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Optimum Investigation of LED Bulbs Light as Photon Energy on Photovoltaic Panel Installed Inside Buildings

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Abstract

This study was conducted to obtain the angle of elevation of solar panels (PV) to harvest photon light energy sources from LED bulbs that are often used in residential homes or buildings. The PV tilt angles tested are 0, 15, 30 and 90º by placing a constant bulb in its position. The results of the observations show that a slope of 0º produces the highest PV electrical power, although it is not significant compared to the other 3 slope angles. The decrease in PV output power occurs when the slope angle increases. Optimum power of 16.93 Watt is obtained by using a Hannochs bulb at a power of 15 Watt with an angle of elevation of 0º. Furthermore, the power decreased to 16.33, 12.92, and 12.91 Watts at angles of 15, 30 and 90º, respectively. Further research is still needed by increasing the variation of bulb power above 15 Watts to validate the position of the PV panels on the walls of the building according to light source.

Keywords: light energy, photovoltaic panel, interior building, LED energy

1. Introduction

The sun is a source of energy that is very important for the benefit of mankind and the natural surroundings. The sun is a source of renewable energy that is pollution-free, environmentally friendly, quiet and free. However, technology is needed to harvest the energy optimally. The technology that is widely known to the millennial community is photovoltaic or photovoltaic (PV) panels. This panel is made up of arranged and bonded semiconductor crystals that can absorb photon light and solar thermal energy at the same time. However, what the panel needs is only photon light that is able to excite electrons to the holes, so that there is a difference in voltage and electric current flow in the junction (+) and negative (-).

The sun is not the only source of energy that PV can use to generate electricity. Other energies such as LED light bulbs in buildings or domestic and office buildings are alternative photon light that can be obtained free of charge at night. So the bulb becomes a source of lighting as well as a new source of energy for PV whose electrical output can be used for charging electronic devices such as mobile phones, power banks and laptops. This process will help save electricity usage of PLN per month. The problem with PV panels is determining the right angle between the light from the bulb and the PV surface on the walls of the building. Therefore, this study aims to investigate several angles of PV panel elevation by assuming the position of a static LED bulb on the ceiling of the house under review. After knowing the elevation angle, the aesthetic value of the panel position in the interior of the building becomes a separate x factor.

Several studies related to the use of the bulb as photon energy have been carried out. Mustofa et al., [1] investigated the radiation of Halogen, Incandescent and Xenon bulbs as energy sources in a mini-hybrid photovoltaic and thermoelectric generator (TEG) using a hot mirror as a photon and thermal bulb separator. The test results displayed focus more on the size of the light spectrum that goes to the PV and TEG without displaying the output power. This research was continued in the following year by Piarah et al., [2]. They compared the spectrum splitters of hot and cold mirrors by using only 50 Watt Halogen bulb as the energy source to be splitted by the mirror. The difference lies in the PV and TEG positions. The results indicate in total that the cold mirror splitter is larger in terms of PV and TEG output power. Simultaneously, research related to the same topic was also carried out in [3], [4], [5] and [6]. The simulation results show that the PV module provides good output power characteristics according to the dimensions of the

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PV with the type of bulb as a photon energy source, while the output power (voltage and electrical current) produced by the TEG module is very small and can be ignored.

However, from the reference sources above, no one has tested the type of LED bulb as an energy source that aims to excite electrons to holes in the conductive polycrystalline crystals of the PV panel surface. This LED is a type of bulb that is currently widely used in home and office buildings. Kamaludin et al., [7] have used a TEG module with an LED bulb as a source of thermal radiation which results are still small. Although the electrical power is still small, the application of the LED bulb as a thermal energy source has provided an overview of the TEG output power characteristics that are in accordance with the theoretical basis of the module. Need to test for PV module as well. In this study, the test has directly used monocrystalline type commercial solar panel (60 Wh), so the results can be directly applied.

