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Effect of Weather and Environmental Conditions on the Performance Parameters of 3 Salient Photovoltaic at UTHM Johor

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Abstract: As is generally known, a multitude of production procedures are used to create PV panels today. Varying solar panel types react differently to environmental factors such as radiation, temperature, and wind speed. They also have different voltage and current values, spectrum responses, and temperature coefficients. However, the difficulty in this study is to examine the actual PV performance data to differentiate the information for the three main types of PV panels in order to determine the best panel. So, the purpose of this project is to review the three types of solar panel performance under real weather and environmental conditions and to identify the most suitable solar panel to be installed in UTHM. After installing all three solar panels, their performance parameters will be compared in order to choose which one is the most suitable to be installed in UTHM. The data will be collected every 15 minutes from 11:40 a.m. until 4:40 p.m and the experiment are only 5 hours. After the experiment has succeeded, the data collection from the memory card needs to transfer to Microsoft Excel to continue doing the analysis of this project. After the experiment was completed, data analysis was performed where for efficiency, monocrystalline recorded a better value while for performance ratio, polycrystalline had a better value. For OPE, thin films show a more stable graph than the others. However, for overall results, polycrystalline is the best panel compared to monocrystalline and thin film.

Keywords: Monocrystalline, Polycrystalline, Thin Film, Performance Parameters

1. Introduction

Renewable energy such as solar power generators is easily disseminated to homes, schools, and businesses, requiring no additional development or land space to assemble, and operate in a safe and quiet manner [1].

PV panels are manufactured nowadays using a variety of production processes, as is well known. Various types of solar panels have different spectrum responses, temperature coefficients, voltage and

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current values, as well as different reactions to environmental elementssuch as radiation, temperature, and wind speed. PV system efficiency is measured in a controlled laboratory environment at 25 °C and a radiation level of 1000 W/m2 by manufacturing firms [2]-[4]. However, the solar spectrum changes depending on location. Although it is known that energy efficiency and performance of PV panels change according to atmospheric conditions like temperature, radiation, etc., determining the best efficient panel type is an important criterion [5]. Evaluating different panel type technologies according to atmospheric conditions and selecting the most efficient panel types have been the subject of many studies [6]. It was the innovation that was developed to monitor, measure and control theenvironment parameters. During a one-year period in India, Sharma et al. tested p-Si, hetero- junction with instruction thin layer silicon (HIT) and amorphous single junction silicon (a-Si) modules in the solar energy center. They compared the energy efficiency and performance ratios (PR) with the measurements from the outside environment and simulation findings [7]. So, it can help the community to differentiate the potential of solar energy to generate electricity based on the environment and weather.

The two basic electrical characteristics used to characterize solar cells are the open-circuit voltage (Voc) and short-circuit current (Isc). When the whole produced photocurrent travelsthrough the internal diode, the voltage across the diode is called Voc. These two variables influence the temperature. Another aspect that influences how much electricity for solar panelproduces is their efficiency. The capacity of a panel to convert sunlight into useful energy is referred to as its efficiency. Performance ratio (PR) is a simple approach to convey system performance. It's the ratio of the power generated to the electricity that would have been generated if the plant continually converted sunlight to electricity at the DC nameplate rating.

2. Materials and Methods

2.1 Materials

There are several materials used in this project which are monocrystalline solar panels, polycrystalline solar panels and thin film solar panels as shown in Figures 1-5. The data logger is used to collect the reading of voltage and current for all the panels.

