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Development and Performance Evaluation of Roof Top Small Scale Solar PV System

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ABSTRACT: Many renewable energy conversion systems have been built in order to reduce the use of fossil fuel and minimize global warming. Solar power plant, one of many renewable energy systems, has promising potential in green energy sector. However, there are only a few solar PV system installed in roof top of a building. Thus, the present work aims to development small scale roof top solar PV system and to investigate its performance. The 300 WP solar PV system is installed on a roof top of the office building of campus III-IST. AKPRIND. The performance of the system in terms of output current, output voltage, output power, and conversion efficiency. The results shows that maximum output current of 3.91 ampere and maximum output voltage of 58.29 volt were obtained at day 3 and day 5, respectively. The output current give predominant effect on output power of the solar PV system. The trend of output power is similar to that of output current. Maximum output power of 173.25 W was generated at day 3 where maximum output current was measured. Thus, it can be figure out that the solar PV system has an conversion efficiency of almost 58%.

KEYWORDS: roof top, solar, energy, conversion, power plant

1. INTRODUCTION

In last decades, the use of renewable energy has got increasing attention worldwide. Many renewable energy conversion systems have been built in order to reduce the use of fossil fuel and minimize global warming. Solar power plant, one of many renewable energy systems, has promising potential in green energy sector. Commonly, solar energy is converted into electrical energy. Solar energy is abundant and requires low costs conversion technology, make solar energy extremely popular [1] and in fact that solar power contribution is higher when compared with other sources [2]. Besides converted into electric energy [3], solar energy was also utilized as heat source [4.5], in refrigeration and cooling [6, 7], in industrial processing [8], and many other utilizations. Passing by equatorial line, Indonesia has solar energy potential about 208 GW [9].

A simple solar power plant consists of photo voltaic, solar charge controller, battery, and inverter. A photo voltaic adsorbs and converts solar radiation into electric energy. Photo voltaic cell utilizes photon from sun light into electrical energy [1]. The electric energy is stored in the battery and controlled using solar charge controller during battery charging. An inverter is used to convert DC current into AC current. Performance of photo voltaic plays an important rule to overall solar power plant performance. Many works on enhancing photo voltaic performance have been conducted by several researchers. Performance of photo voltaic increased by combining transparent solar panel and large Fresnel lens concentrator [2], by using transparent conductive electrode structure of photo voltaic [10], by using concentrated crystalline silicon solar cell-slicing cell [11]. Meanwhile, enhancing performance of photo voltaic different photovoltaic thermal (PVT) configurations was also reported [12].

As cities continue to densify in the face of the global climate, energy, and biodiversity crises [13], many are looking to rooftops to fill the demand for space needed by humans and the environment. Flat roofs, which are cost-effective, optimize space, and are often adopted in dense urban areas, can be used to install the solar PV system. Thus, the 300 wp solar PV system is installed on a roof top of the office building of campus III-IST. AKPRIND. The performance of the system is also analyzed and evaluated.

2. MATERIAL AND METHOD

The present work is begun with installation of 300 WP solar PV system on the roof top of 3 stories building of campus III-IST. AKPRIND. The system uses 6 units of a 50 Wp polycrystalline PV. Figure 1 presents photograph of the installation work. The stand of the PV is made from 30 mm x 30 mm L profile Steel.

Fig. 1. Photograph of installation work

Figure 2 displays schematic diagram of the 300 Wp solar PV system in the present work. The system is constructed by solar panel (PV), solar charger controller MPPT, battery 12V/100Ah, inverter 1000 W, AC load, and MCBs. The PV absorbs solar irradiant and converts it into electrical energy. Solar charger controller controls the voltage and current to the battery. The inverter 1000 W is used to convert DC to AC prior to be supplied to the AC load of LED lamp.

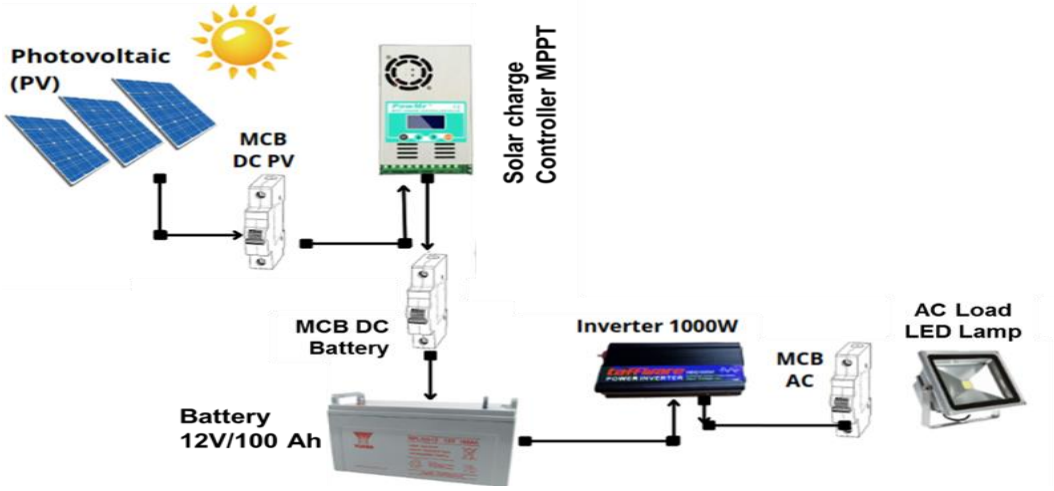


Fig. 2. Schematic diagram of the PV system

Once the system is installed, its performance is analysed and evaluated. The data collection is performed from 9 am to 3 pm for 5 days. Fig. 3 present a photograph of the data collection. The performance of the solar PV system is evaluated in term of power output and conversion efficiency by using Eq. (1) and Eq. (2)

$$P = V \times I \quad (1)$$

$$\eta = \frac{P}{WP} \times 100\% \quad (2)$$

where V is the output voltage (Volt) and I is the output current (Ampere) of the solar PV system, and WP is the solar PV system watt peak (i.e. 300 W)

Fig. 3. Photograph of data collection

3. RESULTS & DISCUSSION

The 300 WP solar PV system installed on roof top works properly as shown in Fig. 4. The system able to give lighting on the roof top of the building all the night long.