Regarding the PV panel elevation angle, with 4 poly silicon crystalline panels arranged in series-parallel, Wardy et al., [8] placing the angle of elevation around 122º with an average power of 21 Watts. They concluded that weather conditions affect the magnitude of the voltage, while the surface temperature affects the magnitude of the PV output current. Temperature rises, PV amperage goes down. Lysbetti et al., [9] using PV panel tilt angles of 45, 60, 90, 120 and 130º. The angle of 60º which shows a more stable and optimal PV output voltage. Tira et al., [10] in the test using a 10 Wp PV panel, comparing solar radiation with a sun simulator using a 500 W Halogen bulb that can be adjusted its voltage with a dimmer. The tilt angle that is set is the position of the bulb, not the panel PV. The optimal PV slope is 10º.

The slope of PV affects its output power as described in the studies above by utilizing radiation from both the sun irradiation and the sun simulator of a high-power Halogen bulb of 500 Watt. The high power bulb is not used commercially by the public, so its application is limited, suitable only for experiment in the laboratory. In this study, we will use low-power LED bulbs that are widely used by people in residential homes.

2. Materials and Methods

In this study, the bulb was placed at the top position which was installed statically and ensured that the light that radiated shone on the entire surface of the PV. Different study from Tira et al., [10], where the position of the bulb can be tilted and forms an angle with a constant PV panel, this study places a static bulb like [11]. The position of the PV at a distance of 25 cm from the bulb with elevation angles of 0, 15, 30 and 90º. The tilt angle of 0º means the panel is perpendicular to the direction of the light, while 90º the PV panel gets light from the side of the bulb. The PV panel used is a monocrystalline type with dimensions of 70 x 54 cm with a maximum of 60 W as specified in Table 1.

Table 1. Specification of monocrystalline photovoltaic

Technical Data	
Peak Power (Pmax)	0 W
Production Tolerance	3%
Maximum Power Current (Imp)	.33 A
Maximum Power Voltage (Vmp)	8 V
Short Circuit Current (Isc)	.67 A
Open Circuit Voltage (Voc)	50 VDC

Figure 1. Type of bulbs on PV testing

Meanwhile, the type of bulb used there are 3 trademarks; Hannochs 15 Watt, Camus 20 Watt, and Philips 20 Watt (Figure 1). Hannochs is different from the others because it doesn't get the same power as the other two brands, so it's only close to the chosen one. The 3 types of bulbs are widely used by consumers at home. However, to prove the validity of the bulbs another study should be conducted.

Furthermore, experimental set-up was carried out by installing a light steel frame. This frame is a support for PV panel and the bulb poles. as shown in Figure 2.2. The measuring instruments used during the test were a digital multimeter, digital infrared thermometer, and a watt meter with a rechargeable sealed lead-acid battery for energy storage. The PV output power measurement is recorded every minute with 60 minutes each slope of PV panel and one single bulb type. The bulb is left Switch-On for 10 minutes before measuring the voltage and current to adjust to ambient temperature and power stability.

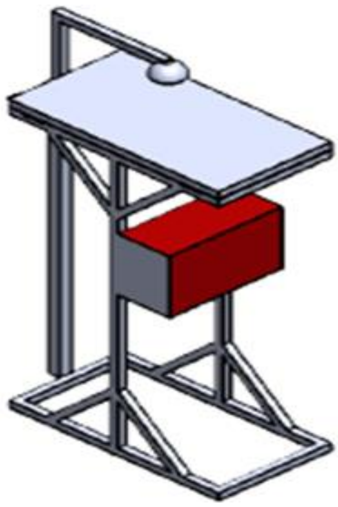

Figure 2. Experimental set-up of PV elevation

3. Results and Discussion

3.1 LED bulb 15 Watt Hannochs as source of irradiance at PV elevation on 0, 15, 30 and 90º

From the 4 graphs below show that the greater the PV elevation angle to the Hannochs LED bulb irradiation source, the lower the output power. 0º PV angle is the best, but the PV slope angle is not the main factor for installing interior room building. The aesthetic value of the room is a factor that also needs to be considered.

