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Fabricating Stationary Solar Power Generator

Rogelio Rambuyan
Technical Education and Skills Development Authority, Tuguenarao City, Philippines, rcrambuyan@tesda.gov.ph

ABSTRACT

Global warming and climate change is a phenomenon caused by electric power plant and other establishments using fossil fuel and other pollutants. Green Technology is one of the best solutions to solve the problem.

Technology Research and Innovations was introduced to support Green Technology, create green jobs and ultimately help protect the environment. The project will not only serve as an alternative source of power for the delivery of basic services in the office but also useful for household use with or without power failure.

This project examines the functionality of using the Stationary Solar Power Generator. This project was installed in Electrical Installation room of TESDA-RTC Tuguegarao City, Philippines. The study is important because it addresses the absence of electrical power. With the existing system, electrical room became brownout free and the power produced by the project was used by the office to operate computers, printers and charged gadgets during power interruptions.

Data for this study were gathered by testing its functionality, durability and efficiency. The findings suggest that the use of this project is more economical than using conventional generators and candle light. It is very useful during power interruption. Main conclusions from the study are: The project generates savings, environmental friendly and produces better alternative source of power. The main recommendations arising from this report are: The project can be innovated into portable solar power generator with higher load capacity.

Key words: Stationary Solar Power Generator, Solar Generator, Off Grid Solar Power Generator

1. INTRODUCTION

There is a need to establish an alternative source of energy to lessen the negative effect of gas emissions to the ozone layer resulting to global warming and climate change. Such phenomenon is happening because of air pollution caused by massive gas emission by various air pollutants. There is a need to reduce gas emissions to help protect and save our planet, and one of the solutions is to develop alternative source of energy by utilizing renewable energy like Photo Voltaic Systems or Solar Power Systems [6-14].

In 2008, the Philippine Government promulgated RA 9513 otherwise known as “Renewable Energy Act of 2008”, an act promoting the development, utilization and commercialization of renewable energy sources and for other purposes [4-5].

Using generators are expensive and even create a noisy environment and produces air pollution. Prices of fuel are increasing and the Regional Training Center (RTC) alone spends an average of P1,500.00 for the fuel of the generator set in one day. A small scale project, “Stationary Solar Power Generator” was conceptualized to solve the problem and support green technology. It utilizes PV Systems and use sun power as a source of electricity to be stored in a battery. Charging takes place at daytime where sunlight is not hindered by any materials that blocks sunlight to the Solar Panel [3, 13-14].

The research is focused on the fabrication and testing the functionality of the project and to determine the advantages of the Solar Power Generator against existing power generators using diesel and gasoline engines.

The project “Stationary Solar Power Generator” were assembled to provide alternative source of energy for office and home use especially during power failures. Lighting system used 12V DC to energize DC loads such as LED lights while inverter is used to energize AC loads. Initial investment appears expensive but more economical in the long run since there is no need to purchase fuel to operate the project.

SYSTEM DESCRIPTION

The block diagram shown in Fig. 1 shows the whole concept of Stationary Solar Power Generator. The PV modules capture photo voltaic power (Ppv) from the sun using two pieces of 100W PV Modules, series connected, for better voltage efficiency [1]. The quality of harness and conversion of solar energy is also dependent on the amount of sunlight radiated from the sun, cleanliness of the Solar Panel (should be free from dust), and free from any obstacle (shading) from sunlight to the solar panels [2]. The output of the PV modules is then fed to the input of the Solar Charge Controller with multiple power point tracking (MPPT) system to ensure the high quality of the electrical power system [1]. The system used Deep Cycle Storage Battery to store electrical energy. Several types of battery can be used but Lithium Ion battery has a better efficiency compared to other types of batteries [3]

The system is independent, (off-grid) not connected to power grid, and intended to replace generator sets using gasoline or diesel fuel engines. This is to ensure zero gas emission, cleaner air working environment, noise free, efficient and sustainable [3] especially during power interruptions and prolonged power failure caused by calamities like typhoon, earth quake, volcanic eruptions and other forms of calamities.

