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Performance Studies of Photovoltaic Power Output Through Reflector under Perlis Climate Condition in Perlis

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Abstract: In developing photovoltaic (PV) technology, it is necessary to develop the lower cost of PV power. One of the economical methods to increase power output is using the reflector method. Under this concept, the PV panel is attached with reflector. The reflector is attached facing east and west due to sun movement. So, the reflector can reflect the scattering sunlight onto the PV panel. Reading of power output was taken under different weather and different type of reflector. The experiment was undergoing in cloudy day and erratic day. In other hand, the installation of reflector must be considered to the PV panel temperature because the high temperature will affect the PV panel performance. The developed of reflector has several advantages compare to normal installation. From the experiment undertaken, by using mirror reflector, the mirror can produces 23.58% higher than fix position without reflector and 6% higher than aluminium. The installation of mirror is cheap, simple and not requires any require any additional equipment.

Keywords: solar photovoltaic; solar reflector; mirror reflector; cloudy day; erratic day.

1. INTRODUCTION

In the field of renewable energy, solar PV system is one of applying technology. One useful method to make the solar energy more competitive is installing the PV module with reflector in the system. Nowadays, the reflector system has been used to increase power output due to solar irradiance that harvesting. In order to harvest optimum solar irradiance, the suitable reflector design, types of solar module and chooses the optimum angle to increase the power output of a PV panel are necessary to study. The reflector will be placed under the different angle and focusing the sunlight onto the PV panel. This is a cost-effective way to produce clean and renewable energy that benefits our environment and health.

2. STRUCTURE OF MIRROR AND FRAME SELECTED

Mirror reflection form is simplest but it can increase the output from the PV. The frame for the mirror is using aluminium, thus the aluminium also can reflect the sunshine effectively [1]. The reflector size is design 55% from the panel size. Mirrors are attached with 10 watt panel with 0.5 cm gap. This is because to avoid the heat transfer from panel to reflector [2]. Figure 1 illustrates the dimension and measurement of the frame layout.

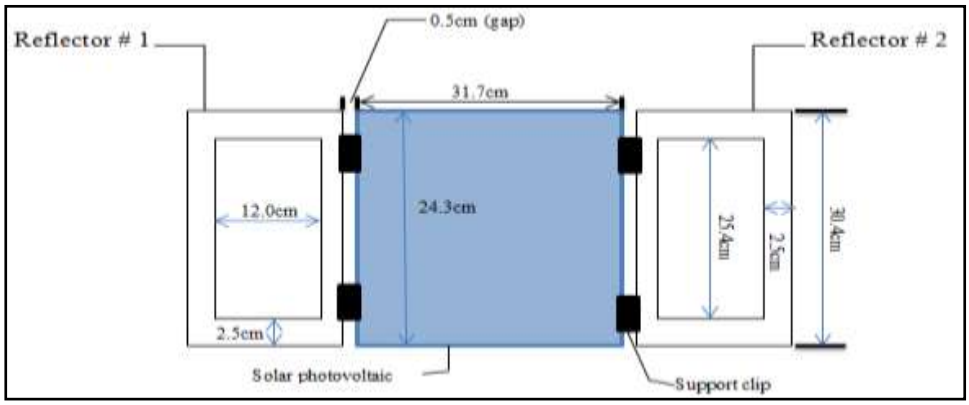

Figure 1: Dimension and measurement of the frame layout

3. SOLAR PV STAND DESIGN

Solar PV stand design must be consider to air space between solar PV and surface (ground) to avoid air trapped. The air trapped causes the solar PV overheating and the temperature will increase. The solar PV frame also designs free air concept on the back side. Figure 2 shows the PV stand design in front view. The base stand must be stable dimension, this because the hardware is exposes to wind blowing and to avoid it fall down.

Figure 2: PV stand design in front view

4. EXPERIMENTAL SETUP AND RESULT

This testing is to observe the differential of output by using the two types of reflector and PV panel during cloudy day. The mirror are placed facing west and east. The result will indicate the output power performance and the efficiency of the PV panel during the cloudy day condition. Normally, during cloudy day the performance and efficiency of PV panel is decreasing. However, by using reflector in this test it able to increase. The experiment has started at 9.00 am until 4.30 pm. The data are recorded for every half an hour. The data collected for Monocrystalline PV panel is shown in Figure 3.