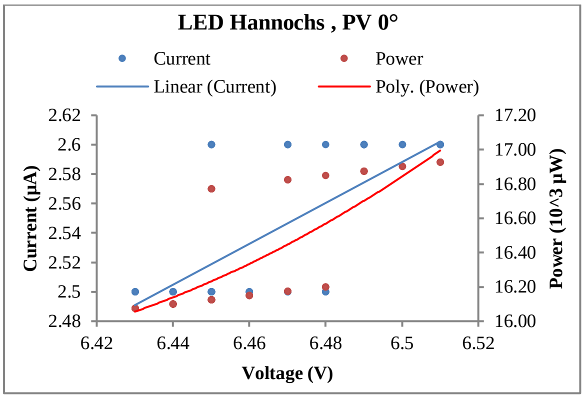

Figure 3. Power of monocrystalline PV panel at 0º elevation angle with 15 Watt Hannochs LED bulb radiations

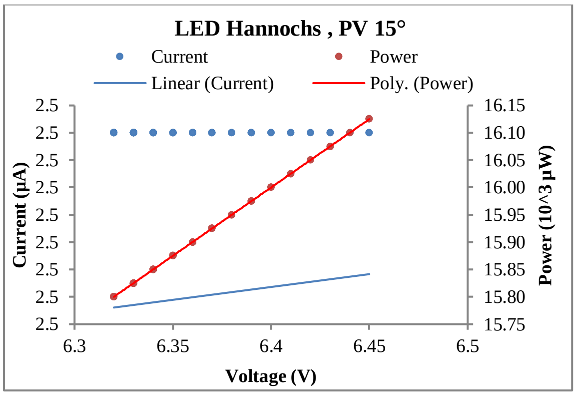

Figure 4. Power of monocrystalline PV panel at angle of 15º with 15 Watt Hannochs LED bulb radiations

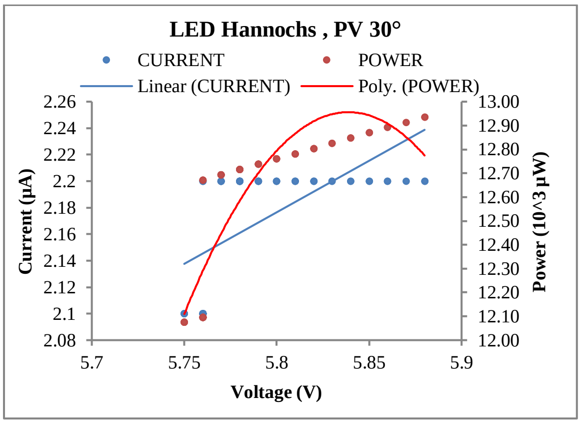

Figure 5. Power of monocrystalline PV panel at angle of 15º with 15 Watt Hannochs LED bulb radiations

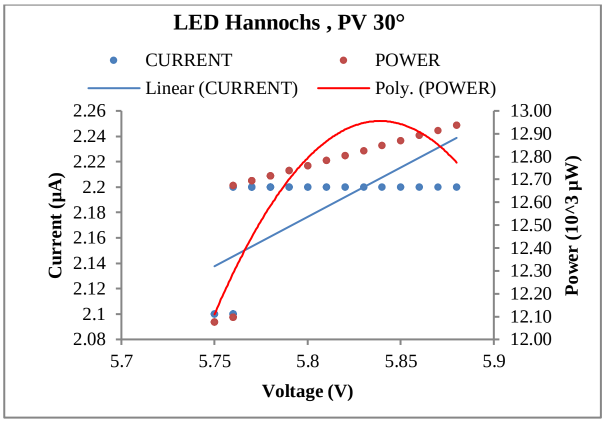

Figure 6. Power of monocrystalline PV panel at angle of 90º with 15 Watt Hannochs LED bulb radiations

3.2 LED bulb 20 Watt Camus as source of irradiance at PV elevation on 0, 15, 30 and 90º

The below figures describe power of 20 Watt of Camus LED bulb in which it has same trend as the 15 Watt Hannocs bulb light. Interestingly, 15 Watt contributes more PV output power than that of 20 Watt. One of the possible causes is the unequal surface geometry of the bulb, which affects the area and intensity of the light beam to the PV. In addition, changes in the light irradiation angle affect the PV output power which has been simulated in the study [12].

