ASSESSMENT OF SOLAR ENERGY POTENTIAL FOR TWO SELECTED AREAS IN YANGON REGION

Khin Sandar Khaing[1], Khet Khet Tun[2], Kalyar Thwe[3]

Abstract

Solar energy is the most abundant energy resource on Earth. It can be captured and used in several ways such as photovoltaic technology. In order to investigate a potential use of concentrating solar power technologies and select an optimum site for these technologies, it is necessary to obtain information on the geographical distribution of monthly average daily solar irradiation over an area of interest. This paper aims to evaluate the potential of renewable energy source of solar in two selected areas of South Aye Village in Khayan Township and Kyutawwa Village in Thongwa Township at Yangon Region. Additionally, solar energy collected data were analyzed for six months starting from January till June, 2020. Feasibility of harnessing for monthly mean solar energy was investigated by using 50 W photovoltaic solar panels. The solar power received on one day for month was checked by solar panel checker. From all the records measured, it was found that the measurements value for the solar energy from South Aye Village was more than that of Kyutawwa Village. In South Aye Village, the highest solar irradiation was estimated as 7.47 kWh/m^2/day in May and the lowest was 4.47 kWh/m^2/day recorded in June. The annual average daily solar radiation for Kyutawwa Village has been between 4.27 kWh/m^2/day and 7.26 kWh/m^2/day. This study indicates that selected areas had great potentials for utilizing solar energy system. It is also wanted to get benefits the development of the society and to have an impact on solar power generation technology and solar power generation.

Keywords: solar energy, photovoltaic technology, 50 W photovoltaic solar panels

Introduction

Renewable energy sources such as solar energy, hydropower, wind power, geothermal energy and biomass in its various forms. There is one natural energy resource without pollution: the solar energy. Every location on Earth receives sunlight at least part of the year. The amount of solar radiation that reaches any one spot on the Earth's surface varies according to geographic location, time of day season, local landscape and local weather. Because the Earth is round, the sun strikes the surface at different angles, ranging from 0° (just above the horizon) to 90° (directly overhead). When the sun's rays are vertical, the Earth's surface gets all the energy possible. The Earth revolves around the sun in an elliptical orbit and is closer to the sun during part of the year. When the sun is nearer the Earth, the Earth's surface receives a little more solar energy. The rotation of the Earth is also responsible for hourly variations in sunlight. In the early morning and late afternoon, the sun is low in the sky. Its rays travel further through the atmosphere than at noon, when the sun is at its highest point. On a clear day, the greatest amount of solar energy reaches a solar cell around solar noon.

Human life is inseparable from the sun, and the vast majority of energy human need is directly or indirectly from the sun. Solar energy is the energy obtained by capturing heat and light from the Sun. The method of obtaining electricity from sunlight is used to as the photovoltaic method. The solar energy that the sun radiates every hour is potentially sufficient to ensure one-year world energy consumption. This is the case when all sunlight is captured and completely converted into electricity.

Myanmar is well suited for solar energy, as it receives good amounts of solar energy due to its near equatorial location. Solar radiation has a vast potential to be converted into power, but

[1] Dr, Lecturer, Department of Physics, East Yangon University
[2] Dr, Lecturer, Department of Physics, East Yangon University
[3] Dr, Professor, Department of Physics, University of Mandalay

due to dependence on weather conditions and seasonal change, solar energy can be unpredictable and unreliable.

Solar power is the resources of much energy, for example, the wind power, chemical energy, potential energy of water and other are all converted by the solar power. Some main methods of using solar power are such as solar cells, photoelectric conversion by the energy contained in sunlight into electricity. Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaic (PV). Photovoltaic cells convert light into an electric current using the photovoltaic effect. Solar panels use the power of the sun to generate clean power. The reason for their huge popularity is that solar power is reliable, affordable, easy to install and causes no pollution.

This research aims to report on the amount of solar energy impact mainly in two selected Villages of Khayan and Thongwa Townships. The solar panels will be used to identify electricity availability in the study areas. It is also wanted to investigate an area of solar energy consumption for the development of Myanmar, to select suitable areas for development requires a preliminary investigation.