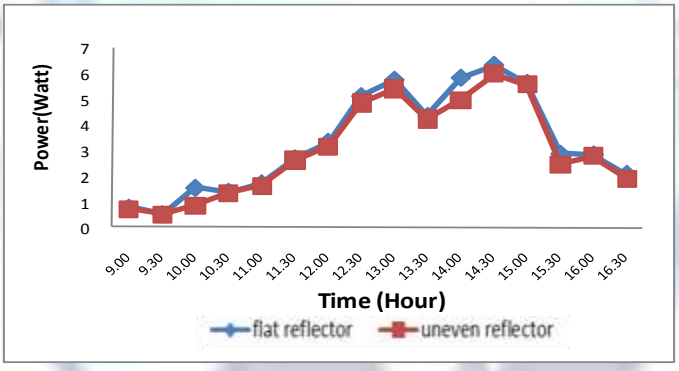

Figure 3: The data collected for Monocrystalline PV panel in cloudy day.

From the calculation analysis, Monocrystalline PV with flat and uneven reflector, it shows that by using a flat reflector has produced higher average power output which is 3.33 Watt comparable to uneven reflector 3.08 Watt. The testing also undergo on during the erratic day. Erratic day means in that day, the weather is inconsistent and unpredictable. This testing is to observe the difference which output is higher by using the two types of reflector and PV panel. The result decisions indicate which options to ensure better power output and the efficiency is in better condition while in the cloudy day. In this experiment, the data are taken for every half an hour to record where it is more valid data recorded. The experiment has started at 9.00 am to 4.30 pm. The result is shown in Figure 4.

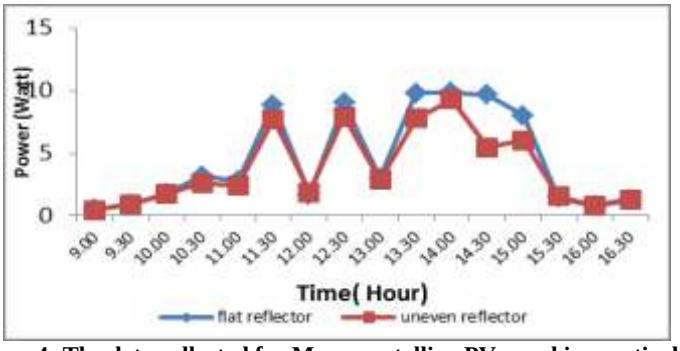

Figure 4: The data collected for Monocrystalline PV panel in erratic day.

5. ANALYSIS OF DIFFERENT WEATHER CONDITION

From the testing conducted for Monocrystalline panels in different weather condition show that monocrystalline produce higher power output. The testing was conducted using a type of reflector which is flat and uneven reflector. The purpose of these two different types of reflector is to show the pattern of radiation reflector that produced by the PV panel. There are several of testing have undergo to collect in a cloudy and erratic day of weather condition. This is because Malaysia is located near the equator which is received abundant of sunlight, average temperature and heavy rains along the year. However, the result from the data collected show that using flat reflector able to increase 19.5% the output compared to uneven reflector.

The uneven reflector is scattering the sunlight to everywhere. The result shows that, on the different weather, the monocrystalline PV panel produce the higher power output. The monocrystaline is made out of the highest grade silicon and the efficiency rate of monocrystalline solar panel type is typically 15%-20% [3], while the polycrystalline silicon are low cost and low efficiency (5% to 10%) [4]. The monocrystalline silicon tends to good performance in low light condition, so that, in a cloudy day, the output from the monocrystalline PV panel still is the highest compared to polycrystalline PV panel.