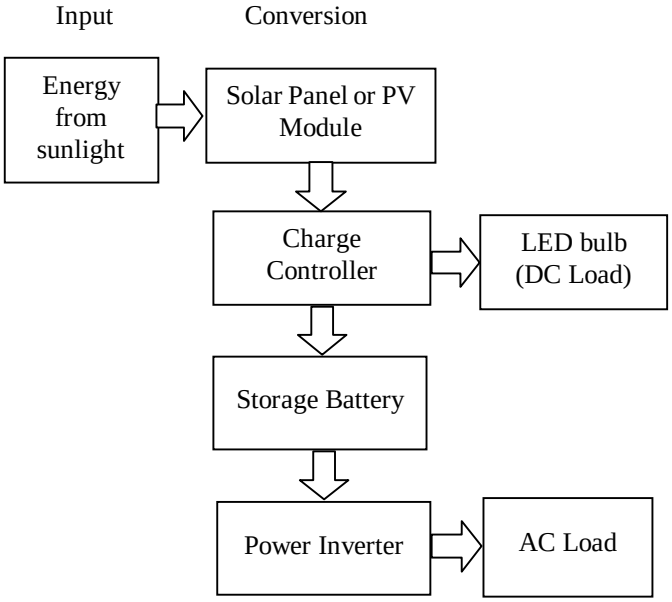

Figure 1: Block Diagram of the Stationary Solar Power Generator

PARTS AND SPECIFICATIONS

This project uses four sub systems component to complete the project. It uses two solar panel rated 17.6 volts, 100 watts, mono-crystalline type (Table 1), 30A PWM Charge controller (Table 2), Maintenance Free Lead Acid Battery (Table 3), and Power inverter (Table 4).

PV MODULES

The PV MODULE built-in diodes are connected to prevent discharging during the absence of sunlight (see Fig. 2). Each end of the wires is connected with a red (+) and black (-) terminals. The solar panel is mounted on fabricated steel frames made out of angle bar. (Fig. 3)

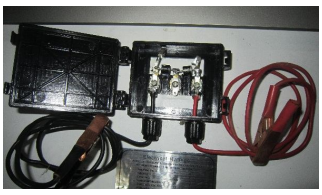

Figure 2: Solar Panel Terminals

Figure 3: Solar Panel Assembly

Table 1: Solar Panel Specifications

Maximum Power	**(Pmax)**	**100Wp +/-3%**
Maximum Power Voltage	(Vmp)	17.8V
Max. Power Current	(Imp)	5.56A
Open Circuit Voltage	(Voc)	22.14V
Short Circuit Current	(Isc)	5.92A
Maximum System Voltage	1000VDC	

CHARGE CONTROLLER

The charge controller and night switch is integrated in one circuit. It regulates the output voltage and the current from the solar panel going to battery for optimum charging. The charge controller automatically charges the lead acid battery (12V, 100Ah) during daytime and charging is best at bright sunlight with no clouds shadowing or any other object that hinders direct sunlight towards the solar panel.

Light will be switched on and off automatically during night time and daytime respectively. Number of operating hours may be set through the charge controller. Procedures on how to do it is indicated in the operation's manual. Use MPPT type of charge controller for more efficient charging capacity.

Figure 4: Charge Controller (PWM) replaced with MPPT.

Table 2: Charge Controller & Night Switch Specifications

Brand Name	**Description**	**Type**
Any Brand	Programmable ,	PWM or MPPT
	12V/24V	
	30A	

STORAGE BATTERY

The battery stores electrical energy for future consumption. The battery used in this project is 12V, 65Ah rechargeable lead acid battery (Fig. 5). Battery specifications are shown in Table 3. The battery was then replaced with 100Ah deep cycle battery for durability and larger load capacity.

