pumping system.

2.3. Testing solar panel

The 100 WP capacity solar panel was tested on the rooftop of the ITATS Building. This test is carried out at the specified location and Time; the solar panel module testing time is 7 hours. The testing steps in solar panel research are shown in Figure 2 as follows, first, prepare solar panels that have been set with tilt angles of 15°, 20°, and 25°. Second; The battery is turned on, which will charge a current of up to 35 A when the solar panel's temperature rises. Third; Heat energy conversion into electrical energy will be channeled to the battery. Fourth; The solar panel will process a data logger (Arduino Microcontroller, Bluetooth receiver, solar charge controller, and memory card module) that records from Time to Time. Fifth; Testing is carried out for seven days from 09:00 to 15:00. Sixth, data loggers in voltage, current, and temperature values are calculated to find the input and output power. Seventh, the cooling process will work if the temperature sensor on the thermocouple shows more than 45 °C. The pump will turn on automatically, and water will flow from the reservoir to the solar panel.

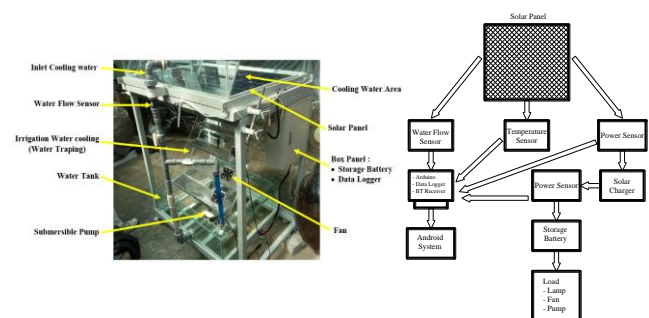


Figure 2. Test rig for solar panel with water cooling.

2.4. Research Process

This research work begins by collecting literature data from previous research and national or international journals related to the research used. Next is the planning, design, and installation of water cooling solar panels. The next stage is taking experimental data to test the performance of water cooling solar panels. If the tool is appropriate, proceed to the next stage, namely the analysis of the results of taking experimental data. The last stage is

drawing conclusions that contain statements taken briefly from the overall results of the discussion or analysis show figure 3. A literature review is the first stage carried out to find out the theories developed in each field studied. This is an essential reference for research. The literature review is carried out by exploring the material relevant to this research. Tool design develops tools, techniques, and methods to improve productivity and manufacturing efficiency. The goal of tool design is to reduce manufacturing costs by ensuring quality and boosting efficiency at the same time. Assembly compiles and unifies several parts into a tool or machine with a specific function. Assembly begins when the object is ready to be installed and ends when the object is wholly joined. Analyzing data is a method by which a group of people works together to discover connections among disparate sets of data, draw comparisons between them, find commonalities and differences, and build data models that can be used to make better decisions about the problems and research questions they have identified.

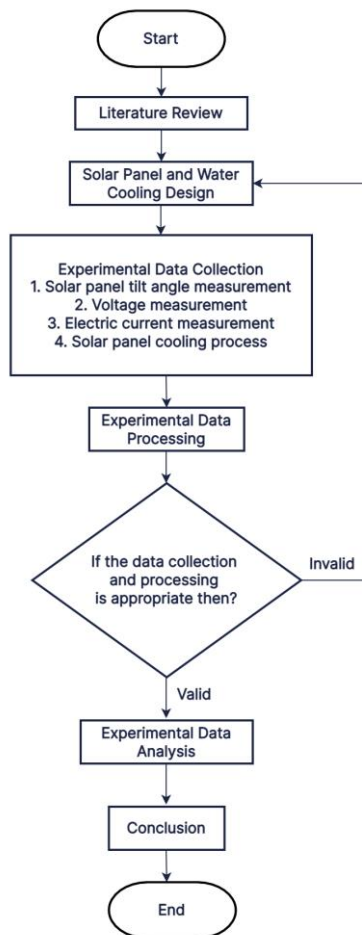


Figure 3. Research Process.

3. Result And Discussion

The cooling system on solar panels is essential for several reasons; namely, the cooling process on solar panels can increase the lifespan of solar cells and improve output power by degrading an area of the panel-solar. The technique of cooling carried out on solar panels is water

flowing over the surface, which is directly exposed to radiation [15]. This study shows the cooling phenomenon on solar panels. Figure 4 shows that the temperature will increase from 09:00 to 12:00, then the temperature will decrease when the afternoon arrives. The cooling effect can reduce the temperature level at all variations of the angle of inclination (15° , 20° , and 25°) by 25%, 24%, and 22% to the panel temperature limit. Circulation the cooling process overcomes excessive heat on the solar panels, and running water will clean the surface of the solar panels because dirt and dust attached to the solar cells' area will degrade the tier intensity of radiation and the percentage efficiency of the panels.