Materials and Methods

Location of Solar Home System in Some Selected Areas

Solar home system is beginning to the benefits of power and light to solar energy. In this research, the roof mounted 50 W solar panel (3.178 ft^2 or 0.295 m^2) was used for the period of January to June in 2020. The suitable solar energy collected areas such as system I (South Aye Village in Khayan Township) and system II (Kyutawwa Village in Thongwa Township) at Yangon Region were selected. The geographical location of Khayan Township is between Latitude 16° 54' 20" N and Longitude 96° 33' 47" E. Thongwa Township is situated between Latitude 16°45' 35.93" N and Longitude 96°31' 29.93" E. The map of Yangon Region, showing the selected Township is shown in Figure 1 and 2. The Roof-mounted 50 W solar panels in South Aye Village at Khayan Township and Kyutawwa Village at Thongwa Township are shown in Figure 3 and 4. The monthly output solar power received on the system I and II were recorded with solar panel checker. The monthly average solar energy received per area per day on the system I and II were calculated.

Figure 1 The map of Yangon Region, showing the selected Township (Khayan)

Figure 2 The map of Yangon Region, showing the selected Township (Thongwa)

Figure 3 Roof-mounted 50 W solar panel in South Aye Village at Khayan Township

Figure 4 Roof-mounted 50 W solar panel in Kyutawwa Village at Thongwa Township

Solar Energy Potential Using Photovoltaic (PV) Technology

Solar energy is converted sunlight directly into electricity using photovoltaic technology. The two types of PV technologies are flat plate and concentrating PV. Both PV technologies use solar cells that are made of semiconductor materials to absorb sunlight. When light is incident upon solar cell can generate and support an electric current without being attached to any external voltage source. The schematic block diagram of the solar power home system is shown in Figure 5. A solar photovoltaic (PV) system consists of a solar PV panel (module), a charge controller, a battery, an inverter, and interconnection wiring.

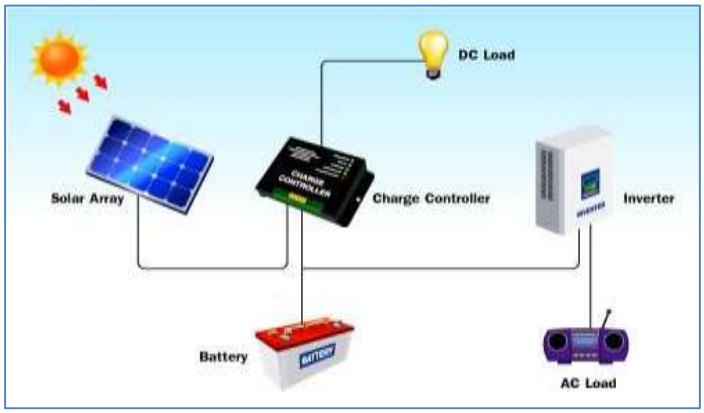

Figure 5 The schematic block diagram of the solar power home system

Working Principle of Solar Cell

When a solar cell is illuminated by sun-light, photons energy of the incident light is converted to direct current electricity through the process of photovoltaic effect of the solar cell. The solar cell works in three steps: (1) Photons in sunlight hit the solar panel and are absorbed by semiconductor materials, such as silicon. (2) Electrons (negatively charged) are knocked loose from their atoms, causing an electric potential difference. Current starts flowing through the material to cancel the potential and this electricity is captured. (3) An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity. Figure 6 shows the working principle of solar panel.

When sunlight strikes the surface of a solar cell, some of the photons are energetic enough to free electrons from the N-type semiconductor. Incident light causes electron-hole pairs to be generated in the semiconductor and there is increase in the concentration of minority carriers (electrons in the p-type region and holes in the n-type region) in the depletion region. Some of the electron-hole pairs immediately recombine. But if the electron-hole pairs are near the P-N junction, the junction potential barrier (due to diffusion) causes the "charge" pairs to separate. The negative electrons move to the N-type side of the cell and the "positive" holes move to the P-type side. The separation of the charges gives rise to a "terminal" voltage. When connected to an external circuit, a current flow as long as sunlight illuminates the cell. The solar panel charges the batteries during the day and the batteries run the light at night.

