Performance of Solar Cells under Total Solar Eclipse in Central Sulawesi of Indonesia

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Performance of Solar Cells under Total Solar Eclipse in Central Sulawesi of Indonesia

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Abstract. This paper reports the observation of performance solar cells when the total solar eclipse occurs in central Sulawesi, Indonesia. The observation was done by measuring some parameter and calculating the performance of solar cells. It was found that performance of solar cell was decreased linearly before total solar eclipse happen and its performance increase after the total solar eclipse. The performance of a solar cell when a total solar eclipse occurs is nearly zero because the intensity of the light measured by the instrument is equal to zero. It was concluded that the performance of solar cells was influenced by the intensity of light.

Keywords: Solar cell, total solar eclipse, Sulawesi

1. Introduction
Solar cells are electronic devices that serve to convert photons into electrical energy [1-5]. This device is one of the leading in the conversion of renewable energy into electricity. The performance of this device depends on the magnitude of the intensity of photons received. Electricity generated at low intensity is smaller when compared to high intensity [6-10]. The efficiency of solar cells is influenced by light intensity [11]. At high light intensity, solar cell efficiency tends to decrease. Therefore, the effect of light intensity on the performance of solar cells is significant to investigate.

A total solar eclipse is an event where the sun position parallel to the moon so that within a few minutes sunlight is not transmitted to the earth (dark earth). A total solar eclipse is a rare event [12-20]. This event occurs over a span of decades in different places. In 2016, total solar eclipses can only be observed in several regions of Indonesia such as Palembang, Palu, Ternate, Palangkaraya, and Balikpapan.

Some papers reported observations on several physical parameters when a solar eclipse. This phenomenon affects the meteorological parameters, such as solar radiation, temperature, and humidity [12]. Solar total eclipse also related to meteorological parameters and environment [13]. According to their reports, it was found that some physics parameter has specific behavior when the total solar eclipse occurs. Thus, in this paper, we report the behavior of solar cells when the solar eclipse occurred Palu (Central Sulawesi, Indonesia) on March 9th, 2016. The effect of another parameter that changed when the total solar eclipse occurs in the performance of solar cells was also discussed.
2. Experimental Methods
The location of the observation is Tondo at Palu District (Central Sulawesi, Indonesia). Observations were performed on March 9th, 2016 from 07.28 to 08.47 WITA, where measurements of all variables were performed on every two minutes. The intensity of the sunlight was measured with a solar power meter (TM206). To obtain data on the performance of solar cells when a solar eclipse occurs we measured the I-V characteristics of silicon solar cells. Current and voltage measurements were examined using multimeters while measuring the intensity of light using a solar power meter.

3. Results and Discussion
Total solar eclipse is a condition where sunlight is covered by the moon so that no sunlight is received on the surface of the earth. On solar total eclipse phenomenon, sunlight reduces to minimum condition and in this condition is very interesting to reveal the performance of solar cells considering there is no reference to report it. Photos, when the total solar eclipse occurs, are shown in Figure 1 (a). The observed silicon solar cell performance is shown in Figure 1 (b).

![Figure 1. (a) Solar Total Eclipse; (b) Silicon Solar Cells](image)

The performance of solar cells was depended on solar radiation as formulated in Equation (1).

\[ E = \varepsilon \langle A \rangle \Delta t \]  

(1)

where \( E \) is the efficiency of solar cells; \( \varepsilon \) is the average intensity of sunlight on the cell; \( \langle A \rangle \) is the cross-sectional area of the solar cell panel, and \( \Delta t \) is the time radiation of the sun.

In this study, the intensity of sunlight was observed every two minutes, and it was started at 07.28 until 08.47 WITA as shown by the graph in Figure 2. It can be seen that there is a decrease in the intensity of sunlight between 07.28 until 08.36 and the minimum intensity was found between 08.38 sd 08.41 WITA. Furthermore, the intensity of sunlight has increased again. In relation to Equation 1 that the electric power generated by solar cells is proportional to the intensity of sunlight. It is evidenced by observations on electric current and the voltage generated when a solar eclipse occurs.
The observation of the electric voltage generated by the solar cells is shown in Figure 3. The reduction of the voltage occurs with the change in the intensity of the sun. The minimum voltage that a solar cell possesses occurs when the intensity is minimum. This data is in line with the observed light intensity shown in Figure 2.

Temperature change is one factor that affects the performance of solar cells. Ref. [21] reported that with a significant increase in temperature give rise to the decrease of the electric voltage and fill factor. The reduction of voltage and fill factor causes a decrease in solar cell performance. From observations during the total solar eclipse, it is known that the temperature change is only about three degrees Celsius. Thus, no significant effect of temperature change during the total solar eclipse on the performance of silicon solar cells.
Figure 4. Observation of the solar cells current during a total solar eclipse

The presence of magnetic fields also affects the performance of solar cells. Ref. [22] reported that the presence of a high magnetic field causes a decrease in the efficiency of solar cells. The magnetic field may relate to the mobility of the carriers (electrons and holes) in the solar cells. From the observations during the total solar eclipse occurs it is known that no significant magnetic field changes [13].

The observations as reported in Ref. [14] also indicate that there is no significant gravitational change in Poso (Central Sulawesi) and Lembang (West Java) areas when the total solar eclipse occurs. Thus, there is no gravitational influence on the performance of solar cells at the time of total solar eclipse occurred in Central Sulawesi [12,23]. However, other environmental effects such as winds are expected to affect the dust flying around the observation site [11,17]. We suspect that the presence of dust during a total solar eclipse also resulted in decreased solar cell performance [24].

4. Conclusion
The performance of solar cells under the solar eclipse has been successfully observed. It is known that when a solar eclipse occurs, the intensity of sunlight decreases before eclipse and increases again after the eclipse occurs. It was found that performance of solar cell was decreased linearly before total solar eclipses happen and its performance increase after the total solar eclipse. The performance of a solar cell when a total solar eclipse occurs is nearly zero because the intensity of the light measured by the instrument is equal to zero. It was concluded that the performance of solar cells was influenced by the intensity of light.

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