(a) Monocrystalline Solar Panel

Figure 1: Monocrystalline Solar Panel (425W)

(b) Polycrystalline Solar Panel

Figure 2: Polycrystalline Solar Panel (290W)

(c) Thin Film Solar Panel

Figure 3: Thin Film Solar Panel (100W)

(d) Data Logger

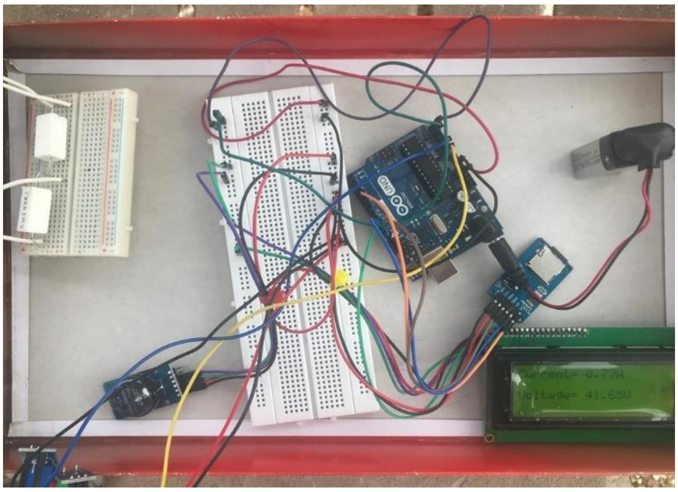

Figure 4: Data Logger

(e) Solar Irradiance

Figure 5: Solar Meter

2.2 Methods

The three data loggers will be set up with the right connection to read the value of voltage input and current. When solar panels generate the power, a current sensor and a voltagesensor will measure the voltage and the current for all those panels but for the connection, the voltage sensor will connect parallel with the solar panel while the current sensor is connected in series with the solar panel which is then all the values are stored in the memory card (micro-SD card). Moreover, a solar meter has been used in order to measure the value of solar irradiance. The data will be collected for every 15 minutes from 10 a.m. until 3 p.m which theexperiment is only 5 hours. This experiment was conducted on June 21, 2022. After the experiment has succeeded, the data collection from the memory card needs to transfer to Microsoft Excel to continue doing the analysis of this project.

2.3 Equations

Efficiency, Output Power Efficiency (OPE), Performance Ratio (PR), Fill Factor (FF),and Power are the key indicators for evaluating a PV module's performance. These important indices may be calculated using model equations using electrical and environmental characteristics as variables. The data logger is used to measure the electrical parameters (Vmax,Voc, Imax, Isc). The following are the model equations that must be used.

The power (P) can be determined by Eq (1)

$$P = V_{oc} \times I_{sc} \quad (1)$$

The module efficiency (η) can be obtained using Eq (2).

$$\eta = \frac{P_a}{Z_a \times A_M} = \frac{I_a \times V_a}{Z_a \times A_M} \times 100 \quad (2)$$

OPE and PR are obtained by Eqs (3) and (4) respectively.

$$OPE = \frac{P_a}{P_{max,STC}} \times 100 \quad (3)$$

$$\text{PR} = \frac{P_a \times Z_a}{P_{max,STC} \times Z_{STC}} \quad (4)$$

Next, FF can be considered the maximum power, short circuit current, and open-circuit voltageof a solar module, shown in Eq (5)

$$FF = \frac{V_{max} \times I_{max}}{V_{oc} \times I_{sc}} \quad (5)$$

3. Results and Discussion

3.1 Results

The graph in Figures 6.7 and 8 show the results for each parameter including efficiency, performance ratio and output power efficiency.