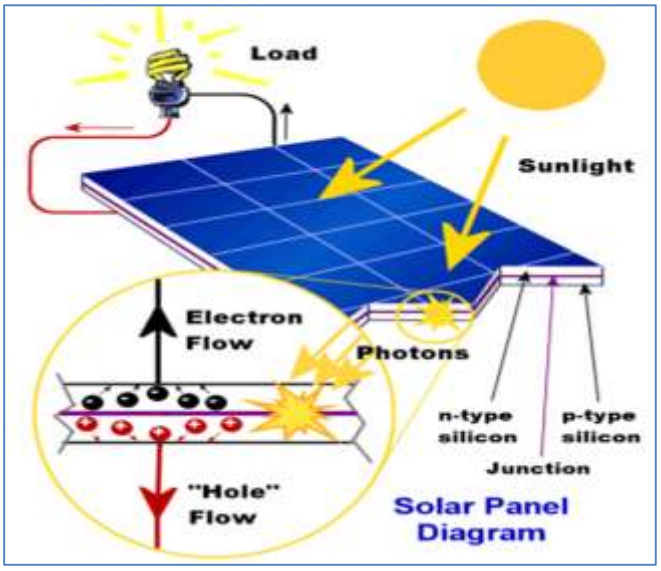

Figure 6 The working principle of solar panel

Results and Discussion

Experimental Recorded Data of Solar Energy

The mathematical method was used to calculate the total output power (P), the average solar energy (E_{av}) and the average solar energy per area per day (E/A) for two selected areas. The daily irradiation energy is hence obtained and then repeated for every one hour and its summation for one day. The hourly variation with the power output for May from 50 W solar panel at studied areas are shown in Figure 7 and 8. On average, these studied areas receive about 6 hours of sunshine per day. Solar radiation is closely related to the sunshine duration. Its seasonal and spatial variations are thus very much the same as in the case of sunshine.

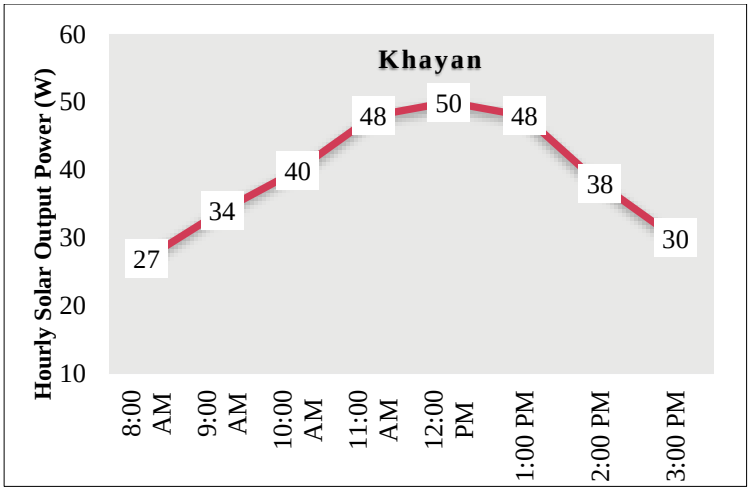

Figure 7 The hourly variation with the power output for May from 50 W solar panel at Khayan Township

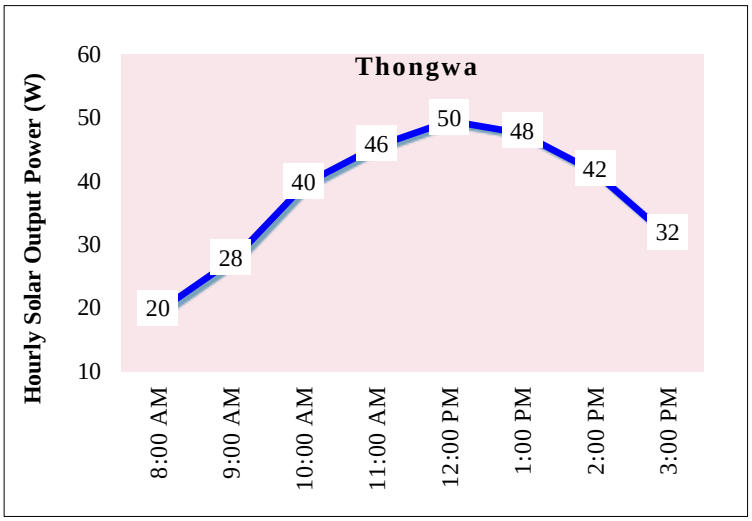

Figure 8 The hourly variation with the power output for May from 50 W solar panel at Thongwa Township