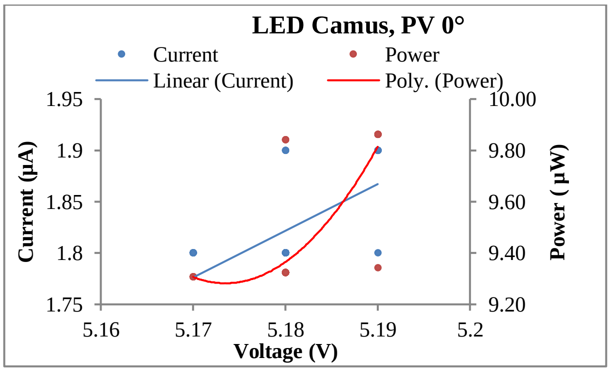

Figure 7. Power of monocrystalline PV panel at angle of 0º with 20 Watt Philips LED bulb radiation

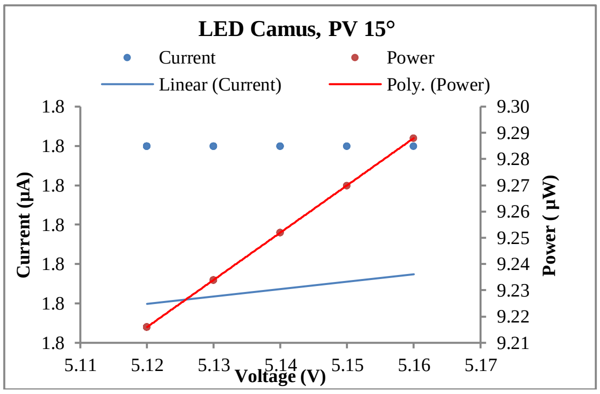

Figure 8. Power of monocrystalline PV panel at angle of 15º with 20 Watt Camus LED bulb radiation bulb radiations

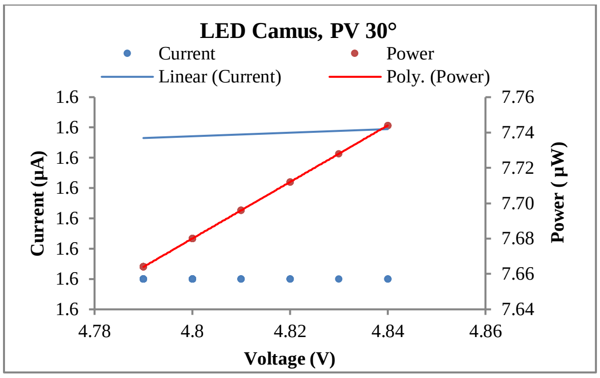

Figure 9. Power of monocrystalline PV panel at angle of 30º with 20 Watt Camus LED bulb radiation

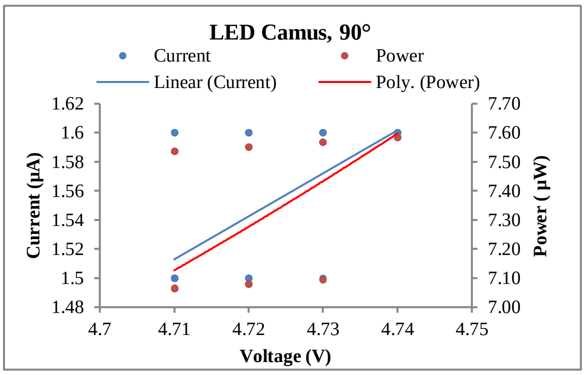

Figure 10. Power of monocrystalline PV panel at angle of 90º with 20 Watt Camus LED bulb radiations

3.3 LED bulb 20 Watt Philips as source of irradiance at PV elevation on 0, 15, 30 and 90º

The power of Philips bulb to generate electricity through PV is still less than Hannocs. The best type of domestic bulb light in this study is Hannochs even though it's only 15 Watts. It is important to do further research on the characterization of this type of bulb by adding the higher and more varieties bulb power. In general, the angle of inclination of solar panel does not provide a significant difference in output power by using light bulbs as a photon energy source. This means that the installation of solar panels on the interior room walls of buildings has the potential to provide electrical energy conservation for the use of small DC-powered electronic devices, such as computer/notebook and power bank.