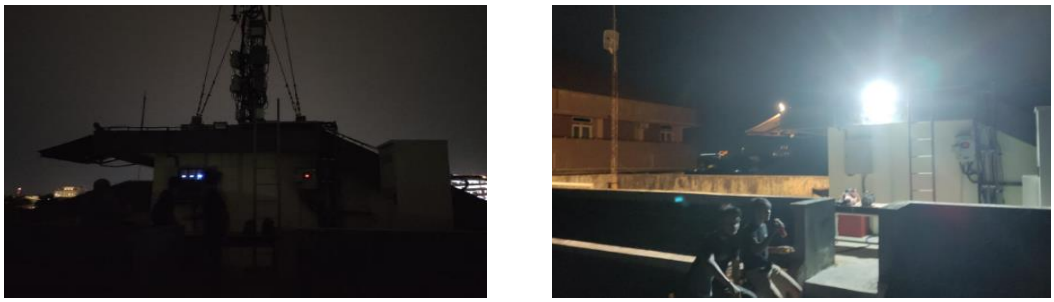
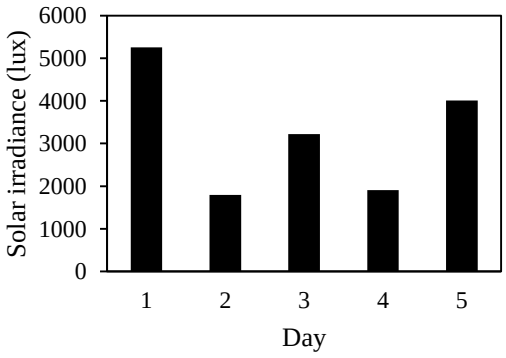
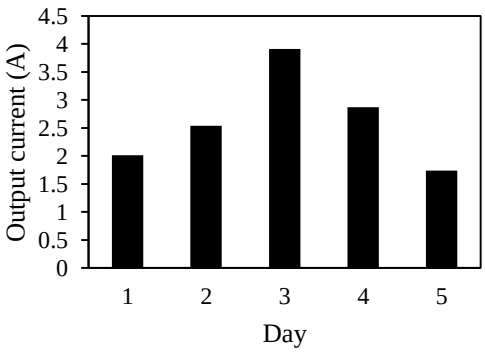


Fig 4. Electricity from the roof top solar PV system

Meanwhile, Fig. 5 shows solar irradiance during data collection, output current, output voltage, and output power of the solar PV system. During data collection, average solar irradiances fluctuates . Maximum solar irradiance was measured at day 1, about 5252.29 lux. In contrast, minimum value of 1792.29 lux was observed at day 2. The trend of solar irradiance differs with that of output current, output voltage, as well as output power. This, indicate that the performance of the PV is not only affected by solar intensity, but may also affected by other factor, such as surface temperature of the PV.





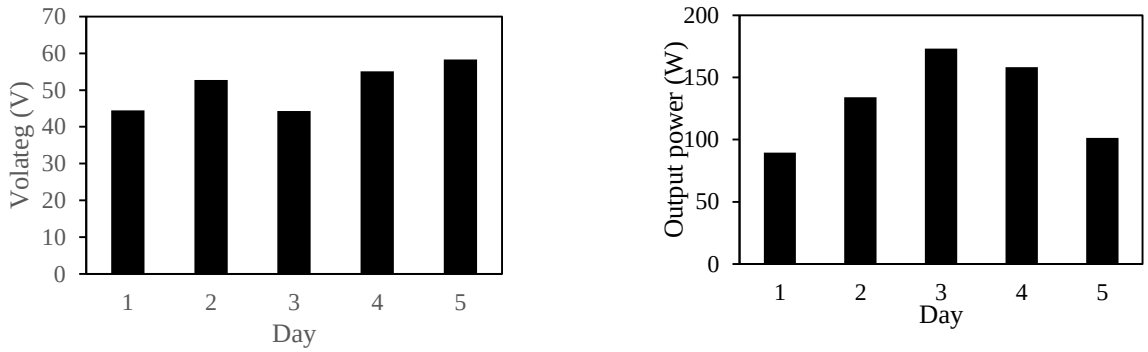


Fig. 5. Performance of the 300 WP solar PV system

Maximum output current of 3.91 ampere and maximum output voltage of 58.29 Volt were obtained at day 3 and day 5, respectively. Observing Fig. 5, it can be stated output current give predominant effect on output power of the solar PV system. The trend of output power is similar to that of output current. Maximum output power of 173.25 W was generated at day 3 where maximum output current was measured. Thus, it can be figure out that the solar PV system has an conversion efficiency of almost 58%.

4. CONCLUSION

The 300 WP of solar PV system is installed successfully on roof top of 3 stories office building of campus III- IST AKPRIND. The system able to give lighting on the roof top of the building all the night long. Maximum output current of 3.91 ampere and maximum output voltage of 58.29 volt were obtained at day 3 and day 5, respectively. It can be stated that output current give predominant effect on output power of the solar PV system. Maximum output power of 173.25 W was generated at day 3 where maximum output current was measured. Thus, it can be figure out that the solar PV system has an conversion efficiency of almost 58%.

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