To calculate monthly average daily solar irradiation intensity, data for the number of days in one month were averaged. The average solar energy per area per day (E/A) received on the system I and II (50 W solar panels) were calculated from the experimental recorded data of solar energy. The monthly average solar energy received per area per day for South Aye Village in Khayan Township is given in Table 1 and Figure 9. The solar radiation of South Aye Village in Khayan Township ranges from 7.47 kWh/m^2/day in the month of May and drops lower to 4.47 kWh/m^2/day in the month of June. The monthly average solar energy received per area per day for Kyutawwa Village in Thongwa Township is shown in Table 2 and Figure 10. The values of monthly average solar radiation received per area per day ranging from 4.27 kWh/m^2 to 7.26 kWh/m^2 for Kyutawwa Village in Thongwa Township.

Table 1 The monthly average solar energy received per area per day for South Aye Village in Khayan Township

Month	Total sunshine hours per day t (hrs)	Total Solar Output Power received in a day P (W)	Calculated Solar Energy received in a day E_{av}(kWh)	Collected Area A (m^2)	Average Solar Energy received per area per day E/A (kWh/m^2/day)
January	7	300	2.10	0.295	7.13
February	6	291	1.74	0.295	5.91
March	6	286	1.71	0.295	5.81
April	7	289	2.02	0.295	6.86
May	7	315	2.21	0.295	7.47
June	5	264	1.32	0.295	4.47
Average	6	291	1.85	0.295	6.28

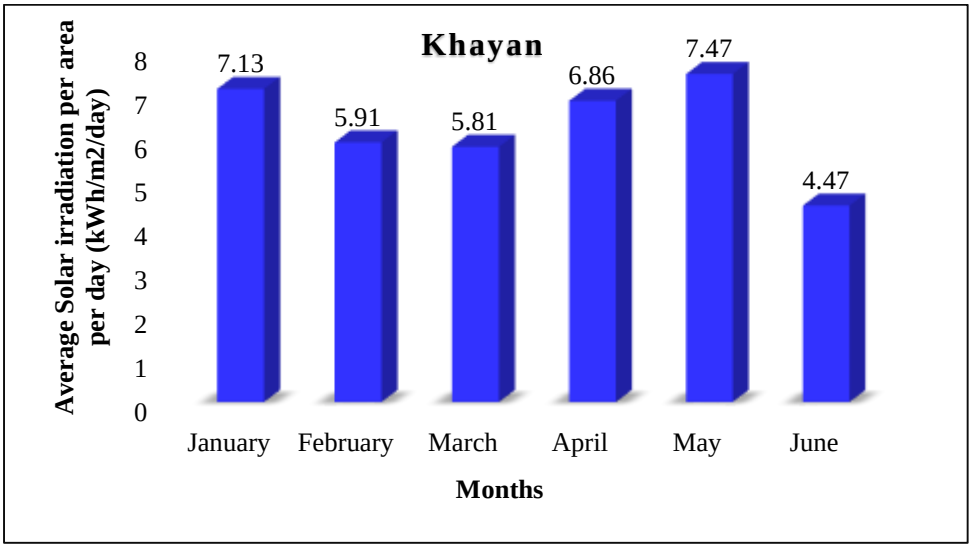

Figure 9 The graph of the monthly average solar energy received per area per day for South Aye Village in Khayan Township

Table 2 The monthly average solar energy received per area per day for Kyutawwa Village in Thongwa Township

Month	Total Sunshine hours per day t (hrs)	Total Solar Output Power Received in a day P (W)	Calculated Solar Energy Received in a day E (kWh)	Collected Area A (m^2)	Average Solar Energy received per area per day E/A (kWh/m^2)
January	7	296	2.07	0.295	7.02
February	6	284	1.70	0.295	5.78
March	7	287	2.01	0.295	6.81
April	6	274	1.64	0.295	5.57
May	7	306	2.14	0.295	7.26
June	5	252	1.26	0.295	4.27
Average	6	283	1.80	0.295	6.12