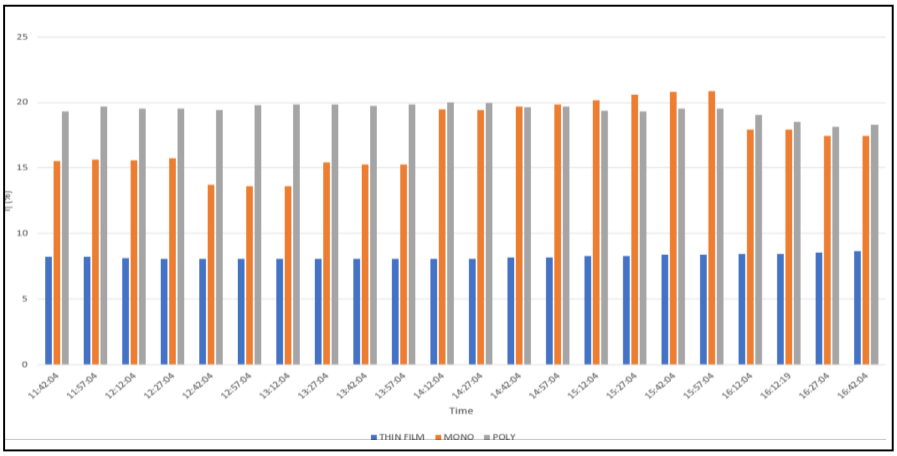

Figure 6: Efficiency of three different PV panel types

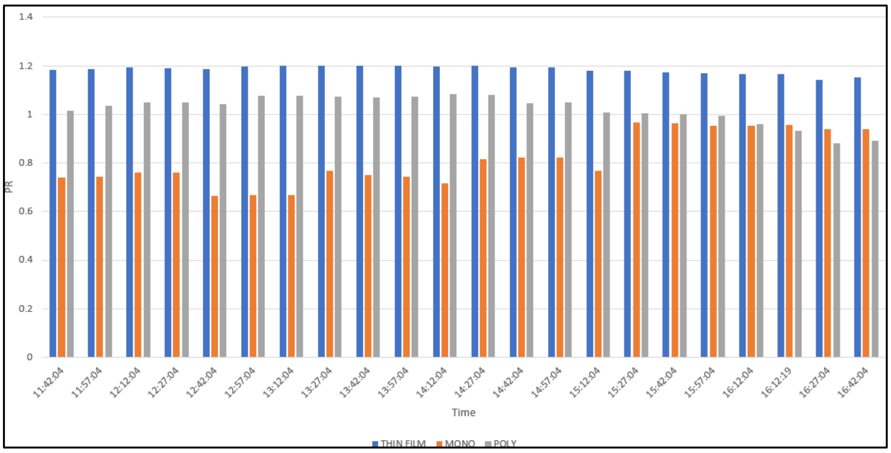

Figure 7: Performance Ratio of three different PV panel types

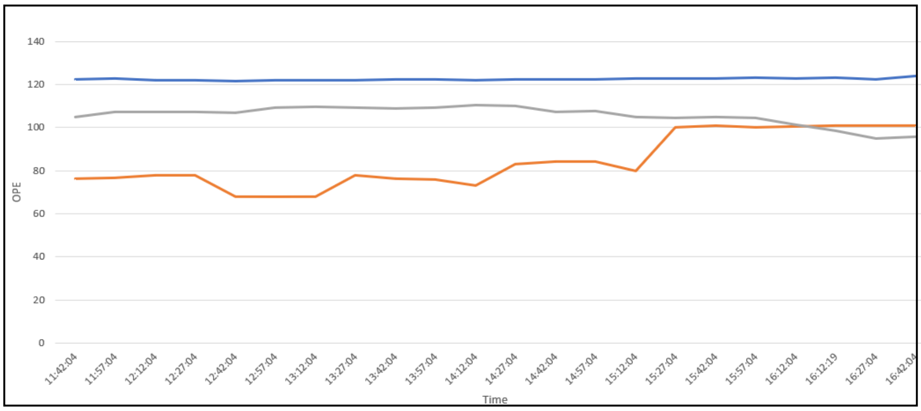

Figure 8: Output Power Efficiency of three different PV panel types

Based on Figure 6, the comparison between the efficiency of Monocrystalline, Polycrystalline, and Thin Film solar panels is shown in Figure 6. From the graph, it can be compared that polycrystalline has a higher efficiency from 11:42 AM until 14:27 pm which a value is 19.28%and it changes slowly but still at the same rate. After that, the efficiency of monocrystalline is increased while the thin film is having the lowest data of efficiency. It can be observed that thin film only got 8.36 %. So, it can be concluded that thin film has less efficient than monocrystalline and polycrystalline panels. Moreover, the graph shows that polycrystalline isthe most efficient but it should be monocrystalline panel because monocrystalline is cut froma single source of silicon crystals of high purity while polycrystalline is blended from multiplesilicon sources and this will impact their efficiency.