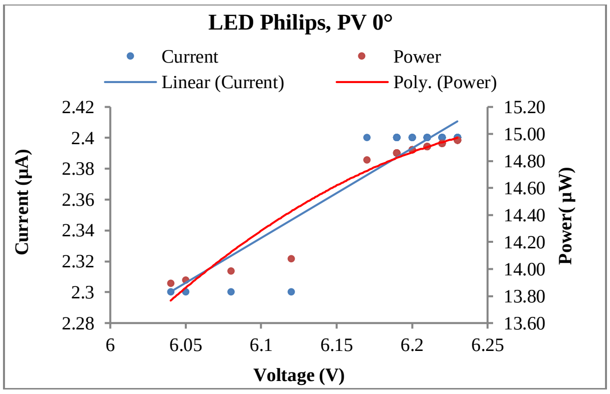

Figure 11. Power of monocrystalline PV panel at angle of 0º with 20 Watt Camus LED bulb radiation

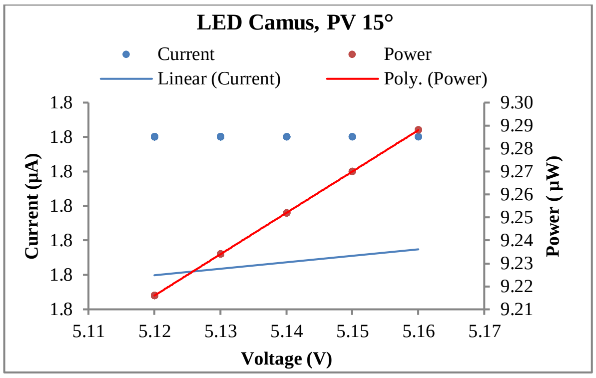

Figure 12. Power of monocrystalline PV panel at angle of 15º with 20 Watt Camus LED bulb radiations

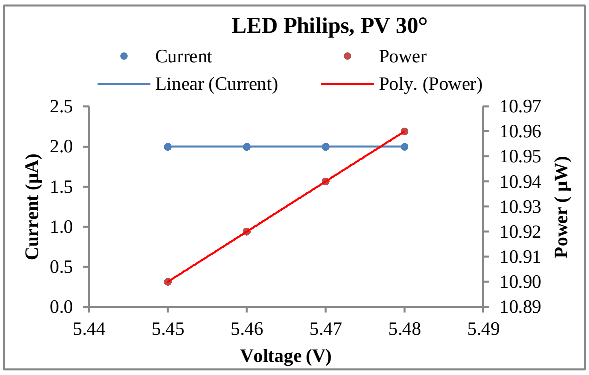

Figure 13. Power of monocrystalline PV panel at angle of 30º with 20 Watt Camus LED bulb radiation

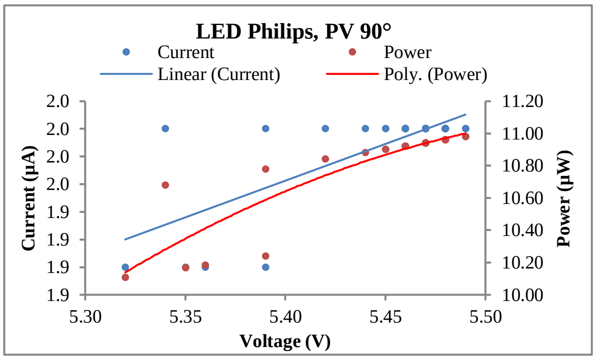

Figure 14. Power of monocrystalline PV panel at angle of 90º with 20 Watt Camus LED bulb radiations

The results of research using light bulbs as a source of constant irradiation of energy are certainly different from using solar energy that changes irradiance, and its air mass every time as well as the height factor at the observation location [13].

The results of this study indicate that the PV output power is still relatively small for the needs of electronic devices sourced from AC electricity (the State Electricity Company), but it is only sufficient for charging small power devices, such as charging mobile phones and fans. The way to fix this is by using a rather bigger bulb and PV power. It is also important to add more variative LED colors to provide much light intensity and spectrums [14]. Besides that, combining the light of the bulb in the night and sunlight on the day will generate more output PV power and can be store in a battery, too. Sunlight can be let into the interior of the building by applying room construction management [15].

4. Conclusions

In conclusion, research on the angle of inclination of solar cells at angles of 0, 15, 30 and 90º to the light source of an LED bulb provides clues about optimizing the electrical power generated by PV at night. From this study, Hannochs brand provides an optimum output power, although at a lower power commercially compared to Camus and Philips brands. Of course, to obtain a more valid study, a higher and more varied Hannochs power variation is needed.

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