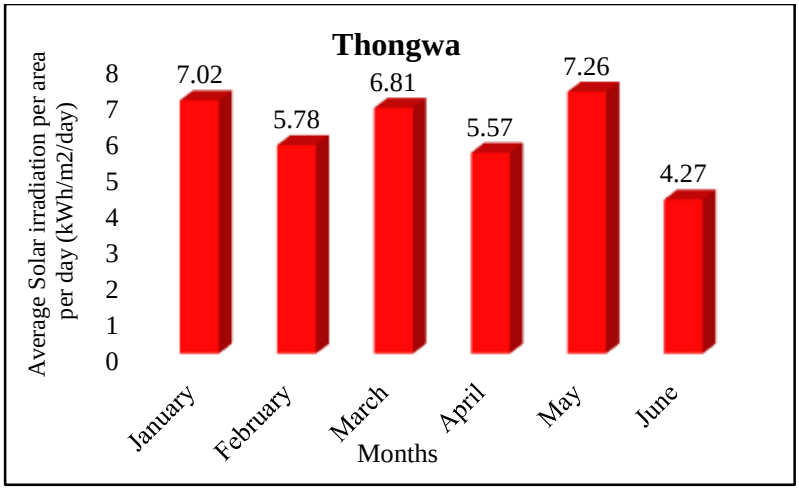

Figure 10 The graph of the monthly average solar energy received per area per day for Kyutawwa Village in Thongwa Township

Discussion

The comparison results of solar energy received in one day for two studied areas are shown in Table 3 and Figure 11. In all results, the highest solar irradiation was in May and the lowest was in June. The comparison results of solar Energy Received per area per day in two studied areas are displayed in Table 4 and Figure 12. Myanmar Electric Power Enterprise (MEPE) experimental measurements indicate that irradiation intensity of more than 5 kWh/m^2 was observed during the dry season. So, according to all solar energy data, the average daily solar irradiation in two selected Villages of Khayan and Thongwa Townships were considered to be well. Due to variating monthly global solar radiation, the energy output by a solar energy conversion system would vary from month to month. The two most important effects that must be allowed for are due to the variable temperature and irradiance. Temperature has an important effect on the power output from the cell. Irradiance is directly proportional to the short-circuit current of a solar cell.

Table 3 The comparison results of solar energy received in one day for two studied areas

Month	**Solar Energy received in one day E_{av}(kWh)**	
	Khayan	**Thongwa**
January	2.10	2.07
February	1.74	1.70
March	1.71	2.01
April	2.02	1.64
May	2.21	2.14
June	1.32	1.26
Average	1.85	1.80

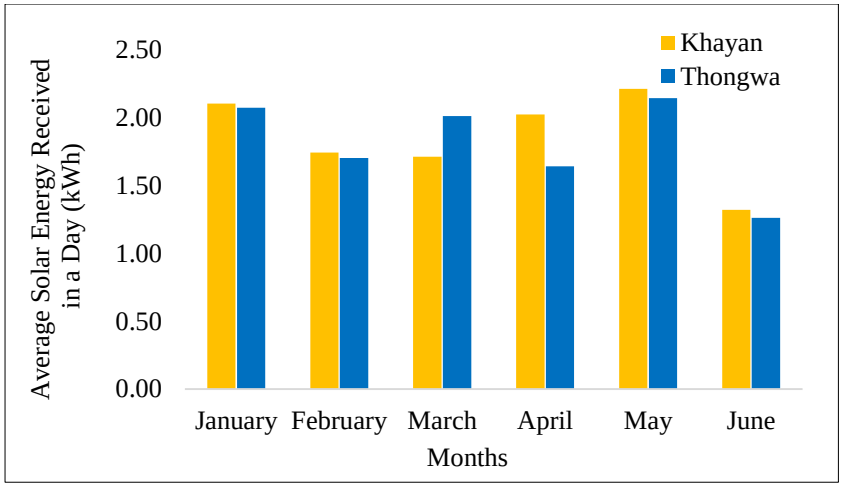

Figure 11 The graph of the comparison results of solar energy received in one day for two studied areas

Table 4 The comparison results of solar Energy Received per area per day in two studied areas

Month	Average Solar Energy Received per area per day E/A (kWh/m^2/day)	
	Khayan	Thongwa
January	7.13	7.02
February	5.91	5.78
March	5.81	6.81
April	6.86	5.57
May	7.47	7.26
June	4.47	4.27
Average	6.28	6.12