Figure 5: Storage Battery (Lead Acid Battery)

Table 3: Battery specifications

Battery Type	Lead Acid, Maintenance Free Battery
Cycle Use	14.4V – 15.0V
Standby Use	13.5V – 13.8V
Rated Capacity	65Ah/20Hr

POWER INVERTER FOR AC LOAD

The power inverter (Figure 6) is used to operate AC load. The input voltage of the power inverter is 12V and the output voltage is 220VAC. Its capacity is based on its rated power. This project used 1500W power inverter with pure sine wave voltage output. Higher power rating for higher load capacity can also be used provided that load does not exceed 80% of the power rating of the inverter to avoid overloading which may result to system failure.

Figure 6: Power Inverter (Pure Sine Wave)

Table 4: Power Inverter Specifications

Power	1500W
Input Voltage	12V DC
Output Voltage	220V AC
Output Waveform	Pure Sign Wave
Frequency	60 Hz

LED BULB (DC LOAD)

The lights used in this project is a 12V LED bulb, 9W either connected in the load side of the solar charge controller circuit or directly taken from battery (Fig. 7) Red and black wires are connected to the positive and negative terminal of the bulb respectively. The LED lamp complete specifications are shown on Table 4.

Fig. 7: LED lamp (12V)

LOAD CAPACITY

The Solar Power Generator has the capacity of 200W PV Panel with Power Inverter capacity 1500W. Higher capacity inverter can also be used but the battery operation will be shorten.

Table 5: LED Lamp Specifications

Power	9W
Operating Voltage	12V
Max Current	750mA
Luminous flux	340LM to 765LM
Color Temperature	3500K to 6500K
Working Temperature	0ºC to 40ºC
Storage Temperature	-20ºC to 60ºC

GENERATED SAVINGS

Savings in 1 month = (P1,500.00 x 25 days = P37,500.00) when Tuguegarao was severely damaged by Super typhoon Lawin, leaving the place without power in more than one month. The same project was used intensively after the super typhoon Ompong. Generator set usually consumes gasoline expenses with a minimum of P1,500.00 in one day brown out. This project's initial investment is not expensive (P20,000.00) and more economical in the long run since it has no fuel consumption at all.

RESULTS AND FINDINGS

Before the full implementation of the project, a proto type of the four sub systems were assembled (solar panel, battery, LED Bulb, solar charge controller). The researcher performed several test and experimented the project's functionality and noted the following observations:

CHARGING CONDITIONS

1. Charging happens best during sunny days (Figure 8) from 9:00am -3:00pm. In this case, the battery is fully charged. (13.5V)
   - ➢ The battery charged on a sunny day can light the LED bulb (9W) efficiently for up to 12 hours.
   - ➢ AC Load, full load capacity can sustain 8 hours continues operation during sunny day, sufficient to operate at least 1 laptop / desktop computer, a printer and electric fan for a whole day operation in the office.

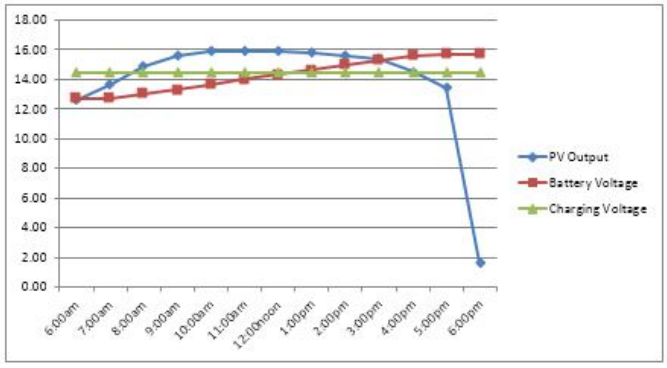

Figure 8: PV voltage and Battery voltage levels during normal sunlight (sunny day).