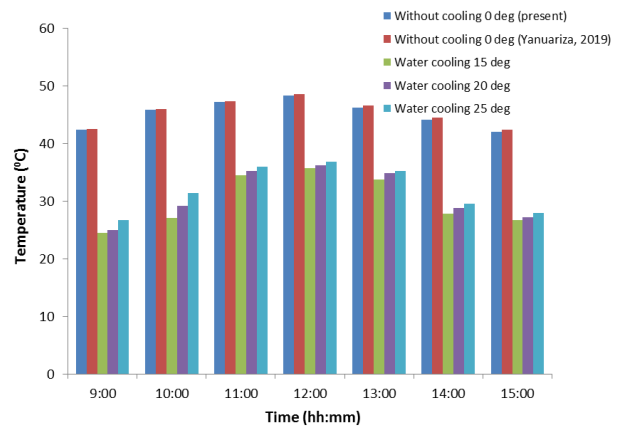


Figure 4. Temperature Varies to Time

Cooling models on solar panels are needed. It aims to cool solar panels at normal working temperature conditions of 35°C . The modeling of solar panel cooling produced the peak power output if cooling begins when the solar panel temperature reaches a maximum of 45°C , which is the optimal temperature limit when determining the board [16]. The output power is selected from the voltage across an open circuit, the current of a short course, and the fill factor on the solar panel. The value of efficiency was a measure or calculation of the power output compared to the power input, and It is the value of the intensity radiation on the surface area panels. The intensity radiation value is obtained from the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG) [13]. This study shows the difference in output power resulting from variations in the angle of inclination of 15° , 20° , and 25° with water cooling on solar panels. Figure 5 shows the value of the output power has increased starting at 09:00 to 12:00, almost all variations in the angle of inclination that are carried out have an increase in output power. It is the impact of an increase in solar radiation. On the other hand, data collection from 13:00 to 15:00 has decreased output power. The maximum output power generated occurs in solar panels with a height of 25° at 76 W per hour. The quantity of energy produced by the panels affects the value efficiency that arises. Figure 6 shows that the efficiency value is directly proportional to the output power value so that the power output increases and decreases will have an impact on the efficiency of solar panels. The maximum

efficiency has increased at a slope angle of 25° by 18%. This research has shown the effect of adding a cooling system that significantly affects solar panels' output power and efficiency. Temperature fluctuations can affect the performance of solar panels. The addition of this cooling system is very effective in stabilizing the temperature and keeping the cross-sectional area of the panels clean, so it does not affect solar radiation hitting the solar panels. This reason has been fully explained in the previous literature.

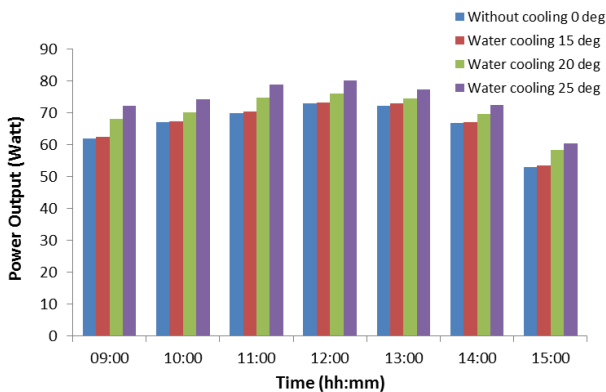


Figure 5. Power Output Varies to Time

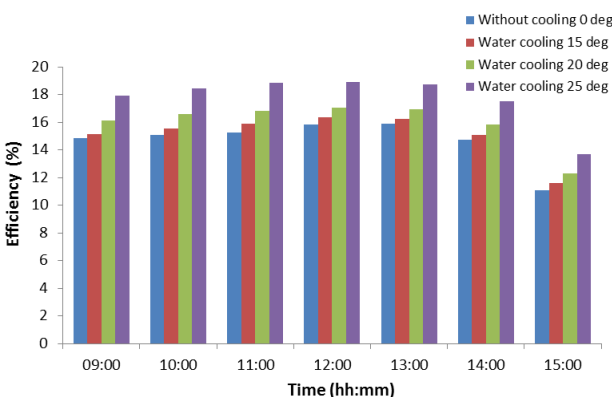


Figure 6. Efficiency Varies to time

4. Conclusion

The study explored the use of cooling systems on the surface of solar panels. Application of experiments on 100 WP solar panels with tilt angle settings of 15° , 20° , and 25° , the conclusions obtained is the cooling process can increase the radiation incident on the solar panels due to the refractive effect on the water layer. It will always maintain the maximum working temperature of the boards of solar. Due to the continuous flow of water, the cooling system will keep the surface area of the solar panels free of dust and dirt. The cooling water system affects to intensifies the efficiency and power output of the solar panels. It grows at variations on the solar panel angle 25° at noon when the solar of intensity radiation increases maximally. The cooling water system is straightforward and can be applied to all standard solar panels without significantly increasing costs.

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