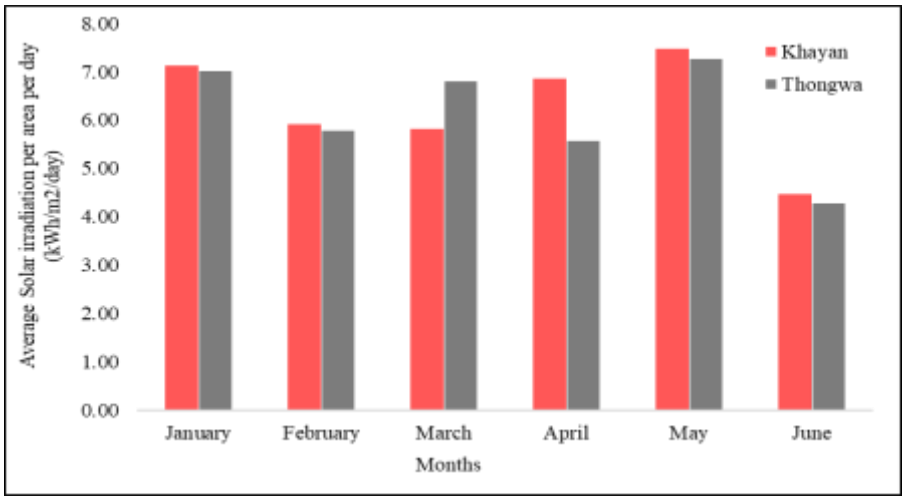

Figure 12 The graph of the comparison results of solar energy received in one day for two studied areas

Table 4 shows for 50 W solar panel of studied areas the list of the most common household appliances used with typical wattage rating with time tendencies of use. By studying the daily habits and energy requirements of the households in these areas, the present household energy consumption is estimated.

The block diagram of the uses of home appliances for 50 W solar panel is shown in Figure 13. For example, four 10 W light bulbs and a 60 W fan require 100 watts of power. To use these appliances for 3 hours, we will need a total of 300 watts of power. Divide a total of 300 watts of energy by six hours of sunlight a day to get 50 W. So, we need to use a 50 W solar panel to use four 10 W light bulbs and a 60 W fan for 3 hours.

Table 4 The list of the most common household appliances for 50 W solar panel

Electrical application of Household type	Effect [W]	Normally time of use/ Remarks
2 light bulbs to 5 light bulbs	From 3 to 12 W	05:00-06:00, 18:00-20:00
Stereo	30	19:00-22:00
Radio	7	10:00-12:00, 13:00-14:00
Fan	35	19:00-22:00
Mobile charger	6	05:00-06:00, 19:00-21:00

Figure 13 The block diagram of the uses of home appliances for 50 W solar panel

Concluding Remarks

This study indicates that the region of South Aye Village in Khayan Township has more abundant availability of solar energy. According to most of results, South Aye Village in Khayan and Kyutawwa Village in Thongwa Townships are good regions for solar photovoltaic system because the average daily solar radiation intensity is more than 5 kWh/m^2. The amount of electricity generated from solar energy depends upon the available sunlight. In this research, 50 W off-grid solar system was used for lighting, mobile charging and battery charging.

People can see the applications everywhere in the life. Such as solar photovoltaic power plant, household solar photovoltaic power generation system, solar lights, solar cars and some other applications. Solar energy usage in Myanmar is still very low, but it is currently used to charge battery back-up systems for radio telephones, telephone switchboards, television relay stations, water pumping stations and solar freezers for hospitals in rural areas. Nowadays, even government is offering rebate and tax exemptions to those who install Solar Power in their home. In the most remote locations, solar energy is the ideal source of electricity.

Today's electricity supply in Myanmar is generated by fuel generators and hydroelectric power plants. However, far-flung areas which are away from National Grids cannot enjoy the electricity generated by these sources. The possible applications of the successful development of economic solar energy conversion to meet needs for mechanical or electrical energy are wide. Applications of solar power will require the substantial development of new technology.

People in South Aye Village of Khayan and Kyutawwa Villages of Thongwa Townships at Yangon Region believe that they are enjoying the development of the solar energy system. Since Myanmar is a land of plentiful sunshine, solar energy is available around the country. So, researchers have also been doing research concerning about solar cells in Myanmar. If so, everywhere away from National Grids can enjoy the electricity generated by solar energy. It is hoped that the data obtained from this research will be useful to generate electricity from solar energy in the studied areas.

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