2. The battery is not fully charged (70% only) during cloudy or partly sunny day (Figure 9).
   - The battery charge on a cloudy day can light the led bulb (9W) efficiently for up to 8 hours.
   - Desktop/laptop computer and printer can operate up to 6 hours (minimize using electric fan)

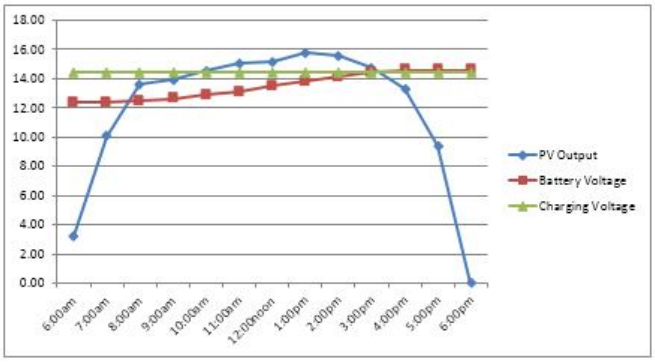

Figure 9: PV voltage and Battery voltage levels during cloudy day.

3. Charging did not happen during rainy days when there is a continuous rain (Figure 9). However, it was observed that the battery can be partially charged if the rain stops and there is intermittent sunlight.

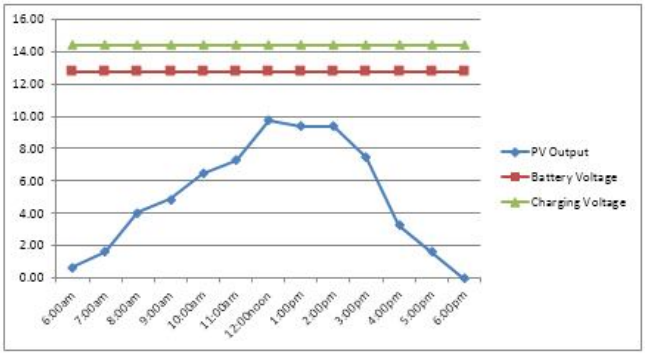

Figure 10: PV voltage and Battery voltage levels during rainy day.

The battery, charged on a cloudy day under intermittent sunlight condition can light the led bulb on a very limited time. In this case, stop using the system for the battery to recover its charging capacity. The table below shows the summary of charging observations in different variables. (Table 6)

Table 6: Charging Summary

Weather Condition:	Battery Charge Level After Test:
Sunny	Fully Charged
Cloudy	50% - 70% Charged
Rainy (no sunlight)	No charging happen

SUMMARY

This solar power generator is conceptualized because of frequent power interruption in the locality. The design is originally composed of 1 solar panel (100W), 30A solar charge controller (PWM), 56Ah battery and 500W power inverter. The project then has only very limited capacity. The researcher however decided to increase its capacity to accommodate more loads and more number of hours operation. The panel was increase to 200W (100W x 2 pcs.) for faster charging, while the power inverter was changed from 1500W to 3000W. The battery can also be changed from 65Ah to 100Ah. Use Deep Cycle battery instead of Lead Acid Battery for longer operation. In this case, the project cost also increased.

Charging is most affected during cloudy and rainy days which made charging difficult to reach its maximum charging for the battery. If the battery is not fully charge, it will be easily drain which caused the system not functional. The battery should be fully charge before use. To do this, the solar panel must be place to an open area for a direct sunlight. Make sure that the solar panel has no obstruction to hit from direct sunlight.

The connections of load for lighting circuit can be taken from Solar Charge Controller. In this case, operation of light may be set on user defined setting based on the need of the user. (Refer to manual for setting details). Use separate manual control switch for individual bulb. Use 12V LED Bulb only.

CONCLUSION

Solar Power generator is not to replace any existing power or electrical utility either at home or at the office. Rather, provides an alternative source of energy during power interruption instead of using generators with very expensive fuels. The project is sufficient to produce supply for an ideal household, class room and office use.

More reliable, sustainable and economical than using conventional power generators during power failure and during calamities. The project not only generates savings but also environmental friendly and produces better alternative source of power. The main recommendations arising from this study are: The project can be innovated into portable solar power generator with higher load capacity. Modifications, however, needs careful study on the charging system and loading capacity to avoid damage on the project. Any modifications should be specific and within the coverage of the Philippine Electrical Code (PEC) or similar electrical regulations for other countries. MPPT charge controller is more efficient to use than PWM charge controller.

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