Figure 7 shows the comparison in performance ratio of three types of solar panels. Based on the graph, it can be observed that thin film has a higher PR compared to the other solar panels. The average value of PR for the thin film is 1.18. After that, followed by polycrystalline which has an average of PR 1.022 while monocrystalline got 0.81. This shows that thin film has a good PR because a highPR indicates a properly operating site or well-installed PV technology at the site.

Based on Figure 8, the Output Power Efficiency (OPE) for the thin film is the highest and more stable.Polycrystalline and monocrystalline are below the thin film. The value of OPE is in a range of 122-123, while in monocrystalline, the high OPE value is starting at 3:00 pm until 4:00 pm when the value is a hundred and above. It shows that the OPE of monocrystalline is increased but for polycrystalline, the value of OPE has decreased starting at 4:00 pm.

Based on Table 1, it shows the maximum, minimum and average value of performance parameters for all the panels. Monocrystalline shows the best efficiency even though its maximum efficiency is more than its manufacturer efficiency which around 19.8 %. So, it can be analyze that it relates with the temperature coefficient. When the temperature rises by one degree Celsius (33.8 °F), the temperature coefficient tells us how quickly solar panel efficiency will decrease. But this does not mean that polycrystalline solar panel have a lower quality. It is just because of their material properties, they have a lower conversion efficiency. Next, the more closely a PV panel's PR value is calculated to 100 percent, the more effectively that PV panel is functioning. Realistically, a number of 100% is not possible since operating a PV panel will always result in inevitable losses (e.g. thermal loss due to heating of the PV modules). However, high-performance PV panels may achieve performance ratios of up to 80%. Other than that, the output power of the PV module depends on solar irradiance and temperature. Increased solar radiation causes PV modules to produce more power. The other factors, such as temperature, current, and voltage, likewise risewhen the solar irradiation does, increasing the power output of the PV module. Based on theseresults, all panels are suitable for the installation in Parit Raja but from this project, polycrystalline solar panel is the most suitable because it has a better performance compared with the others

Table 1: The value of max, min and avg for three solar panels

	MONOCRYSTALLINE				POLYCRYSTALLINE				THIN FILM			
	η	PR	OPE	FF	η	PR	OPE	FF	η	PR	OPE	FF
Max	20.87	0.97	101.012	0.55	20.01	1.08	109.603	0.87	8.64	1.20	123.81	0.75
Min	13.58	0.67	67.88	0.81	18.11	0.88	94.80	0.75	8.05	1.14	121.44	0.74
Avg	17.31	0.81	84.25	0.68	19.43	1.02	105.68	0.84	8.23	1.18	122.47	0.74

4. Conclusion

A search for relevant journals and publications for the project will be the first step in the overall flow chart for how it will be prepared. After the proposed title, three different types of solar panels were selected. Then, to verify that the prototype works as planned and to ensure the performance of the solar panel, performing tests and correcting the damage that occurred before the final presentation and submitting a project report is essential.

Through the experiments that have been conducted, it is clear that objective 1 has been achieved because I was able to analyze the performance parameters for three different solar panels. For efficiency parameters, monocrystalline data change over time. This is because it depends on the temperature factor. Meanwhile, if the solar irradiance is high, then the temperature will be high and the power will also be high. This will affect the performance ratio and OPE for each panel as it depends on the weather and environmental conditions.

Next, through this experiment, the most suitable solar panel at UTHM can be determined. This may be due to differences in each panel's performance parameters. Although polycrystalline has a larger performance ratio, monocrystalline has a superior efficiency measure. Moreover, the thin film graph for OPE is more stable and steadier than the others. So, in conclusion, polycrystalline is the best panel for overall results compared to other panels.

Acknowledgement

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