6. ANALYSIS ON DIFFERENT TYPE OF REFLECTOR

The PV is placed in three different parameters there are without reflector, 30° facing north with aluminium reflector and 30° facing north with mirror reflector. The result of the testing is shown in the Figure 5 below. The Figure 6 is shown the result that undergo with the aluminium as the reflector. The irradiance was 496.5 W/m^2. The thermal imaging camera was used to capture the thermal affect. HS1 is the hot spot while the CS1 is the cool spot.

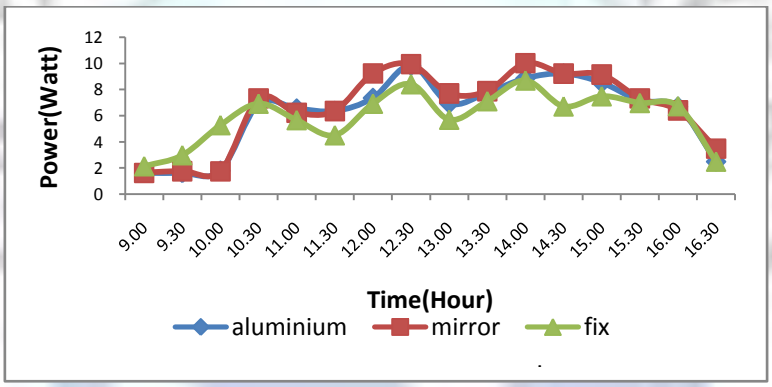

Figure 5: Power output of different type of reflector

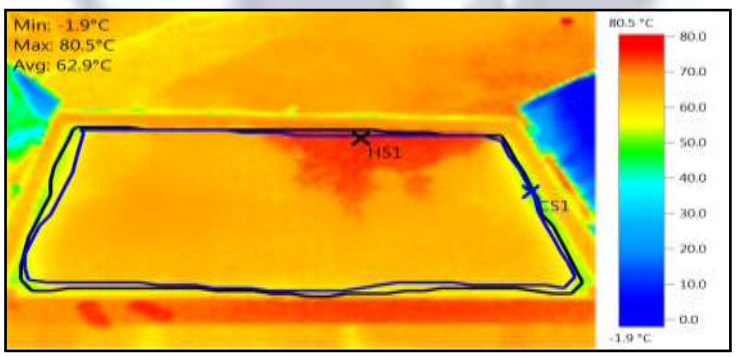

Figure 6: Result from the thermal imaging camera

7. FINDING ON DIFFERENT TYPE OF REFLECTOR

The experiment was conducted on two types of reflector which is aluminium, mirror and without reflector. The purpose of these differentials is to show the different of power output even using the same category of the reflector and temperature effect which is discussed in another section. The mirror and aluminium are categorized under shiny reflector. The type of reflector that use in reflection technique can influence the solar PV output. From the Figure 7 show that at 9.00 am to 10.00 am the power output of no reflector is higher than the aluminium and mirror reflector. It is due to shade that occurs by the east reflector. Yet, during the mid-hour (11am-3 pm), the mirror reflector power

output is higher than the aluminium reflector and without reflector. The mirror reflector is allowed that any sunlight hitting the top, bottom or centre of the reflector at an optimum angle, will reflect onto the solar cell at the opposite point that it hit the reflector, angle of incidence equals the angle of the reflector [1]. The aluminium also can reflect the sunlight, the surface is shiny but the bends make the sunlight go anywhere [5].

During the mid-hour, the mirror reflector is 23.58% higher than without reflector and 6% higher than aluminium. For example in the daily life situation, the batteries can fully charge in short duration by using the solar panel attached with the mirror. From the testing conducted, show that the front PV panel temperature is not proportional to the sun radiation. It is due to the natural effect during the experiment such as humanity, temperature surrounding and wind. Malaysia has two monsoon regimes; it is the Southwest Monsoon occurring in late May to September and the Northeast Monsoon from November to March. In the Southeast Monsoon, it brings heavy rainfall, so humanity at that time is higher. The Southwest Monsoon normally signifies relatively drier weather.

CONCLUSION

The concept of reflecting sunlight can produce 23.5% output compare to without reflector but need to choose the suitable reflector type. The mirror reflector had produces 6% output compared to aluminium type. The reflection of the mirror is the simplest form, easy to get and price is reasonable.

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